

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

VIETNAM RAILWAYS (VR)

**STUDY FOR THE FORMULATION OF HIGH SPEED RAILWAY
PROJECTS ON HANOI – VINH AND HO CHI MINH – NHA TRANG
SECTION**

FINAL REPORT

TECHNICAL REPORT 3

**RESULT OF BASELINE SURVEY FOR ENVIRONMENTAL AND
SOCIAL CONSIDERATIONS**

June 2013

ALMEC CORPORATION

JAPAN INTERNATIONAL CONSULTANTS FOR TRANSPORTATION CO., LTD.

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PREFACE

In response to the request from the Government of the Socialist Republic of Vietnam, the Government of Japan decided to conduct the Study for the Formulation of High Speed Railway Projects on Hanoi – Vinh and Ho Chi Minh – Nha Trang Section and entrusted the program to the Japan International cooperation Agency (JICA).

JICA dispatched a team to Vietnam between April 2011 and June 2013, which was headed by Mr. IWATA Shizuo of ALMEC Corporation and consisted of ALMEC Corporation, Japan International Consultants for Transportation Co., Ltd., Oriental Consultants Co., Ltd., Nippon Koei Co., Ltd. and Japan Transportation Consultants, Inc.

In the cooperation with the Vietnamese Counterpart Team including the Ministry of Transport and Vietnam Railways, the JICA Study Team conducted the study which includes traffic demand analysis, natural and socio-economic conditions, alignment planning, consideration of various options including the upgrading of existing railway, technical standards for high speed railway, implementation schedule and institutions, and human resource development. It also held a series of discussions with the relevant officials of the Government of Vietnam. Upon returning to Japan, the Team duly finalized the study and delivered this report in June 2013.

Reflecting on the history of railway development in Japan, it is noted that Japan has indeed a great deal of experience in the planning, construction, operation, etc., and it is deemed that such experiences will greatly contribute to the railway development in Vietnam. JICA is willing to provide further cooperation to Vietnam to achieve sustainable development of railway sector and to enhance friendly relationship between the two countries.

It is hoped that this report will contribute to the sustainable development of transport system in Vietnam and to the enhancement of friendly relations between the two countries.

Finally, I wish to express my sincere appreciation to the officials of the Government of Vietnam for their close cooperation.

June 2013

Kazuki Miura
Director, Economic Infrastructure Department
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TABLE OF CONTENTS

1	INTRODUCTION	1-1
1.1	Outline of Baseline Survey for Environmental and Social Considerations	1-1
1.2	Collected Information and Results of Baseline Survey	1-3
2	NORTH SECTION	2-1
2.1	Natural Environment	2-1
2.1.1	Topography and Geographical Features	2-1
2.1.2	Soil Erosion	2-5
2.1.3	Groundwater.....	2-10
2.1.4	Protected Areas.....	2-21
2.1.5	Landscape.....	2-23
2.1.6	Forest	2-24
2.1.7	Biodiversity	2-24
2.1.8	Flora and Fauna.....	2-57
2.1.9	Natural Hazards	2-91
2.2	Living Environment.....	2-118
2.2.1	Air Quality.....	2-118
2.2.2	Surface Water Quality	2-119
2.2.3	Groundwater Quality	2-121
2.2.4	Soil	2-122
2.2.5	Noise	2-123
2.2.6	Vibration	2-129
2.2.7	Solid Waste	2-129
2.3	Social Environment	2-130
2.3.1	Land Use and Demography	2-130
2.3.2	Land Acquisition and Compensation	2-155
2.3.3	Socio Economic Condition	2-157
2.3.4	Cultural and Historical Heritages.....	2-158
2.3.5	Public Health	2-159
2.3.6	Vulnerable Groups	2-159
2.4	Others	2-165
2.4.1	Climate Change	2-165
3	SOUTH SECTION	3-1
3.1	Natural Environment	3-1
3.1.1	Topography and Geographical Features	3-1
3.1.2	Soil Erosion	3-7
3.1.3	Groundwater.....	3-11
3.1.4	Protected Areas.....	3-29
3.1.5	Landscape.....	3-34
3.1.6	Forest	3-34
3.1.7	Biodiversity	3-39
3.1.8	Flora and Fauna.....	3-64
3.1.9	Natural Hazards	3-95

3.2	Living Environment.....	3-131
3.2.1	Air Quality.....	3-131
3.2.2	Surface Water Quality	3-132
3.2.3	Groundwater Quality	3-134
3.2.4	Soil	3-135
3.2.5	Noise	3-136
3.2.6	Vibration	3-137
3.2.7	Solid Waste	3-137
3.3	Social Environment	3-138
3.3.1	Land Use and Demography	3-138
3.3.2	Land Acquisition and Compensation	3-152
3.3.3	Socio economic condition	3-152
3.3.4	Cultural and Historical Heritages.....	3-154
3.3.5	Public Health	3-155
3.3.6	Vulnerable Groups	3-157
3.4	Others	3-161
3.4.1	Climate Change	3-161

LIST OF TABLES

Table 1.1.1	Utilization of Information Collected in Baseline Survey.....	1-1
Table 1.2.1	Result of Collection of Major Information Sources	1-3
Table 1.2.2	The Result of Information Collection by Questionnaire (Natural Environment)	1-3
Table 1.2.3	The Result of Information Collection by Questionnaire (Living Environment).....	1-4
Table 1.2.4	The Result of Information Collection by Questionnaire (Social Environment)	1-4
Table 1.2.5	The Result of Information Collection by Questionnaire (Others).....	1-4
Table 2.1.1	Topography and Geographical Features.....	2-1
Table 2.1.2	Characteristics of Soil Erosion at Each Province	2-6
Table 2.1.3	Characteristics of Groundwater at Each Province	2-10
Table 2.1.4	Average Water Exploitation Volume in 2008 in Main Wells	2-13
Table 2.1.5	Summarization on Ha Nam's Groundwater Aquifers	2-16
Table 2.1.6	Ground Water Reserves in Certain Places in Thanh Hoa.....	2-18
Table 2.1.7	Summary on the Groundwater-Monitored Locations	2-19
Table 2.1.8	Potentially Exploitable Groundwater Reserve of Nghe An.....	2-19
Table 2.1.9	Summary on the Wells Supplying Water for agriculture.....	2-20
Table 2.1.10	Domestic Water Usage Situation of the Rural Areas in Nghe An Province.....	2-21
Table 2.1.11	Special-Use Forest at Each Province	2-21
Table 2.1.12	Wetland Sites of Biodiversity and Environmental Value in Vietnam.....	2-22
Table 2.1.13	Marine Protected Areas at Each Province	2-22
Table 2.1.14	Protected Areas by International Treaty/Agreement at Each province.....	2-23
Table 2.1.15	Other Important Areas to be Concerned.....	2-23
Table 2.1.16	Chalacteristics of Landscape at Each Province.....	2-24
Table 2.1.17	Forest Area by Type.....	2-24
Table 2.1.18	Charateristics of Biodiversity at Each Province	2-25
Table 2.1.19	Current Forest Area by Forest Type	2-32
Table 2.1.20	Production Volume of Plants in Nam Dinh Province.....	2-33
Table 2.1.21	Quantity of Poultry and Cattle in Nam Dinh Province	2-33
Table 2.1.22	Production Volume of Aquaculture at Nam Dinh Province	2-34
Table 2.1.23	Area of Mangrove Land.....	2-50
Table 2.1.24	Changes in the Area of Protection Forest, Mangrove Forest and Coastal Planted Forest.....	2-51
Table 2.1.25	Characteristics of Flora and Fauna.....	2-57
Table 2.1.26	The Biodiversity of Creatural Species of Hanoi	2-64
Table 2.1.27	Endangered Species in Hanoi City (Flora).....	2-66
Table 2.1.28	Endangered Species in Hanoi City (Fauna)	2-67
Table 2.1.29	Endangered Species in Ha Nam Province (Flora).....	2-69
Table 2.1.30	Endangered Species in Ha Nam Province (Fauna).....	2-70
Table 2.1.31	High-Level Flora in Xuan Thuy National Park.....	2-70
Table 2.1.32	Endangered Species in Ninh Binh Province (Flora)	2-78
Table 2.1.33	Endangered Species in Ninh Binh Province (Fauna)	2-80
Table 2.1.34	Flora and Fauna inat the Specia -Use Forests in Thanh Hoa Province	2-84
Table 2.1.35	Endangered Species in Thanh Hoa Province (Flora)	2-84

Table 2.1.36	Endangered Species in Thanh Hoa Province (Fauna)	2-85
Table 2.1.37	Endangered Species in Nghe An Province (Flora)	2-88
Table 2.1.38	Endangered Species in Nghe An Province (Fauna)	2-89
Table 2.1.39	Characteristics of Natural Hazards at Each Province	2-91
Table 2.1.40	Characteristics of Flood at Each Province	2-96
Table 2.1.41	Summary of the Recorded Rainfall in Hanoi in 2008	2-98
Table 2.1.42	List of 25 Points / Locations Exposed to Flooding in Hanoi	2-99
Table 2.1.43	Affected Waterlogged Areas	2-101
Table 2.1.44	Characteristics of Landslide at Each Province	2-106
Table 2.1.45	Characteristics of Typhoon at Each Province	2-109
Table 2.1.46	Number of Typhoons Hit Nam Dinh Province	2-111
Table 2.1.47	Other Hazards at Each Province	2-113
Table 2.1.48	List of Damages by Environmental Incidents	2-114
Table 2.1.49	Burnt Forest Areas, 2005–2009	2-115
Table 2.2.1	Air Quality Monitoring System at Each Province	2-118
Table 2.2.2	Typical Result of Air Quality at Each Province	2-119
Table 2.2.3	Surface Water Quality Monitoring System at Each Province	2-119
Table 2.2.4	Typical Result of Surface Water Quality at Each Province	2-121
Table 2.2.5	Groundwater Quality Monitoring System at Each Province	2-121
Table 2.2.6	Typical Result of Groundwater Quality at Each Province	2-122
Table 2.2.7	Soil Monitoring System at Each Province	2-122
Table 2.2.8	Typical Result of Soil Quality at Each province	2-123
Table 2.2.9	Noise Monitoring System at Each Province	2-123
Table 2.2.10	Typical Result of Noise Monitoring	2-124
Table 2.2.11	Noise Level at Lim Bridge Crossroad- Ninh Binh City (from 06h-22h)	2-126
Table 2.2.12	Noise Level at T-junction of Chieu Market- Tam Diep Town (from 06h-22h)	2-126
Table 2.2.13	Noise Level at Towns (6h – 22h)	2-126
Table 2.2.14	Final Disposal Sites at Each Province	2-129
Table 2.3.1	Land-Use and Demography at Each Province	2-130
Table 2.3.2	Demographic Information at Each Province	2-131
Table 2.3.3	Land Structure Based on Main Use Purposes	2-133
Table 2.3.4	Structure of Agricultural Land and Housing Land	2-133
Table 2.3.5	Structure of Forestry Land in Soc Son District	2-133
Table 2.3.6	Structure of Unused land, Rivers, Springs, Rock Mountains	2-134
Table 2.3.7	Hanoi Land Categories	2-134
Table 2.3.8	Agricultural Land Use Situation as of 2009	2-147
Table 2.3.9	Non-Agricultural Land Situation	2-149
Table 2.3.10	The Land-Use Area Change by-Year	2-154
Table 2.3.11	Relavant Laws and Regulations on Land Acquisition and Compensation	2-155
Table 2.3.12	Percentage of Households having House by Type of House and Province	2-157
Table 2.3.13	Living Area per capital by Type of House and Province (Unit: m2)	2-157
Table 2.3.14	Durable goods per 100 households by region	2-157
Table 2.3.15	Illiterate Rate (over 15 year old)	2-158
Table 2.3.16	Cultural and Historical Heritages at Each Province	2-158

Table 2.3.17	Public Health at Each Province.....	2-159
Table 2.3.18	Gender and Ethnic Minority at Each Province	2-159
Table 2.3.19	Ethnic Distribution at Hanoi City	2-161
Table 2.3.20	Ethnic Distribution at Ha Nam Province.....	2-161
Table 2.3.21	Ethnic Distribution at Nam Dinh Province.....	2-162
Table 2.3.22	Ethnic Distribution at Ninh Binh Province	2-162
Table 2.3.23	Ethnic Distribution at Thanh Hoa Province	2-163
Table 2.3.24	Ethnic Distribution at Nghe An Province	2-164
Table 2.3.25	Poverty Rate by Province.....	2-164
Table 2.4.1	Climate Change at Each Province	2-165
Table 2.4.2	Loading Amount of Gas Emission in Recent Years and in the Future.....	2-167
Table 2.4.3	The Salinity Monitored at Some Locations along Three Major Rivers of Nam Dinh	2-168
Table 2.4.4	Changes in Mining and Construction Material Production, Paper Production in Recent Years.....	2-170
Table 2.4.5	Thanh Hoa Population, 2006–2009.....	2-171
Table 3.1.1	Topography and Geographical Features at Each Province	3-1
Table 3.1.2	Soil Erosion Data at Each Province	3-7
Table 3.1.3	Possible Land Slide and Erosion Places in HCMC	3-9
Table 3.1.4	Ground Water Data at Each Province	3-11
Table 3.1.5	Groundwater Reserves of Khanh Hoa	3-13
Table 3.1.6	Result of Analyzing Water Samples in Khanh Hoa	3-15
Table 3.1.7	Monitoring Result of Cyanua Content in Khanh Hoa	3-17
Table 3.1.8	Underground Water Reserve	3-17
Table 3.1.9	Special-Use Forest Area by Province	3-29
Table 3.1.10	Fauna Species in Cat Tien National Park.....	3-29
Table 3.1.11	Landuse in Nui Chua National Park.....	3-31
Table 3.1.12	Wetland Reserves.....	3-31
Table 3.1.13	Marine Protected Areas	3-32
Table 3.1.14	Khanh Hoa Mangrove Forest Area	3-32
Table 3.1.15	Seagrass Area, No of Seaweed Species in Khanh Hoa.....	3-33
Table 3.1.16	Protected Areas by International Treaty	3-33
Table 3.1.17	Other Important Areas of Concern.....	3-34
Table 3.1.18	Landscape.....	3-34
Table 3.1.19	Forest Area by Type.....	3-35
Table 3.1.20	Forest Cover Changes in Khanh Hoa	3-35
Table 3.1.21	Indicators of Forestry Development	3-37
Table 3.1.22	The Change of Forest Area by-Year (2000 to 2005 to 2009)	3-38
Table 3.1.23	Characteristics on Biodiversity at Each Province	3-39
Table 3.1.24	List of Protected Areas in Binh Thuan Province	3-52
Table 3.1.25	Fauna and Flora Species in Can Gio Submerged Zone (Excluding Small Invertebrate Fauna Species)	3-63
Table 3.1.26	Charateristics of Flora and Fauna at Each Province	3-64
Table 3.1.27	Species Diversity of Coral Reefs and Sea Grass in Khanh Hoa Seas.....	3-65

Table 3.1.28	Endangered Species in Khanh Hoa Province (Flora)	3-67
Table 3.1.29	Endangered Species in Khanh Hoa Province (Fauna)	3-69
Table 3.1.30	Flora Sectors–Nui Chua National Park	3-71
Table 3.1.31	Fauna group – Nui Chua National Park	3-72
Table 3.1.32	Floral group in Phuoc Binh Natural Reserves	3-73
Table 3.1.33	Fauna group in Phuoc Binh Natural Reserves	3-73
Table 3.1.34	Endangered Species in Ninh Thuan Province (Flora)	3-74
Table 3.1.35	Endangered Species in Ninh Thuan Province (Fauna)	3-75
Table 3.1.36	Endangered Species in Binh Thuan Province (Flora).....	3-77
Table 3.1.37	Endangered Species in Binh Thuan Province (Fauna).....	3-78
Table 3.1.38	List of Endemic Species	3-83
Table 3.1.39	Endangered Species in Dong Nai Province (Flora)	3-84
Table 3.1.40	Endangered Species in Dong Nai Province (Fauna)	3-85
Table 3.1.41	Fauna and Flora Species in HCMC (excluding small invertebrate fauna species)..	3-87
Table 3.1.42	Rare and Precious Fish Species in Can Gio Mangrove Forest	3-89
Table 3.1.43	Endangered Species in HCMC (Flora)	3-93
Table 3.1.44	Endangered Species in HCMC (Fauna)	3-93
Table 3.1.45	Characteristics of Natural Hazards at Each Province	3-95
Table 3.1.46	Statistics on the Damage caused by Natural Disasters in Ninh Thuan Province in the Period from 2006–2010	3-97
Table 3.1.47	Characteristics of Flood at Each Province	3-101
Table 3.1.48	Alarm Level of Flood in Khanh Hoa Province	3-102
Table 3.1.49	Characteristics of Landslide at Each Province	3-108
Table 3.1.50	Some Typical Locations of Red-land Erosion and Sediment Flood in Phan Thiet City and Suburban Areas.....	3-110
Table 3.1.51	Some Major Causes of Landslide along Shoreline of Southern Central Region ...	3-111
Table 3.1.52	List of Landslide Damage in HCMC from 2006-2011	3-114
Table 3.1.53	Characteristics of Typhoon at Each Province	3-115
Table 3.1.54	Damage Caused by Storms and Rains in the Period 2006–2009	3-116
Table 3.1.55	The Quantity of Typhoons and Tropical Depressions Developing on East Sea in 2010	3-117
Table 3.1.56	Other Hazards at Each Province	3-120
Table 3.1.57	Oil Spills in HCMC, 2005-2009	3-130
Table 3.2.1	Monitoring System of Air Quality at Each province	3-131
Table 3.2.2	Typical Result of Air Quality	3-132
Table 3.2.3	Monitoring System of Surface Water Quality at Each Province	3-133
Table 3.2.4	Typical Result of Surface Water Quality.....	3-134
Table 3.2.5	Monitoring System of Groundwater Quality at Each Province	3-134
Table 3.2.6	Typical Result of Ground Water Quality at Each Province.....	3-135
Table 3.2.7	Monitoring System.....	3-135
Table 3.2.8	Typical Result of Soil Quality at Each Province	3-135
Table 3.2.9	Monitoring System of Noise at Each Province	3-136
Table 3.2.10	Typical Result of Noise Monitoring	3-137
Table 3.2.11	Final Disposal Sites at Each Province	3-137

Table 3.3.1	Land Use and Demography at Each Province	3-138
Table 3.3.2	Natural Land Divided according to Land Use Purposes and Land Types in Khanh Hoa Province.....	3-139
Table 3.3.3	Land Use in Ninh Thuan Province.....	3-141
Table 3.3.4	Natural Land Area of City/Districts in Ninh Thuan Province.....	3-142
Table 3.3.5	The Current Situation of the Land using in Binh Thuan	3-143
Table 3.3.6	Land Use Situation of 2010	3-148
Table 3.3.7	Landuse Inventory by Year in HCMC.....	3-149
Table 3.3.8	Land use Plan and Statistical Data of HCMC (ha)	3-150
Table 3.3.9	Relavant Laws and Regulations on Land Acquisition and Compensation.....	3-152
Table 3.3.10	Percentage of Households having House by Type of House and Province	3-153
Table 3.3.11	Living Area per capital by Type of House and Province	3-153
Table 3.3.12	Durable goods per 100 households by region	3-153
Table 3.3.13	Illiterate Rate (over 15 year old).....	3-153
Table 3.3.14	Cultural and Historical Heritages at Each Province.....	3-154
Table 3.3.15	Public Health at Each Province.....	3-155
Table 3.3.16	Gender and Ethnic Minority at Each Province	3-157
Table 3.3.17	Ethnic Distribution at Khanh Hoa Province	3-158
Table 3.3.18	Ethnic Distribution at Ninh Thuan Province	3-158
Table 3.3.19	Ethnic Distribution at Binh Thuan Province.....	3-159
Table 3.3.20	Ethnic Distribution at Dong Nai Province	3-159
Table 3.3.21	Ethnic Distribution at HCMC	3-160
Table 3.3.22	Poverty Rate by Province at Each Province	3-161
Table 3.4.1	Characteristics of Climate Change at Each Province	3-161

LIST OF FIGURES

Figure 2.1.1	Water Exploitation of Underground Water in Hanoi City	2-13
Figure 2.1.2	Resource Exploration on River (site photo).....	2-50
Figure 2.1.3	Illegal Hunting.....	2-52
Figure 2.2.1	Noise Level (Lmax) in 2010 at Some Key Intersections at 6-8h	2-127
Figure 2.2.2	Noise Level (Lmax) in 2010 at Some Key Intersections at 22-24h	2-127
Figure 2.2.3	Noise Level (Lmax) in 2010 at Residential Area Near Industrial Zone at 22-24h..	2-128
Figure 2.2.4	Noise Level (Lmax) in 2010 at Residential Concentratdion on 6-8h	2-128
Figure 2.3.1	Land Use (2005).....	2-146
Figure 2.3.2	Land Use (2009).....	2-146
Figure 2.3.3	Land-Use Change by Type in Period 2006–2009	2-155
Figure 2.4.1	Average Water Levels in Duong River during the period 2005–2010.....	2-166
Figure 3.1.1	Coliform Value in Well Water	3-16
Figure 3.1.2	Map of Saline Groundwater in Van Ninh Area	3-18
Figure 3.1.3	Map of Saline Groundwater Sub-Zone in Ninh Hoa.....	3-19
Figure 3.1.4	Map of Saline Groundwater Sub-zone in Nha Trang	3-19
Figure 3.1.5	Map of Saline Groundwater Sub-Zone in Cam Ranh.....	3-20
Figure 3.3.1	Percentage of Natural Land according to Land Types.....	3-139

Figure 3.3.2 Land Use Structure.....	3-140
Figure 3.3.3 Khanh Hoa Land Use Structure	3-140

ABBREVIATIONS

5ECSR	Five-year environmental current status report
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nation
CBD	Convention on Biodiversity
CFC	Chlorofluorocarbon
CITES	Convention on the Trade in Endangered Species
COD	Chemical Oxygen Demand
CPC	City People's Committee
DARD	Department of Agriculture and Rural Development
DFSC	Department on Flood and Storm Control
DOC	Department of Construction
DOCST	Department of Culture, Sport and Tourism
DOH	Department of Health
DONRE	Department of Natural Resources and Environment
DOST	Department of Science and Technology
DOT	Department of Transport
EBA	Endemic Bird Area
EIA	Environmental Impact Assessment
EN	Endangered
EPSD	Environment Public Security Department
EZ	Economic zone
FLA	Forest land allocation
FPD	Forest Protection Department
FS	feasibility study
FSCC	Flood and Storm Control Committee
FZS	Frankfurt Zoological Society
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMO	Genetically Modified Organism
Ha	Hectare
HAZOP	Hazard and Operability Study
HCMC	Ho Chi Minh City
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome
HSR	high speed railway
IBA	important bird area
IDRMP	Integrated Disaster and Risk Management Project
IEE	Initial Environmental Examination
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
IZ	Industrial Zone
JICA	Japan International Cooperation Agency
JSC	Joint Stock Company
KDC	Residential area
Km	kilometer
KOICA	Korea International Cooperation Agency
LP	landscape protection area
LTIA	Long Thanh International Airport
LURRO	Land-use Right Registration Office
MARD	Ministry of Agriculture and Rural Development
mm	Millimeter
MND	Ministry of National Defense
MOC	Ministry of Construction
MOCST	Ministry of Culture, Sport and Tourism
MOH	Ministry of Health
MOLISA	Ministry of Labor, Invalid and Social Affairs

MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MOT	Ministry of Transport
MPA	Marine Protected Area
MPS	Ministry of Public Security
MST	Ministry of Science and Technology
MTI	Ministry of Trade and Industry
NBR	Natural Biosphere Reserve
NP	National Park
NR	Nature Reserve
NUFU	National Urban Forestry Unit
NGO	Non-governmental Organization
NH	National Highway
PPC	Provincial People's Committee
PR	Provincial road
Pre-FS	Pre-feasibility Study
QCVN	Vietnam Technical regulations
SEA	Strategic Environmental Assessment
SEDP	Socio-Economic Development Plan
SFEZ	South Focal Economic Zone
SP	Species/habitat Conservation Area
sp./spp.	Species
TCVN	Vietnam standards
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCC	United Nations Framework Convention on Climate Change
UNICEF	United Nations Children's Fund
VEPA	Vietnam Environment Protection Agency
VII	Vietnam Irrigation Institute
VITRANSS2	The Comprehensive Study on the Sustainable Development of Transport System in Vietnam
VND	Vietnam Dong
VR	Vietnam Railways
WB	World Bank

1 INTRODUCTION

1.1 Outline of Baseline Survey for Environmental and Social Considerations

1.1 Baseline survey was conducted in order to collect secondary data regarding environmental and social conditions of the cities/provinces along the alignment as the part of the IEE Study. The data was utilized for alignment and station location planning, comparing alternatives to select optimal one, and preparation of provisional scoping, mitigation measures, monitoring methodologies and technical requirements for EIA in the future. The baseline information was collected through following methodologies.

- (a) **Review of Existing Studies:** The environmental and social consideration studies of the existing study on HSR, namely KOICA Study (2007), Pre-FS Study by Vietnam Railways (2009), and VITRANSS2 by JICA (2010), were reviewed. In addition, EIA studies especially for transportation sector (railways, roads etc) were reviewed to confirm the actual practice of EIA in Vietnam.
- (b) **Secondary Information Collection:** By sending questionnaires to the cities/provinces of the target priority sections and visiting the government offices, secondary information was collected.
- (c) **Conduct of Field Reconnaissance:** Along the potential alignment, field reconnaissance was conducted to set the alternative alignment and station locations. Additional field reconnaissance was conducted on the selected optimal alternative especially to collect the information on sensitive areas.
- (d) **Preparation of Environmental Sensitivity Map:** From the collected information, the spatial information which can be utilized for the alignment planning was extracted and summarized as environmental sensitivity maps. More detail on the environmental sensitivity maps is discussed in Technical Report No.4 Environmental Sensitivity Map.

1.2 The utilization of the information collected through the baseline survey was summarized in Table 1.1.1.

Table 1.1.1 Utilization of Information Collected in Baseline Survey

Collected Information Items	Utilization of Information				
	Environmental Sensitivity Map	Setting Alternatives	Comparative Analysis of Alternatives	Provisional Scoping	Provisional Study on Mitigation / Monitoring / ToR for EIA
1.Climate and Meteorological Phenomena			✓	✓	✓
2.Topography	✓	✓	✓	✓	✓
3.Geology	✓	✓	✓	✓	✓
4.Soil Erosion	✓	✓	✓		✓
5.Hydrology			✓		✓
6.Ground water			✓	✓	✓
7.Ecosystem/Flora and Fauna/Biodiversity		(✓/8)	(✓/8)	✓	✓
8.Protected Area/Forest	✓	✓	✓	✓	✓
9.Coastal Zone				✓	✓
10.Landscape		(✓/8)	(✓/8)	✓	✓
11.Natural Disaster	✓			✓	✓

Collected Information Items	Utilization of Information				
	Environmental Sensitivity Map	Setting Alternatives	Comparative Analysis of Alternatives	Provisional Scoping	Provisional Study on Mitigation / Monitoring / ToR for EIA
12. Air quality			✓	✓	✓
13. Offensive Odor					
14. Water quality				✓	✓
15. Bottom sediment					
16. Soil quality				✓	✓
17. Ground Subsidence					
18. Noise/Vibration		(✓/25)	✓	✓	✓
19. Low frequency noise		(✓/25)		✓	✓
20. Wave obstruction		(✓/25)		✓	✓
21. Disturbance of sunshine		(✓/25)		✓	✓
22. Solid waste				✓	✓
23. Land use	✓	✓	✓	✓	✓
24. City /Regional Development Plan		✓	✓	✓	✓
25. Urban area/settlement	✓	✓	✓	✓	✓
26. Regional Economy			✓	✓	✓
27. Livelihood				✓	✓
28. Cultural and Historical Heritage/Assets	✓	✓	✓	✓	✓
29. Vulnerable Groups (Ethnic minorities/Indigenous peoples)	✓	✓	✓	✓	✓
30. Public Health				✓	✓
31. Accidents				✓	✓
32. Climate Change		(✓/2)		✓	✓

Note: ✓: Considered item, (✓/number): Considered item together with some other item of that number (for example, "landscape" was considered as protected areas (number 8) in the comparison of alternatives
 Source: JICA Study Team

1.2 Collected Information and Results of Baseline Survey

1.3 The secondary information was collected through the questionnaire survey, interview survey of local governments, and literature survey including Internet search.

1.4 The secondary information sources evaluated most useful among others are “Five Year Environmental Current Status Report (5ECSR)” and “Landuse Map” and the collected result is in Table 1.2.1 as follows. The result of information collection through questionnaires are summarized in Table 1.2.2 (natural environment), Table 1.2.3 (living environment), Table 1.2.4 (social environment), and Table 1.2.5 (others).

Table 1.2.1 Result of Collection of Major Information Sources

Kind of Information	No of Submitted Provinces	Description
5ECSR	11	9 provinces submitted 5ECSR which contains substantial information. 1 province submitted 5ECSR which does not contain much information (especially lack in monitoring data). 1 province submitted the annual environmental report in 2010.
Land Use Map	11	All provinces submitted the current landuse map or landuse planning map. But features of the map namely the year of the data preparation, scale of map, and type of map (current/plan) are different from province to province. Detail is in Technial Report No.4 on Environmental Sensitivity Map.

Source: JICA Study Team

Table 1.2.2 The Result of Information Collection by Questionnaire (Natural Environment)

Item	General Findings from Collected Information
1-1 Climate and Meteorological Phenomena	<ul style="list-style-type: none"> All provinces follow national standard. Monitoring record is provided by 9 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).
1-2 Soil Erosion	<ul style="list-style-type: none"> All provinces follow national standard. Monitoring record is provided by 9 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).
1-3 Hydrology	<ul style="list-style-type: none">
1-4 Ground Water	<ul style="list-style-type: none"> All provinces follow national standard. Monitoring record is provided by 9 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).
1-5 Protected Species (flora, fauna and aquatic fauna)	<ul style="list-style-type: none"> The list of protected species in the protected areas was provided by 11.
1-6 Protected Area and Forest	<ul style="list-style-type: none"> The list of protected areas and forest area information is provided by 5 provinces. Protected area and forest area can be extracted from landuse map.
1-7 Landscape	<ul style="list-style-type: none"> Not much information was provided except for the landscape protection areas (This is the part of 1-12 protected areas)
1-8 Hazard: Floods	<ul style="list-style-type: none"> Hazard maps are collected from 2 provinces. The flood record for recent few years is provided by 10 provinces.
1-9 Hazard: Landslides	<ul style="list-style-type: none"> Hazard maps are collected from 2 provinces. The landslide record for recent few years is provided by 2 provinces.
1-10 Hazard: Typhoons	<ul style="list-style-type: none"> The typhoon record for recent few years is provided by 11 provinces.
1-11 Hazard: Other natural hazard	<ul style="list-style-type: none"> The other natural hazard information such as oil spill is provided by 11 provinces.

Source: JICA Study Team

Table 1.2.3 The Result of Information Collection by Questionnaire (Living Environment)

Item	General Findings from Collected Information
2-1 Air Quality	<ul style="list-style-type: none"> All provinces follow national standard. Monitoring record is provided by 9 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).
2-2 Water Quality	<ul style="list-style-type: none"> All provinces follow national standard. Monitoring record is provided by 9 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).
2-3 Soil Contamination	<ul style="list-style-type: none"> All provinces follow national standard. Monitoring record is provided by 9 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).
2-4 Noise	<ul style="list-style-type: none"> All provinces follow national standard. Monitoring record is provided by 9 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).
2-5 Vibration	<ul style="list-style-type: none"> All Provinces follow national standard. No information is provided by provinces.
2-6 Low Frequency Noise	<ul style="list-style-type: none"> There is no regulation, standard or related information.
2-7 Solid Waste	<ul style="list-style-type: none"> Related information is provided by 10 provinces (5ECSR) and some partial information by 2 provinces (related environmental report).

Source: JICA Study Team

Table 1.2.4 The Result of Information Collection by Questionnaire (Social Environment)

Item	Target Area
3-1 Land Use	<ul style="list-style-type: none"> Landuse information is provided from all provinces (year/accuracy is different)
3-2 Compensation for Involuntary Resettlement	<ul style="list-style-type: none"> 11 provinces provided the provincial regulations. Official rate of land is provided from 11 provinces
3-3 Public Facilities	<ul style="list-style-type: none"> Limited data is provided from provinces on hospital and schools (02 provinces provided the names of several major public buildings located in the province) Landuse map information have religious facility, graves, and pagodas
3-4 Cultural Heritages	<ul style="list-style-type: none"> List of cultural heritages is provided by 7 provinces. Location map is not available.
3-5 Vulnerable Groups (incl. ethnic minorities)	<ul style="list-style-type: none"> Census information on ethnic population by communes of all provinces.
3-6 Public Health	<ul style="list-style-type: none"> Limited information is provided by 5 provinces.

Source: JICA Study Team

Table 1.2.5 The Result of Information Collection by Questionnaire (Others)

Item	Target Area
4-1 Climate Change	<ul style="list-style-type: none"> Climate change issues including global warming, change in rainfall and typhoon were collected as environmental reports of cities/provinces

Source: JICA Study Team

2 NORTH SECTION

2.1 Natural Environment

2.1.1 Topography and Geographical Features

2.1 Generally, most of provinces are located in North and Central Delta with flat, coastal mountainous terrains in the north section. Particularly, each province possesses its typical characteristics as described in detail below.

Table 2.1.1 Topography and Geographical Features

Province/City	Available Documents	Description
Ha Noi	5ECSR of Hanoi City period 2006-2010, Chapter 1: Natural Conditions.	Hanoi's topography slopes down gradually to the direction of north-to-south and west-to-east; the average height is 5 to 20 m higher than the sea-level.
Ha Nam	Annual Environmental Status Report in 2010, Chapter 1, 1.1 Natural Conditions.	Topography of Ha Nam can be divided into limestone mountains, low hills and plain area. Most of the eastern part of the province falls into the plain area.
Nam Dinh	5ECSR period 2005- 2009, Chapter 1 Overview on Natural Condition.	Almost all area of the province is flat and can be divided into plain area and coastal area.
Ninh Binh	5ECSR of Ninh Binh City period 2005-2009, Chapter 1 Overview on Natural Conditions.	Ninh Binh can be divided into three zones: mountainous (30%), central plain (40%), and coastal (30%).
Thanh Hoa	5ECSR period 2006- 2010, Chapter 1 Overview of the Natural Conditions of Thanh Hoa Province.	Thanh Hoa also shows the common features of Vietnam terrain which is a downward gradient from Northwest to Southeast and has three main types of terrains: mountains, midlands and coastal plains
Nghe An	5ECSR period 2005- 2009, Chapter 2 Overall on Nghe An Natural and socio-economic Conditions.	Nghe An is located at the eastnorth of Truong Son mountain range. The provincial terrain is complicated diversity; It is divided with the system of rivers, springs, streams, mountains and hills

Source: JICA Study Team

1) Topography and Geographical Features of Hanoi City

2.2 In accordance with 5ECSR Period 2006-2010 (DONRE), topography and geographical features of Hanoi City is summarized as follows:

- (a) **Topography:** Hanoi's topography slope down gradually to the direction of north-to-south and west-to-east; the average height is 5 to 20 m higher than the sea-level. The major terrain of Hanoi is plain (covering three-quarter of Hanoi's natural area) which is raised with the alluvium from rivers to form the modern alluvial-grounds and the high plains at the right of Da River. Along Hong river, there are tributaries of other rivers, lowlands, lagoons and ponds. The river terraces are distributed only in Soc Son district, and the northern area of Dong Anh district. In addition, Hanoi has the terrain samples of erosion hills and mountains which are majorly gathered in the hilly – mountainous area of Soc Son district.

2.3 The mountainous and hilly area is distributed mainly in the districts as Ba Vi, Soc Son, Quoc Oai, My Duc. Ba Vi Mountain has 1,281 m of height, Gia De Mountain has 707 m of height, Chan Chim has 462 m of height, Thanh Lanh has 427 m of height, Thien Tru has 378 m of height, etc. The suburban area of Hanoi has Soc Son Mountain which belongs to Tam Dao Mountain Range including several mountains located in Me Linh and Soc Son, if Ba Vi mountain range, Huong Son mountain range

and Sai mountain complex are excluded.

2.4 In the urban area, there are some low hills of which the average height is not higher than 20m, such as: Dong Da, Sua, Khan, Nung, etc.

2.5 Hanoi's topography is clearly reflected via the natural flows of the main rivers which run through Hanoi, such as: Cau, Ca Lo, Duong, Hong, and Nhue rivers.

- (b) **Geographical Features:** Hanoi is located within 20 53' to 21 23' of the north latitude and 105 44' to 106 02' of the east longitude. In addition, the capital is located within Hong River Triangle Delta which has unctuous and fertile soil; Hanoi is sheltered with Tam Dao Mountain Range to the north-northeast and Ba Vi – Tan Vien Mountain to the west-southwest.

2.6 Hanoi is adjacent to the provinces as Thai Nguyen and Vinh Phuc to the north, Ha Nam and Hoa Binh to the south, Bac Giang, Bac Ninh and Hung Yen to the east, Hoa Binh and Phu Tho to the west. After being expanded since August of 2008, Hanoi has 3,328.89 km² of total area distributed along both two sides of Hong river; however, the most of area is majorly distributed in the right area of Hong river.

2) Topography and Geographical Features of Ha Nam Province

2.7 The Annual Environmental Status Report in 2010 of Ha Nam Province summarizes the topography and geographical features of the province as follows.

- (a) **Topography:** There are three terrain types as calcareous mountains, shallow hills and plains:
- (i) **The Terrain of Calcareous Mountain:** The absolutely highest height is +419m; the local basic terrain height is around +10 to +14 m. This terrain is one part of the calcareous mountain range that is focally located in Kim Bang district and Thanh Liem one. The terrain is cleaved greatly; there are several steep slopes and abrupt high sharp mountains.
 - (ii) **The Terrain of Shallow Hills:** this one comprises the ranges of dome-shape hills which are interleaved or adjacent to the boundary of the terrain of calcareous mountains. At some areas, these hills together form as the long hilly ranges (the one in Non village, Thanh Luu commune; the one in Chanh Thuong of Liem Son commune) or as the separately hilly crests (in the communes as Thanh Binh, Thanh Luu, Doi Son). The common feature of this terrain type is to have round tops, sloping hillsides (the sloping angle is around 10 to 150); these hills are mostly the bare ones or being cultivated with the food and the industrial crops (green-trees). The solid native rocks are exposed on the hilly surface due to the erosion. Particularly, a part of this terrain is made-up of dolomite (the sedimentary rocks), among the most typical one is But Son mountain range in Kien Khe.
 - (iii) **The Terrain of Plain:** this terrain kind covers a large area of districts as Duy Tien, Binh Luc, Ly Nhan, Phu Ly City and a part of Kim Bang and Thanh Liem. The provincial plain terrain is relatively flat. Specifically, the average high-level of plain surface of Duy Tien, Kim Bang is +3 to +4 m; the one of Ly Nhan is +2 to +3 m; this one of the eastern plain of Thanh Liem and Binh Luc is +1 to +2 m; and, the one of An Lao field in An Lao, Binh Luc is +1 m which the lowest one.
- (b) Being one of the provinces within Hong River Delta, Ha Nam is bounded with Hanoi to the northwest, Hung Yen and Thai Binh to the east, Nam Dinh to the south, Ninh Binh

to the southwest and Ha Binh to the west. The geological coordinates of Ha Nam is 105 45'00" to 106 10'00" of the eastern longitude and 20 22'00" to 20 10'00" of the northern latitude.

2.8 There are several important roads running through Ha Nam, such as: NH1A, North-South railway, PR21A, PR21B, etc. These geological and traffic advantages will be premise which would promote the socio-economic development, the cultural exchange between Ha Nam and others, especially Hanoi capital.

3) Topography and Geographical Features of Nam Dinh Province

2.9 The five-year environmental status report of Nam Dinh Province summarizes the topography and geographical features of the province as follows.

- (a) **Topography:** The topography is quite flat, downward from the northwest to the southeast and it is able to divide into 2 main areas: plain area and coastal area.

2.10 The plain area covers Y Yen district, My Loc district, Vu Ban district, Nam Dinh City, Nam Truc district and Truc Ninh district. It occupies a major of natural area with favor conditions of soil for agricultural and industrial development and traditional handicraft industries.

2.11 The coastal area includes Nghia Hung district, Hai Hau district and Giao Thuy district. The coastal line lasts 72 km but it is divided by river estuaries, specific: Ba Lat estuary (Red River), Day estuary, Ninh Co estuary and Lach Giang estuary.

- (b) **Geographical Features:** Nam Dinh is a coastal and plain delta province and it is located in the South of Red River Delta, bordering Ha Nam Province in the North, Thai Binh Province in the East, Ninh Binh Province in the West and Sea East in the South.

2.12 Nam Dinh Province belongs to the affected zone of economic triangle between Hanoi, Hai Phong and Quang Ninh. It is 90km far away from Hanoi capital and Hai Phong City where are two big markets for exchange, commodity, technology and information and business administration experiences.

2.13 Nam Dinh Province integrates favor conditions for the economic development. The national railway lasts 42 km throughout the province and 5 stations located within the province. Road system is known with NH10 and NH21 is being upgraded into the strategic coastal road of Northern Region. While the river system composes of Red River, Day River, Ninh Co River flowing through the province with a total length of 251 km. Apart from the river ports here, a new Thinh Long seaport has been built to serve the water transport.

2.14 Nam Dinh's coastline is 72km long and has favorable conditions for raising livestock and fishing and developing tourist services such as Thinh Long tourist area (Hai Hau district) and Quat Lam tourist area (Giao Thuy district). Particularly, Xuan Thuy National Park (Giao Thuy district) is recognized by UNESCO as Natural Biosphere Reserve of the Southern Red River Delta.

4) Topography and Geographical Features of Ninh Binh Province

2.15 The five-year environmental status report of Ninh Binh Province summarizes the topography and geographical features of the province as follows.

- (a) **Topography:** The province as a whole covers 1,391 km², spanning various types of landscapes, including hilly and mountainous areas to the west and southwest, and low

plain land mixed with limestone mountains in the center, while fertile delta is at the southeast and coastal areas. Considering topographical issues, Ninh Binh is divided into three zones: mountainous, central plain, and coastal – sea.

- (i) Mountainous Zone includes limestone mountains with steep slopes, earth mountains and hills bordering narrow valleys. This zone covers basically districts of Nho Quan, Gia Vien (north – northeast), and most of Tam Diep town, accounting for almost 30% of the province's area.
- (ii) Central Plain Zone is featured by low rice fields, many lakes, ponds and limestone mountains in between. This zone covers the rest of districts of Nho Quan, Gia Vien, Tam Diep town, Hoa Lu district, Ninh Binh City, and a part of Yen Mo. This zone accounts for almost 40% of total land areas.
- (iii) Coastal and Sea Zone covers all of Kim Son, Yen Khanh, the rest of Yen Mo. The 15km-long coastal area is quite fertile, good for agriculture and aquatic farming. This zone covers more than 30% of the province's area.

2.16 Mountainous landscape features more than half of the province, but scattered and mixed with limestone structure. Hilly area spreads from the west-most point of Gia Vien district southeast bound through Hoa Lu, Yen Mo towards Kim Son and the sea (adjoining to Nga Son district of Thanh Hoa Province). The highest point is the May Bac Peak in Cuc Phuong National Park, 656m, while the lowest point is in Gia Vien (Gia Trung Commune: - 0.4 m). The province has 18km long of coastline in Kim Son district. Day River's mouth is also a zone of soil deposit, claiming the sea by 100-120m each year, equivalent to 140–168 ha.

- (b) **Geographical Features:** Ninh Binh stands at the south-most zone of the Red River delta, more than 90km south from Hanoi, and along the most important transport corridor (North-South) of the country. The province ranges from 19 50' to 20 26' north and 105 32' to 106 20' east.

2.17 The province's boundary is featured as follows:

- (i) North, adjoined to Ha Nam Province
- (ii) East and Northeast, adjoined to Nam Dinh Province
- (iii) Southeast, adjoined to the Eastern Sea
- (iv) West and Southwest, adjoined to Thanh Hoa Province
- (v) West and Northwest, adjoined to Hoa Binh Province

2.18 In this sense, Ninh Binh is granted with ideal geographical locations for socio-economic development: a part of the focal economic zone of the Northern Region, close to the triangle of Hanoi–Hai Phong–Quang Ninh.

5) Topography and Geographical Features of Thanh Hoa Province

2.19 The five-year environmental status report of Thanh Hoa Province summarizes the topography and geographical features of the province as follows.

- (a) **Topography:** The terrain and geomorphology of Thanh Hoa also shows the common features of Vietnam terrain which is a downward gradient from Northwest to Southeast and has three main types of terrains: mountains, midlands and coastal plains.
- (b) **Geographical Features:** Thanh Hoa is a province in the Northern Central Region with geographical coordinates from 19 23' to 20 30' Northern latitudes and 104 23' to

106 30' Eastern longitudes. The boundaries are as follows:

- (i) Bordering to the North with Ninh Binh, Hoa Binh and Son La.
- (ii) Bordering to the South with Nghe An.
- (iii) Bordering to the East Sea with a 102 km long coast line.
- (iv) Bordering to the North with Hua Phan Province of Lao People's Democratic Republic with a 192km border.

2.20 The Northernmost point of Thanh Hoa is Tam Chung commune of Muong Lat district (20'30 Northern latitude, the Southernmost point is Hai Thuong commune of Tinh Gia district (19'23 Northern latitude), the Westernmost point is the foot of Phu Lang mountain in Muong Lat district (104'23 Eastern longitude) and the Easternmost point is Nga Dien commune of Nga Son district (106'30 Eastern longitude).

2.21 Thanh Hoa has 27 districts, towns and cities with a total area of 11,133.4 km², making up 3.4% of the country's natural area, over 70% of land in Thanh Hoa are hilly, mountainous areas and forests.

6) Topography and Geographical Features of Nghe An Province

2.22 The five-year environmental status report of Nghe An Province summarizes the topography and geographical features of the province as follows.

- (a) **Topography:** Nghe An is located at the eastnorth of Truong Son mountain range. The provincial terrain is complicated diversity; it is divided with the system of rivers, springs, streams, mountains and hills. The terrain slope direction is from the westnorth to the eastsouth. The highest mountain is Puxalaileng (with 2,711m of height above the seawater level) in Ky Son district. The lowest terrain area is the lowland districts as Quynh Luu and Dien Chau; within these two districts, some locations have 0.2 of height (above the sea-water level).
- (b) **Geographical Features:** Nghe An is located within Central Region. The locality lays at the coordinatives as 18 33'10" to 20 01'43" of the northern latitude and 103 52'53" to 105 48'50" of the eastern longitude. The province is bounded with Thanh Hoa Province to the north, with Ha Tinh to the south, with Lao People's Democratic Republic to the west and with East Sea to the east.

2.1.2 Soil Erosion

2.23 Soil erosion it is regarded as an alarming problem in the country in general and in the north section in particular, it is usually caused by human activities as well as natural hazards;, when farmers' bad habit in using chemical fertilizer for their cultivation and farming has been recorded mostly in Hanoi City, Ha Nam Province, Nam Dinh Province and Ninh Binh Province. Meanwhile, river bank and sea side are eroded by salinization and acidization found mostly in Thanh Hoa Province and Nghe An Province. Since two these provinces are located in coastal area, sea erosion commonly occurs here in two provinces.

Table 2.1.2 Characteristics of Soil Erosion at Each Province

No	Province / City	Available Documents	Description
1	Ha Noi	5ECSR period 2006-2010, chapter 8, pp.127-130.	Erosion of the Red Riverbanks in Hanoi area has been continuously causing damage to many crops, threatening the stability of many public facilities, warehouse on the riverbanks, even the lives of the people.
2	Ha Nam	No related information on soil erosion found in the documents provided Ha Nam Province.	N/A
3	Nam Dinh	The 5ECSR period 2005- 2009, pp. 87-90.	Soil degradation at present is caused by 2 main factors: natural factor and human factor; soil degradation is caused mostly by salinity intrusion and alkali contamination; dirty substances brought about by rain water and the wash away of soil by rain water. The exploitation of soil to produce construction materials; irrational use and shift in land use purposes (the change of cultivation land to transport roads, irrigation ditches and canals, especially the change of cultivation land to shrimp ponds.
4	Ninh Binh	No related information on soil erosion found in the documents provided Ninh Binh Province.	N/A
5	Thanh Hoa	5ECSR period 2006- 2010, Chapter 8, pp. 141-147	The erosion of river bank and sea side happens annually at a speed of 0.5 – 1m/year. Thanh Hoa has 102km of coast and 1008km of dyke, of which there are 292km of level I to level III dyke, over 700km of level IV dyke and sea dyke
6	Nghe An	5ECSR period 2005- 2009, chapter VI, pp.85-87 and chapter V, pp130-142	Several natural factors have negative impacts on soil environment of coastal and mountainous areas of Nghe An Province. Landslide, erosion, karst process is happening strongly.

Notes: N/A- Not available
 Source: JICA Study Team

1) Soil Erosion in Hanoi City

2.24 According to 5ECSR provided by DONRE: Erosion of the Red Riverbanks in Hanoi area has been continuously causing damage to many crops, threatening the stability of many public facilities, warehouse on the riverbanks, even the lives of the people. The authorities have made many efforts as regulating river embankment; however, the erosion continues and causes severe consequences. The erosion prone areas include Dai Do Dune, Phuc Xa Dune, Hai Boi Dune, Ngoc Thuy Ward, Bat Trang Commune, and Duyen Ha Commune.

2.25 Two main factors that influenced the stability of the Red Riverbanks in Hanoi are morphological changes and geological structure as well as topography - geomorphology.

2.26 According to the topographic monitoring of riverbed and riverbank, the erosion and deposition can be evaluated in the section from Thang Long Bridge; specific is Thuong Cat area, Thuy Phuong area, where strong erosion occurred in the left side of Ap Bac pump station. The mainstream has been in the right side for almost 20 years and Thuy Phuong area tends to be eroded in depth; Chem-Thang Long Bridge section: The flow directs at Tam Xa and the left bank is erode strongly.

- (a) **Duong Estuary-Trung Ha Area:** In the years 2003, 2005, strong erosion and encroachment reached to hundreds of meters into shore. This is the hot spot on the riverbank erosion of Hanoi.
- (b) **Hanoi Port Zone:** In the end of 1970s and in the beginning of 1980s, alluvial was deposited dramatically from -5 level (1976) to +3 (1980) at Hanoi port. As a result, the

main creek moved to the middle of the river. Thanks to the dredging activities and renovation work of Hanoi transport sector since 1990s, Hanoi port has been improved significantly. Particularly, on the cross-section, the deep creek re-formulates near the port reaches the depth of -7 level which is enough for the large vessel.

- (c) **Yen So–Duyen Ha Area:** In the last five, six years, the flow squeezing the banks of Duyen Ha caused strong landslides in this area. In 2005, the irrigation sector made embankment for a segment of the river, so that the erosion phenomenon was limited.

2.27 Assessment of the geological structure and topography- geomorphology shows the impact in the left and right banks of the Red River is very different. On the basis of determining the role (specific gravity) of each element in the principle model and the status of the system, the risk of instability of the route is evaluated according to the criteria integrating the elements of technical conditions and it is divided into 4 sections with 4 risks of different landslides and destabilization.

2) Soil Erosion in Ha Nam Province

2.28 No information on soil erosion is found in collected documents in Ha Nam Province.

3) Soil Erosion in Nam Dinh Province

2.29 According to 5ECSR provided by DONRE, current status and causes of soil erosion are as follows.

(1) Current Status of Soil Erosion

- (a) **For Agricultural Land:** Based on a quick survey, agricultural land is suffering from degradation trend with imbalance nutrition structure due to fact that monoculture and extensive cultivation has used too much pesticides and fertilizers.
- (b) **Signs of Soil Degradation Include:** imbalance in nutrition structure, soil pollution, soil acidization, impoverished soil. Causes of soil acidization are: the wash away of alkali metal, alkali earth metal and the detention of aluminum and Fe; unsuitable fertilization mechanism; the use of acid fertilizer; the contamination of waste water containing acid and acid deposition in the ozone.
- (c) **For Coastal Land:** Soil environment in coastal areas is often suffering from impacts of natural disasters like: storms, floods, cyclones, tsunamis; residential activities like: industrial, agricultural, transport, tourism activities, etc. As a result, coastal land can be degraded and polluted from a variety of sources. Namely, Coastal subsidence is commonly found in Nam Dinh coastal area and now section in Hai Hau district with a length of 40km is being subsided. The most subsidence is in the area from Hai Ly commune to Hai Trieu commune. It is 10-20m of subsidence every year.

(2) Causes of Soil Erosion

2.30 Soil degradation at present is caused by two main factors: natural factor and human factor. Regarding natural factor, soil degradation is caused mostly by salinity intrusion and alkali contamination; dirty substances brought about by rain water and the wash away of soil by rain water. Regarding human factors, soil pollution is mainly caused by human activities, which cause waste; the exploitation of soil to produce construction materials; irrational use and shift in land use purposes (the change of

cultivation land to transport roads, irrigation ditches and canals, especially the change of cultivation land to shrimp ponds.

2.31 Soil degradation has following types:

- (a) **Chemical Degradation:** soil becomes acid with low organic contents and soluble phosphate, poor alkali ion like: Ca^{2+} , Mg^{2+} .
- (b) **Physical Degradation:** soil layer is thinner; structure becomes weakened; absorption ability is low; soil is tight, inconvenient for developing short-term plants.
- (c) **Biological Degradation:** biological activities are low due to the lack of organic substances; soil is acid and contains many toxic substances.

4) Soil Erosion in Ninh Binh Province

2.32 No relevant information on soil erosion as the documents was provided by Ninh Binh Province.

5) Soil Erosion in Thanh Hoa Province

2.33 According to 5ECSR provided DONRE, considering the natural conditions of Thanh Hoa Province, with three fourths of land area are hilly and midland with steep slopes, when there are changes in the climate and ecology, especially vegetation, they often lead to erosion, runoff, which triggers chemical degradation, loss of nutrients and organic matter. Also, direct impacts from human activities such as population growth, poverty, inappropriate farming techniques, deforestation, infrastructure development, urban construction, industrial production, mining, soil properties are altered and become no longer productive.

2.34 Salinization usually happens in coastal districts at different severity. District with high salinization risks are Nga Son, Ha Trung, Hau Loc, along Lach Sung estuary (Ma River), Quang Xuong, Tinh Gia districts at the estuary of Lach Ghep (Yen River) and Tinh Gia district at the estuary of Lach Bach (Bang River).

- (a) Dyke incidence: In 2008, there was some incidences from class I to III dykes:
 - Collapse of culvert under Ta dyke Ma river at K13_875 in Vinh Khang commune, Vinh Loc district.
 - Collapse of Vinh Yen Dyke K3+600+625 left bank of Ma river in Vinh Loc;
 - Collapse of dyke slope on riverside and crack on flood plains near dyke flood on the left bank of Ma river from K23~K28 in Vinh An commune, Vinh Loc district;
 - Destruction of culvert Trung Tuyet K7+145 left bank of Lach Truong, Hoang Xuyen commune, Hoang Hoa district;
 - Riverbank collapse near the dyke foot right of Len River in Hung Loc – Hau Loc;
 - Riverbank collapse near the dyke foot left of Len River in Ha Phu, Ha Trung;
 - Collapse of dyke slope on the left bank of Ma River dyke at K37,740 – K37,766 in Hoang Hop, Hoang Hoa.

- (b) River bank and sea side erosion

2.35 The erosion of river bank and sea side happens annually at a speed of 0.5–1 m/year. Thanh Hoa has 102 km of coast and 1,008 km of dyke, of which there are 292 km of level I to level III dyke, over 700 km of level IV dyke and sea dyke. On major

rivers with dyke (Ma River, Chu River, Len River, Lach Truong River), there are 178 spots with erosion, mostly on Ma river and Chu River with a 56,086 m length, there are 52 spots with signs of erosion but without protective structure with a 35,500 m length of which there are 20 dyke foot erosion spots threatening dyke safety. Many parts by the river floodplains have high erosion speed at an average of 5–10 annually affecting agricultural production of the localities. Sea and estuarial dykes of Thanh Hoa are in the districts of Nga Son, Hau Loc, Hoang Hoa, Quang Xuong, Tinh Gia, Sam Son town. After storm no. 7 in 2005, some dykes were terribly destroyed and no longer provide stability during storm season, especially Hau Loc, Quang Xuong, Tinh Gia and Sam Son town sea dyke, which in recent years have seen investment to strength according to Decision 58/2006/QD-TTg by the Prime Minister. Structure to protect the coast in the province is 53,195 m long, erosion spots without protection are 35,520 m long. Of which there are some fast erosion spots such as in Sam Son town. Handling riverside and seaside erosion in the province every year caused hundreds of billions locally and at central levels to timely resolve before storm season.

6) Soil Erosion in Nghe An Province

2.36 According to 5ECSR 2005–2009 provided by DONRE, current status and causes of soil erosion are as follows:

2.37 Several natural factors have negative impacts on soil environment of coastal and mountainous areas of Nghe An Province. Landslide, erosion, karst process is happening strongly. Soil mantle has to suffer from the impacts and changes according to this process. Thickness, fertility and humus of soil in erosion area are therefore reduced. In addition to geological and terrain impacts, climate factor is also affecting soil quality. Nghe An has to suffer from impacts of Lao's wind, making soil arid all the time, therefore leading to a lack of water for forests and plants.

2.38 Salinization has also affected agricultural soil in the river mouths of communes like: Quynh Di, Quynh Loc, Son Hai, Quynh Thuan (Quynh Luu district); Dien Bich, Dien Van, Dien Thanh (Dien Chau district) and Nghi Quang, Nghi Yen, Nghi Thai (Nghi Loc district). Deforestation The overuse of chemical substances also results in the acidization of soil. Unsuitable cultivation methods on sloping land also lead to erosion and wash-away. Mineral resources exploitation and transport works construction.

2.39 Coastal erosion is causing the erosion processes in coastal areas and coastal estuaries, related to the operation of river and coastal waves and currents. This process greatly affects the development and production life of coastal residents. Ground cracking, landslide hazard phenomenon is due to the gravitational fast force. It usually modifies slopes with gradients over 30.

2.40 Area of coastal protection forest and mangrove forest in Nghe An has decreased from 7,268.38 ha in 1990 to 6,791.50ha in 2008.

2.41 The loss of coastal forest leads to landslide and erosion. Out of 45 coastal communes, there are 19 communes suffering from landslide and erosion. At an average annual landslide of 42 m, Nghe An loses 100ha coastal land per year. Many landslides have intruded into residential areas like in Son Hai, Quynh Long; at some sections like Quynh Bang, Quynh Ngoc, landslide and erosion speed averaged 150–200 m/year. Coastal line along Dien Kim commune (Dien Chau district) landslide is

up to 6km long. The section from Cua Lo to Cua Hoi (Nghì Loc district), before dykes were constructed, had been strongly eroded, block house constructed by France in 1950, which used to 100 m away from coast line, is now right beside sea edge. Half of sand mound, about 15m from Cua Hoi to Xuan Thanh was washed away.

2.42 The trend for landslide along Nghe An coastline is moving coast line towards mainland, creating curvatures with the nose jutting out to the sea, which used to be vacant land formed in the Quaternary. This is natural forest exploited years ago. There are only a number of plants remaining like hassk, *Melastoma affine*. In recent years, about 5,348.1 ha casuarina, acacia, *Erythrophleum fordii*, Santal wood, Tea tree (out of 6,443.3 ha coastal hill land), however, still failing to recover all area washed away and eroded.

2.43 It is necessary for Nghe An DARD to instruct divisions and local authorities to strictly comply with Article 86, section 1, chapter IX of Law on Environmental Protection regarding prevention and dealing with natural hazards and environmental pollution.

2.1.3 Groundwater

2.44 Groundwater reserve is recorded to be rich in north section satisfying the demand of residents, production activities, and business entities. However, groundwater source is recently contaminated due to the surrounding polluted sources; waste water from factories, industrial zones, households etc. Besides, overexploitation of groundwater has also been found in different provinces. How to utilize and protect valuable source of groundwater is the stakeholders's concern now.

Table 2.1.3 Characteristics of Groundwater at Each Province

No	Province / City	Available Documents	Description
1	Ha Noi	Environmental Current Status Report of Hanoi City in 2008 (Hard copy, 325 pages), chapter II, heading 1.5 natural resources, pp. 13-21. See the detail below.	Hanoi is rich with water resources. There are not only water resources for irrigation, aquaculture, forestry, tourism and service but also underground water resources with the potential reserve of 5,914,000 m ³ per day. Therefore, over a decade ago, underground water was exploited through drilled well and nowadays it is the only resource for city water supply.
2	Ha Nam	Annual environmental status report in 2010, Chapter 3, heading 3.2, pp.24-26. See the detail below	Total potentially exploitable groundwater reserve of Ha Nam Province is 165,000,000m ³ per year.
3	Nam Dinh	5ECSR period 2005- 2009, Chapter III, heading 3.2 Groundwater, p.53. See the detail below	There are four types of aquifers found in the province. Among these, Pleistocene aquifer and Pliocene aquifer is considered to be good for the domestic use.
4	Ninh Binh	5ECSR period 2005-2009, Chapter III, Heading 3.1.4, pp.33-34.	There are 5 aquifers in Ninh Binh Province; Thai Binh formation, Hai Hung sub-formation, Ha Noi formation, Vinh Bao formation and Dong Giao formation.
5	Thanh Hoa	5ECSR period 2006- 2010 period, Chapter 3, pp. 52-53, Chapter III, heading 3.2: groundwater. See the detail below.	The ground water within the province of Thanh Hoa is mainly found in storage aquifer and aquifers with cracks.
6	Nghe An	A full report dated Aug. 17, 2011 on social and natural environment prepared by DONRE. 5ECSR period 2005- 2009 (soft copy), chapter III, heading 3.2: Ground water, pp.39-41.	The major two aquifers are found in the province and approximately 140,000 m ³ /day ground water is exploited. The total used groundwater volume is 138,583 m ³ /day (among, 157,352 driven-wells and 40,410 bored-wells are located at the coastal area and supply groundwater for 1,079,219 people distributed within 232,356 households.

Source: JICA Study Team

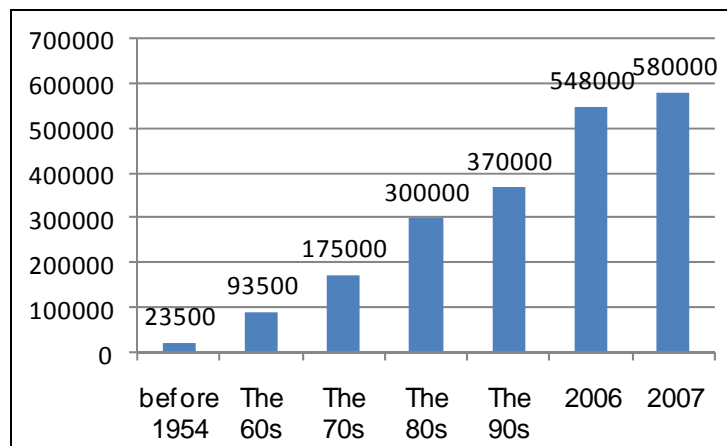
1) Ground Water in Hanoi City (Environmental Current Status Report in 2008)

2.45 Yen Phu water plant is the first underground water exploitation construction in Hanoi. It is built in 1909 with the capacity of 10,000m³ per day. As the time of 2003, this water plant was improved and upgraded with the capacity of 462,500 m³ per day. However, compared to the planned demand (water supply system planning of Hanoi till 2010 and development orientation towards 2020 passed by Prime Minister in Decision No.50/2000/QD-TTg dated April, 24th, 2000), water supply was not efficient and did not meet growing demand of the city, especially, in urban areas, industrial parks. Until the end of 2006, the capacity of water plant in Hanoi is 463,000 m³per day, in 2007, it is 820,000 m³/day. Therefore, in near future, Hanoi will deploy to exploit the surface water for clean water supply; it is planned to build a water plant located in Thuong Cat area to take water from Red river with the capacity of 150,000 m³ per day in the first period and partially from Da river water plant with planned flow of 200,000 m³ per day. Currently, in order to have domestic water and water for production development, Hanoi exploit underground water in 3 following forms:

(1) Water Exploitation in Hanoi City

2.46 Water exploitation is mainly managed by Hanoi Water Business Company. Red River is the main source for underground water supply in Hanoi. Seasonal fluctuation in Red River level will directly affect the efficiency of water exploitation of Hanoi water Business Company. This water exploitation is often draw water from aquifer with big borehole diameter and concentrated in 12 big well group and 14 water supply stations with the medium and small capacity; total exploitation wells are 200 wells. In 2004, Nam Du Thuong with capacity of 30,000 m³ per day, Cao Dinh well with 30,000 m³ per day, Bac Thang Long well in North of Vietnam with capacity of 60,000 m³ per day are put into operation in order to meet the demand of water using; at the same time, Gia Lam water plant was upgraded with capacity of 30,000 m³ per day, water plants in region of Dinh Cong, Linh Dam, Phap Van that have Neogen aquifer are upgraded into 9,000 m³ per day. Establishment of many new water supply stations in industrial parks, center of communes and districts led to the rise of water supply volume.

- Before 1954: 22,000-25,000 m³ per day
- The 60s: 142,000-145,000 m³ per day
- The 70s: 175,000 m³ per day
- The 80s: 300,000 m³ per day
- The 90s: 350,000-390,000 m³ per day



Source: Environmental Status Report/2008/Hanoi DONRE

Figure 2.1.1 Water Exploitation of Underground Water in Hanoi City

2.47 Figure 2.1.1 Bar chart express the development of centralized exploitation of underground water in time in Hanoi.

2.48 Along with the industrialization and urbanization of the country, Hanoi also proceed to build many new water supply stations in industrial parks, center of communes and districts with large and growing scale. Currently, water exploitation volume is about 580,000 m³ per person and fold 23 times in comparison with the first period. Average exploitation volume per year in 2007 in wells is written down in Table 2.1.4.

Table 2.1.4 Average Water Exploitation Volume in 2008 in Main Wells

STT	Water Plant	Exploitation Capacity (m ³ per day)	No.	Water Plant	Exploitation Capacity (m ³ per day)
I	Big well group		II	Big water supply station	
1	Cao Dinh	62,000	1	Bach Khoa	2,500
2	Luong Yen	49,080	2	Bach Mai	6,500
3	Phap Van	22,464	3	Khuong Trung	N/A
4	Ha Dinh	28,000	4	Quynh Mai	3,000
5	Tuong Mai	25,000	5	Lang Bac	20,000
6	Ngoc Ha	40,000	6	Van Don	4,800
7	Mai Dich	45,000	7	Kim Giang	2,000
8	Ngo Si Lien	50,000	8	Giap Bat	1,000
9	Yen Phu	110,000	9	Cao Xa La	10,000
10	Gia Lam	20,000	10	Dong Anh	2,000
11	Nam Du Thuong	42,700	11	Noi Bai	5,000
12	Bac Thang Long	20,000	12	Thuy Loi	3,000
			13	Don Thuy	5,400
			14	Kim Lien	2,000
	Total	514,244		Total	67,200
Total: 581,444					

Note N/A: No data available in the reference document

Source: Environmental Status Report/2008/Hanoi DONRE

(2) Individual Exploitation

2.49 Individual exploitation is managed by agencies, factories, enterprises and these

units have to handle by themselves in drilling, serving eating and living demands and productions of units. This form of exploitation often uses industrial exploitation wells with medium diameter. Each unit can manage one to two drilled wells with exploitation volume of about 50-1,000 m³ per day and the time of exploitation is 5–10 hours per day. Based on the investigation in 2005 (of National Monitoring Schemes), There are about 500 individual wells in Hanoi. Average exploitation volume in 2006 is 130,000 m³ per day.

2.50 Currently, there are 15 exploitation units that got operational license with the supply volume per year of 2–3 million m³ and 4 units that got permission for exploiting kaolin clay to full in Soc Son region.

(3) Water Exploitation in Countryside

2.51 Thanks to the support of UNICEF organization on capital and technology, underground water exploitation serving for people in countryside and areas that haven't been supplied with water from municipal water system has been improved and sped up. Wells with small borehole diameter and pumped by hand (now, it is replaced by motor pump) have capacity of 0.5–3 m³ per day and each household has one. Currently, clean water supply program in countryside has been improved. In some regions, they built centralized water supply system, drilled well with big diameter in order to serve eating and living demand of inhabitants in villages, communes. According to updating statistics, there are approximate one hundred thousand wells with exploitation capacity of 100,000 m³ per day in 4 outskirt districts.

2.52 Underground water exploitation with high intensity will lead to the negative consequences such as degradation, limitation, aquifer contamination. In 2007, there are 84 locations with 143 constructions in underground water exploitation monitoring system in Hanoi City. Rising underground water exploitation volume leads to the forming of funnel feature and results in a decrease of the level of underground water exploitation in South of Red River. According to the sunken ground measure monitoring results, change in underground water level in Pleitoc aquifer is one of the reasons leading to the sunken ground in Hanoi. Based on the measuring figures, consequences caused by low underground water level as the result of exploitation in 3 areas in Hanoi are:

- (a) **In North of Red River and Duong River (referred to as the South of Red River):** underground water level is relatively high and equal because exploitation activities are not centralized and large; underground water maintains at natural status.
- (b) **In Gia Lam:** (located between Duong River and Hong River, referred as to area of weak damage status), the underground water level is less affected by exploitation activities and new water plants do not run at full capacity.
- (c) **In the South of Red River:** underground water level changed a lot and pollution level are increasing because of centralized exploitation, unsuitable well arrangement and single exploitation without control strictly; this situation has not been improved and there is no sign of recovery over years of monitoring.
 - Phap Van well group: is located far from river, therefore it is only affected weakly by the aquatic factors. This well is running at the capacity of 22,464 m³ per day. The results of study show that the fluctuation of this area's

underground water level in 2007 is 3.22 m, almost the same as the fluctuation in Red River but it is weaker. The lowest water level in 2007 is -24.71 m.

- Ngo Si Lien well group: is far from river and in the area affected by aquatic factor, so it gets weak effects. There are 17 wells in Ngo Si Lien well group. The lowest water level here is -21.15 m in 2007, lower than water level of 1.65 m in 2005.
 - Mai Dich well group: there are 21 exploitation wells with the average capacity of 45,000 m³ per day. This well group is arranged in the form of area. Because it is far from water supply-Red River, weak supplementation, exploitation has invaded into static reserves. The water level in 2007 continues to decrease; the lowest water level in 2007 is 28.23 m, lower than the level of 0.003 m in 2005.
 - Ha Dinh well group: there are 12 well running at the average capacity of 28.00 m³ per day. In 2007, the lowest water level is -34.9 m. This is the center of funnel leading to the decrease in water level and also the deepest place in Hanoi water mining because it is located far from the supplement source of Red River, on the other hand, this area has concentration of many water supply stations such as Khuong Trung, Kim Giang, Khu Cao Xa La, Thuong Dinh industry and many other single drilled wells of agencies and also the exploitation activities make fast falling in water level, some signs of static reserve invasion leading to the degradation of other exploitation wells. These bad signs in well group will lead to the degradation of well and interruption in exploitation if there is no suitable adjustment in exploitation volume. Notably, this situation was warned in 2003 and the fact shows that the degradation in well group as well as the development of funnel in the South of Hanoi is very scientific and accurate. They are convincing enough for management agencies to make appropriate adjustments to protect water resources.
- (d) **Source:** Report on underground water status monitoring results in Hanoi in 2008-Center of Monitoring and Natural Resource Analysis of DONRE.

2.53 Study results and negative development of lowering water funnel show that overused exploitation and centralization in inner Hanoi will make decrease in water level in large-scale. This is the reason of water degradation, affecting exploitation wells and volume, increase in pollution and sunken ground. These changes and warnings are very significant for continuous checking to make adjustments in mechanism, suitable exploitation positions in order to protect water source.

2.54 As regulated in Water Resource Law in Decree No.179 of the Government, Decree No.24/2005/ND-CP dated March, 17, 2005 on administrative violation punishment in water resources, legal documents of Ministry of Natural Resources and Environment and directions of City People's committee; From 1995 to now, Hanoi authority issued 200 operational licenses.

2.55 Units, individuals in the City were issued 35 licenses in drilling wells and in exploiting underground water. Currently, investigation and fine given to the violators have been strengthened jointly by Division of Natural Resources Management and Investment-Department of Natural Resources and Environment, Department of Water Resources Management and specialized inspectors.

2) Groundwater in Ha Nam Province (Annual Environmental Status Report in 2010)

2.56 Based on the report on the groundwater resource usage and protection plan, the aquifers within Ha Nam are as below:

(a) Holocene aquifer (qh):

- The pronous aquifer with the mixed river – marine – lagoon sediment; Thai Binh aquifer system was formed 3,000 years ago,
- The pronous aquifer with the mixed marine and lagoon sediment; Hai Hung aquifer system was formed 10,000 years ago,

(b) Pleistocene aquifer (qp):

- The pronous aquifer with the mixed river – marine continental sedimentary, Vinh Phuc aquifer system was formed 150,000 years ago,
- The pronous aquifer with the continental sediment, Hanoi aquifer system was formed 700,000 years ago,
- The pronous aquifer in Pleistocene sediment under Plioxen sediment, the aquifer system was formed 1.8 to 5 million years ago.

(c) Karst fissure aquifer–Dong Giao aquifer system was formed 185 to 225 million years ago. Total potentially exploitable groundwater reserve of Ha Nam Province is estimated about 165,000,000 m³ per year.

Table 2.1.5 Summarization on Ha Nam’s Groundwater Aquifers

Aquifer		Acuifers			Depth Range and Thickness of Aquifer (m)
		Aquifer	Signal	Confined Aquifer	
Pronous aquifer	Halocene (qh)			top confined aquifer	
		Holocene aquifer – Thai Binh Q32tb aquifer system	qh2		It is 1.5 ~ 15m under the ground, the thickness is 2 ~ 3m (it is 6 ~ 8m at some locations)
				Hai Hung above haft confined aquifer	It is 11 ~ 19m under the ground, the thickness is 5 ~ 13m
		Holocene aquifer in Hai Hung Q1-22 hh below haft aquifer system	qh1		It is 12 ~ 15m under the ground (it is 22 ~ 25m at some locations), the thickness is 0.5 ~ 8m
			Holocene – Pleistocene confined aquifer	It is 12 ~ 26m under the ground, the thickness is 11 ~ 32m	
	Pleistocene (qp)	Pleistocene aquifer–Vinh Phuc aquifer system	qp2		It is 30 ~ 35m under the ground, the thickness is 10 ~ 20m
		Pleistocene aquifer - in Hanoi Q2-31 Hn above haft aquifer system	qp1		It is 60 ~ 80m under the ground (it is 100m at some locations), the thickness is 10 ~ 20m
			Confined aquifer		
	Pleistocene aquifer under Plioxen	qp – m, Q1 – Q2		It is 80 ~ 100m under the ground	
Fissure aquifer		Karst fissure aquifer–Dong Giao aquifer system	T2adg		It is 75 ~ 100m under the ground; the thickness of aquifer is insignificant.
			PR-sh		It is >70m under the ground; the thickness of aquifer is insignificant.

Source: Applicative Environment and Geology Center under Vietnam Union of Science – Technology Associations – Ha Nam Province Groundwater Resource Usage and Protection Plan.

3) Ground Water in Nam Dinh Province (5ECSR 2005–2009 Period)

2.57 Nam Dinh's groundwater is distributed majorly within 4 aquifers.

(1) Holocene Pronous Aquifer (qh2)

2.58 This is a shallow aquifer (it is the first aquifer from the surface-ground to the under-ground) which is distributed widely from the western area to the eastern one. The thickness of this aquifer changes within 2~2.8 m. This one is the unconfined-aquifer of which the depth of general still-water level is 0.5~3 m; the water reserve of this aquifer changes within 0.1~1.45 l/s. The subsoil-water's chemical types are diversified; among, the most popular one is bicarbonate-chloride or chloride-bicarbonate. The total mineralization rate is 0.58~3.80 g/l. The subsoil-water of this aquifer is the light and brackish water. This aquifer has poor volume and bad quality. Hence, it is though not a great source to supply water for the great-volume demand of the daily living activities; it is still an important source which supplies water for cultivation, livestock and the domestic purposes which need a small water volume.

(2) Lower-Holocene Aquifer (qh1)

2.59 The distributed area of this aquifer is wide within the entire province; the underground-boundary of this aquifer is limited with the rocky mountains and hills' roots at the west-north and the west-south area. The thickness of this aquifer changes within 1.3~27.5 m. This one is located between two other aquifers (the higher one and the lower one). Therefore, the qh1 aquifer is the confined-one. The water-level of this confined-aquifer changes within 0.5~3.4 m and its water reserve changes within 0.5~5 l/s. This one is considered as the rich water-reserve aquifer which is relatively shallow. Thus, it is advantageous to exploit and use with a greatly exploited volume. However, this aquifer contains the saline brackish water which can't be utilized for the daily living activities (drinking, cooking, etc.).

(3) Pleistocene Aquifer (qp)

2.60 This aquifer is distributed widely, either. The aquifer thickness changes within 10~78 m. This is the artesian aquifer. The artesian water-level is usually 40~60 m higher than the cover of the aquifer (at some points, this one can be 70 m). Hence, this is also a shallow aquifer which is 0~2.25 m under the ground. This aquifer has 0.5~5 l/s of water reserve (this one can be over 5 l/s at some points). Within this aquifer the zones of light-water and saline-water is separated remarkably. Therefore, water at the northern zone is the saline-water of which the total mineralization is over 1 g/l; while at the east-south zone (near the beach) the water is the light-one of which the total mineralization is 0.2 g/l. Generally, this aquifer type is classified as the rich water reserve. The water-quality is basically good and the dynamic of this aquifer is relatively stable and un-changes by-season; so it is the good water source supplying for domestic demands.

(4) Pliocene Aquifer (m4)

2.61 The distributed area of this aquifer is also wide. Its thickness changes within 35~85 m. This is the artesian aquifer which is a shallow one, either. It is located at 0.6~1.2 m under the ground. The aquifer's water reserve changes within 0.4~11 l/s. The water dynamic is relatively stable; it does not affected with the hydrometeorology regime. This aquifer, generally, contains a rich water reserve which can be exploited

to supply for the daily living activities (drinking, cooking, etc.). However, the limit between the light-water zone and the saline-one has not defined officially.

4) Ground Water in Ninh Binh Province (5ECSR Period 2005–2009)

2.62 There are 5 aquifers in Ninh Binh Province as follows:

- (i) Upper Holocene aquifer, Thai Binh formation (QVI3tb)
- (ii) Lower Holocene aquifer, sub-Hai Hung formation (QV11-2hh1)
- (iii) Pleistocene aquifer, Hanoi formation (QII-III1hn)
- (iv) Pliocene aquifer, Vinh Bao formation (N2vb) and
- (v) Karste aquifer forming mid Carbonate Triat, Dong Giao formation (T2adg)

2.63 Of which, Pleistocene aquifer, Hanoi formation is the main source which is extracted to provide domestic water in the province.

2.64 The ground water quality varies significantly by zones. The mineralization is increasing toward the seaside zone. Western and northwest Yen Khanh district areas have better ground water quality. Holocene aquifer could be polluted by industrial and domestic wastes since it is linked directly to the surface water. Holocene aquifer is extracted for bathing and breeding facilities cleaning. This source also is the drinking water source when the rainwater is lacked.

2.65 Groundwater at Hanoi formation is in good quality, meeting the standard of domestic water supply. However, some places are polluted by organic substances, Fe, $Nh4^+$, $NO2^-$, etc.

2.66 Groundwater at Thai Binh and Hai Hung formations is polluted by surface water sources and fails to meet the domestic water supply standards.

2.67 Groundwater at Vinh Bao and Dong Giao formations is good, meeting the domestic water supply standards.

5) Ground water in Thanh Hoa Province (5ECSR 2006-2010 Period)

2.68 The ground water within the province of Thanh Hoa is mainly found in storage aquifer and aquifers with cracks. Ground water reserves in some regions are statistically indicated in the following table.

Table 2.1.6 Ground Water Reserves in Certain Places in Thanh Hoa

No.	Mining Sites	Survey Area (km ²)	Aquifer	Ground Water Reserve by Classes, (m ³ /day)				Notes
				A	B	C1	C2	
1	Bim Son	45	T2dg	21,300	20,000	-	159,000	Bim Son Report
2	Ham Rong	100	Qp	4,000	2,000	9,000	-	Ham Rong Report
3	Sam Son	40	Qh2	-	480	800	26,000	Sam Son Report
4	Tinh Gia	790	Qp, t3, t2, e2	-	-	16,620	173,000	Tinh Gia Report
5	Phuc Do	320	Qp, t2, p2	-	-	3,600	52,471	Phuc Do Report
Grand Total				25,300	22,480	30,020	410,471	

Source: Hydrological and Geological Survey Report in Thanh Hoa, 2000

2.69 In Thanh Hoa Province, there are aquifers rich or very rich of water. They include hollow aquifer Qp (QI-III), cracks aquifers of carbonate sediments. This really is a rich potential source of groundwater in the province. However, to date, there exist no accurate data on their reserves. In addition to the water aquifers above,

there are some other aquifers for consideration, such as: 2sm, O1ds; d1np; K2yc; QI-III. Even though some aquifers classified in groups poor of water, it is possible to find drill holes from which water reserve can meet common needs such as P2ct; P2yd.

2.70 So far the plain areas of Thanh Hoa include 3 locations where mineral water or hot water, has been found, such as Cha Khot (Son Dien-Quan Son), Nghia Trang (Hoang Xuan - Hoang Hoa) and Yen Vuc (Quang Yen-Quang Xuong). The hot-water site of Cha Khot and Nghia Trang, according to existing data, show small reserve. Water is found in some holes in Nghia Trang at the depth of 90m.

2.71 Mineral water site in Yen Vuc was found when the people drilled for water in 1997. The areas of mineral water site covers 1 km², including three villages of Lang Vuc 2, Chinh Canh and Yen Trung. The water is found in laterite aquifer at 45-50 m depth from earth surface. This site is considered the site with good quality significant-volume hot water.

6) Ground water in Nghe An Province (5ECSR Period 2005-2009)

2.72 Nghe An Province has following main aquifers;

- (i) Pronous aquifer
 - Holocene pronous aquifer (qh)
 - Pleistocene pronous aquifer (qp)
- (ii) Fissure and fissure-karstic aquifers
 - Triassic aquifer.
 - Fissure-karstic and cacbonation aquifer.
 - Paleocoic aquifer.

2.73 The monitoring results of groundwater reserves are summarized in the following tables.

Table 2.1.7 Summary on the Groundwater-Monitored Locations

Monitored Locations	Avaluated Rock Reserve (10 ³ m ³ /day)		Aquifer
	Level A + B	Level C ₁	
Hoang Mai	3.0	-	t _{2a}
Vinh - Cua Lo	3.1	3.5	qh
Nam Dan	-	6.0	qp

Note: Level A: Industrially valued mineral reserve (surveyed).
 Level B: Industrially valued mineral reserve (extrapolated).
 Level C₁: Industrially valued mineral reserve (geological documents available).
 Source: Groundwater of Central Region's coastal flatlands, 2007.

Table 2.1.8 Potentially Exploitable Groundwater Reserve of Nghe An

Aquifer	Q _d (m ³ /day)	Q _t (m ³ /day)	αQ _t (m ³ /day)	Q _{tng} (m ³ /day)
Halocen	111,152	3,145	943	112,095
Pleistocen	35,958	2,625	787	36,745
T ₃ n-r đđ	69,189	998	299	69,488
Total	216,299	6,768	2,029	218,328

Note: Q_d: Dynamic Reserve, Q_t: Static Reserve, αQ_t: α Static Reserve Q_{tng}: Potential Reserve
 Source: Groundwater of Central Region's coastal flatlands, 2007.

(a) Groundwater Exploitation and Usage Situation of Nghe An

2.74 According to Annual Environmental Status Report of 2008 issued by DONRE, Nghe An has 420,317 driven-wells, 59,376 bored-wells which supply water for 560,052 households of 2,770,067 people; the total used groundwater volume is 138,583 m³/day (among, 157,352 driven-wells and 40,410 bored-wells are located at the coastal area and supply groundwater for 1,079,219 people distributed within 232,356 households).

Table 2.1.9 Summary on the Wells Supplying Water for agriculture

No.	Commune	No. of Wells	Well type	Depth of Well (m)	Watered Area (ha)
I	Coastal area	2,494	-	-	654.3
	Quynh Luu district	2,010	-	-	352.3
	- Quynh Nghia	10	Bored	5.4	2.5
	- Quynh Minh	700	Driven concrete	4.2 - 4.8	80
	- Quynh Luong	400	Bored	10 - 14	100
	- Quynh Bang	850	Driven concrete	7.5	167.3
	- Quynh Lien	50	Bored	6 - 8	25
	Dien Chau district	280	-	-	302.5
	- Dien Thinh	100	Bored	6 - 8	95
	- Dien Hung	180	Driven concrete	4.5	207.5
	Nghi Loc district	207	-	-	47
	- Nghi Thach	207	Bored	5 - 6	47
	II	Low mountainous land	45	-	-
Xuan Thanh Farm		20	Driven soil	15 - 35	40
Tay Hieu 3 Farm		25	Driven soil	20 - 22	125

Source: Nghe An DARD, 2006.

(b) Groundwater Exploitation Situation of Vinh

2.75 The groundwater source within Vinh City is exploited for the demands of daily living activities and the other needs. Most of the wells are the bored ones which exploited the groundwater of Pleistocene aquifer. The groundwater within Vinh City has been salinized since the over-exploited volume, so this water source can not be utilized for the municipal concentrated water supply system. Hence, the major water source supplying for Vinh City is from Lam river. The groundwater within Vinh is exploited via the driven-wells or the bored-ones which is conducted based on the model of UNICEF (the depth of well is often <30m) to supply for the demands of the municipal people's daily living activities.

(c) Groundwater Exploitation Situation of Cua Lo Provincial-Town

2.76 In Cua Lo provincial-town (including households, hotels, restaurants), the daily living activities is supplied with groundwater. The groundwater is exploited at Nam Cam to supply for Cua Lo. The households which have not served from this concentrated water supply network develop the bored-wells or driven-ones to supply for themselves; these wells mainly exploit the groundwater of Holocene aquifer.

(d) Groundwater Exploitation Situation of Rural Districts and District-Towns

2.77 While the coastal areas can exploit the groundwater for the domestic demands; the district-towns of the highland districts can exploit the surface-water (rivers, streams).

(e) Groundwater Exploitation Situation of Rural Areas

2.78 The rural people utilize the different water sources for their domestic needs, such as: rainy-water, surface-water (river, streams, springs, etc.), groundwater (driven-wells and bored-ones).

Table 2.1.10 Domestic Water Usage Situation of the Rural Areas in Nghe An Province

Facilities	Total Good-Quality Facilities	No. of People Supplied Clean-Water	Rate (%)
Bored wells	21,556	92,458	10
Driven wells	180,371	817,344	77
Rainy-water tanks	52,966	94,353	5
Stream/ spring water	2,788	7,724	2
Concentrated water supply facilities	109	48,793	6
Total	258,150	1,060,671	100

Source: Five year environmental report/2005-2009/Nghe An DONRE

2.1.4 Protected Areas

1) Special-use Forest (National Parks, Nature Reserves, Species/Habitat Conservation Area, Landscape Protection Area, and Scientific Research and Experimental Forest)

2.79 Special-use forest stretches from north to south of the country as described in VITRANSS 2, pp. 2–37 including national parks, nature reserves, species/habitat conservation area, landscape protection area etc. For north section the protected areas make up the most in Thanh Hoa Province, followed by Ninh Binh Province, Nghe An Province and Hanoi City, except Ha Nam Province where no special- use forest exists. The special- use forest plays important role in nature conservation, tourism and research needing strict protection. As shown in the table Hoa Lu Landscape protection area and Ba Trieu temple in Ninh Binh Province and Thanh Hoa Province, respectively are regarded to be closed to the existing railway as well as HSR and in need of consideration.

Table 2.1.11 Special-Use Forest at Each Province

No	Province / City	Type	Name of Special-Use Forest	Area (ha)
1	Ha Noi	NP	Ba Vi (starching out in two province in Hanoi/6,486ha and Hoa Binh/4,263ha)	6,486
		LP	Huong Son	4,355
2	Ha Nam	-	No special use forest exists.	-
3	Nam Dinh	NP	Xuan Thuy	7,100
4	Ninh Binh	NP	Cuc Phuong (starching out in three provinces in Ninh Binh/11,350ha, Thanh Hoa/4,982 ha and Hoa Binh/4,263ha)	11,350
		SP	Van Long	2,736
		LP	Hoa Lu	2,737
5	Thanh Hoa	NP	Ben En	12,033
		NP	Cuc Phuong (starching out in three province in Ninh Binh/11,350ha, Thanh Hoa/4,982 ha and Hoa Binh/4,263ha)	4,982
		NR	Pu Hu	27,503
		NR	Pu Luong	17,662
		NR	Xuan Lien	27,237
		SP	Tam Quy	519
		LP	Den Ba Trieu	300
		LP	Lam Kinh	300
6	Nghe An	NP	Pu Mat	93,525
		NR	Pu Hoat	65,611
		NR	Pu Huong	49,806

Total	334,542
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Note: NP: National Park, NR: Nature Reserve, SP: Species/habitat conservation area, LP: Landscape protection area
Source: MARD and DONRE, compiled by JICA Study Team

2) Wetland Reserves

2.80 In 2001, the National Environment Agency (now the Viet Nam Environment Protection Agency/VEPA) recommended 68 wetland sites as having environmental and biodiversity values. This list contains more comprehensive data than any prior documents, and is regarded that it could serve as the foundation for the identification of wetlands of national and international importance. Following table shows the Isited wetland sites of the target sections.

Table 2.1.12 Wetland Sites of Biodiversity and Environmental Value in Vietnam (2001, VEPA/MONRE)

No	Province/City	Name of Protected Area	Area (ha)
1	Ha Noi	Dong Mo, Ngai Son Lake	900
		Suoi Hai Lake	1,200
		West Lake	526
2	Ha Nam	- No wetland reserve exists.	-
3	Nam Dinh	Xuan Thuy Wetland Nature Reserve	12,000
		Littoral area of Nghia Hung District	9,000
4	Ninh Binh	Van Long Wetland Nature Reserve	3,500
5	Thanh Hoa	Ben En Lake	3,000
		Yen My Lake	95
6	Nghe An	- No wetland reserve exists.	-
Total			30,221

Source: Viet Nam Environment Protection Agency (2005). Overview of Wetlands Status in Viet Nam Following 15 Years of Ramsar Convention Implementation. Hanoi, Viet Nam. 72 pp.

3) Marine Protected Areas

2.81 The MARD has submitted the Primer Minister a plan to establish a system of 15 marine protected areas (MPA) (233,974 ha of marine-based water area and 64,147 ha of inland area). This plan aims to allocate 2% of the country's marine area for biodiversity conservation by 2010. Currently 4 MPAs is officialized, one of which falls in the target sections in Khanh Hoa Province.

Table 2.1.13 Marine Protected Areas at Each Province

No	Province/City	Name of Protected Area	Inland Area (ha)	Marine Area (ha)
1	Ha Noi	-MPA is not yet planned.	-	-
2	Ha Nam	-MPA is not yet planned.	-	-
3	Nam Dinh	-MPA is not yet planned.	-	-
4	Ninh Binh	-MPA is not yet planned.	-	-
5	Thanh Hoa	Hon Me MPA (Planned)	500	6,200
6	Nghe An	-MPA is not yet planned.	-	-
Total			500	6,200

Source: Website of Vietnam Development Forum
(<http://www.vdf.org.vn/Doc/2009/119WSVuThiHoaiThu21Oct09.pdf>)

4) Protected areas by International Treaty/Agreement (Ramsar sites, World Heritages and ASEAN Heritages)

2.82 Following areas are protected by international treaties on the natural environment. There are not World Natural Heritages or ASEAN Heritages in the target provinces in the north section.

Table 2.1.14 Protected Areas by International Treaty/Agreement at Each province

No	Province/City	Type	Name of Protected Area	Area (ha)
1	Ha Noi	-	No natural protected area by international treaties exists.	-
2	Ha Nam	-	No natural protected area by international treaties exists.	-
3	Nam Dinh	Ramsar	Xuan Thuy Natural Wetland Reserve	12,000
		Biosphere reserve	Red River Delta Biosphere Reserve (starching out in three provinces, Thai Binh, Nam Dinh and Ninh Binh Provinces), and total area is 726,798 ha	726,798*
4	Ninh Binh	Biosphere reserve	Red River Delta Biosphere Reserve	726,798*
5	Thanh Hoa	-	No natural protected area by international treaties exists.	-
6	Nghe An	Biosphere reserve	Western Nghe An Biosphere Reserve	1,303,285
Total				2,042,083

Note: *726,798 ha is the total area of Red Delta Biosphere Reserve in three provinces
 Source: Fourth CBD Report, UNESCO website, IUCN website, Ramsar Convention website

5) Other Important Areas to be Concerned (IBA and EBA)

2.83 According to the information from Birdlife International, following Important Bird Area (IBA) and Endemic Bird Area (EBA) are found in the target section.

Table 2.1.15 Other Important Areas to be Concerned

No	Province/City	Type	Name of Protected Area	Area (ha)
1	Ha Noi	-	No IBA exists.	-
2	Ha Nam	-	No IBA exists.	-
3	Nam Dinh	IBA	Xuan Thuy	12,000
		IBA	Nghia Hung	7,600
4	Ninh Binh	IBA	Cuc Phuong	22,200*
5	Thanh Hoa	IBA	Cuc Phuong	22,200*
6	Nghe An	IBA	Pu Mat	91,113
	Hanoi-Nghe An	EBA	Annamese lowlands	5,100,000*
Total		IBA		132,913
		EBA		5,100,000*

Source: Birdlife International Webpage (2012), EBA area stretches from Hanoi to Da Nang, over Vietnam and Laos territory.

2.1.5 Landscape

2.84 The only information available on important landscape is the landscape protection area category under the special-use forest. Besides these areas, there are other areas of natural and cultural importance. Following table shows the major landscapes known in the city/provinces in the north section.

Table 2.1.16 Characteristics of Landscape at Each Province

No	Province/City	Description
1	Ha Noi	<ul style="list-style-type: none"> • Huong Son Landscape Protection Area • Hanoi City area has a plenty of sites of cultural importance.
2	Ha Nam	<ul style="list-style-type: none"> • No information was available.
3	Nam Dinh	<ul style="list-style-type: none"> • No information was available.
4	Ninh Binh	<ul style="list-style-type: none"> • Hoa Lu ancient capital area has the culturally important landscape • Karst formation area represented by Tam Coc.
5	Thanh Hoa	<ul style="list-style-type: none"> • Den Ba Trieu landscape protection area • Lam Kinh landscape protection area • Ngoc Trao landscape protection area • Ham Rong Cultural Relics (War Relic from Vietnam-US War)
6	Nghe An	<ul style="list-style-type: none"> • No information was available.

Source: JICA Study Team

2.1.6 Forest

2.85 The forest area is classified into three categories, namely protection forest, production forest, and special-use forest. The special-use forest is the protected areas discussed in 2.1.4 above. The protection forests are mainly situated in the mountainous area for soil conservation, river bank for erosion control, and for coastal area for wind break and sand protection.

2.86 In the north section, Thanh Hoa and Nghe An Provinces have large forest areas in the western hilly areas, while there is coastal vegetations along Nam Dinh, Ninh Binh, Thanh Hoa and Nghe An Provinces being regarded as important.

Table 2.1.17 Forest Area by Type

.Unit: Ha

No	Province/City	Forest Ratio	Protection	Production	Special-use	Sub-total
1	Ha Noi	7.1%	2,936.64	1,703.95	1,404.41	6,045
2	Ha Nam	8.6%	6,279	2,489	0	8,769
3	Nam Dinh	1.7%	2,917.16	0	85.43	3,002.59
4	Ninh Binh	19.1%	12,443.6	459.26	17,948.24	30,851.10
5	Thanh Hoa	46.7%	232,816.56	249,302.14	83,921.75	566,040.45
6	Nghe An	51.0%	527,111.98	313,386.52	178,404.59	1,018,903.09
Total			784,504.94	567,340.87	281,764.42	1,633,610.23

Source: DONRE/DARD of each province, compiled by JICA Study Team.

2.1.7 Biodiversity

2.87 The biodiversity is under threat through the socio-economic development, especially by the pressure on landuse change from forest to development area, excessive water use and water contamination. Along the north section, the forest remains in the hilly area in the western side of the provinces, while there is effort by the government to manage and conserve mangrove and coastal vegetation in the eastern coastal area.

Table 2.1.18 Characteristics of Biodiversity at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	The 2008 Environmental Current Status report, Chapter III- Heading V, page 288-319.	Due to the socio-economic development of the area, natural vegetations remain only in protected areas, namely Ba Vi National Park and Huong Son Landscape Protection Area. West Lake. Other than these areas, dominant ecosystem is flat paddy area
2	Ha Nam	Annual environmental status report in 2010, Chapter 6, pp.46-49.	Ha Nam has 4 typical natural ecological systems. Ha Nam has 51 species of plants at high level with different ecological amplitude.
3	Nam Dinh	The Environmental Status Report period 2005- 2009, Chapter VI- page 91 to page 100	The major forest ecosystems exist in the mangrove forests, coastal area, and small area of inland mountainous area. XuanThuy National Park serves as the home for migrating birds including many endangered species.
4	Ninh Binh	Five Year Environmental Status Report period 2005-2009, Chapter 7, pp.102-122.	Ninh Binh is the province with diversified and rich ecosystems, divided into five distinguishing systems: forests on limestone mountains ecosystem, hilly ecosystem, delta ecosystem, marine ecosystem, and coastal ecosystem.
5	Thanh Hoa	Environmental current status report 2006- 2010 period, Chapter 4- page 119 to page 125	There are two national parks and four nature reserves in the province, where rich flora and fauna were recorded. Recently, both flora and fauna are degraded due to over exploitation of the forest resources.
6	Nghe An	Environmental current status report 2005- 2009, Chapter 7 – page 95 to page 105	Western part of the province is recognized by UNESCO to be biosphere reserve, where the large forest ecosystem exists. However, the ecosystem has been degraded due to illegal logging, excessive hunting/fishing with illegal trading.

Source: DONRE, compiled by JICA Study Team,5ECSR/2005-2009/Nghe An DONRE

1) Biodiversity in Hanoi City (2008 Environmental Current Status Report of Hanoi City)

(1) Biodiversity and Ecosystem

(a) Diversity of Landscapes and Ecosystems

2.88 Laying with the Northern Flatland, Hanoi has only 2 types of landscape terrain, such as: the low hilly – mountainous terrain and the flatland one. For the ecology, the flora and fauna of Hanoi's natural ecosystems (both the terrestrial and subaqueous ones) perform the typical characteristics of those landscape types.

(b) Diversity of Terrestrial Ecosystems

2.89 Based on the basic characteristic as the specifically covered vegetation, Hanoi has the endemic ecosystems as follows:

- The forests located within the shallow areas (planted forests or restored forests): these ones are located concentrated in the hilly and mountainous areas of Soc Son.
- The wilderness: these ones are distributed in the rural districts.

2.90 However, the low-land forestry vegetations have the greatest biodiversity.

2.91 Based on the landscape terrain and the external morphological appearance, the ecosystems can be classified into the on-rocky-mountain ecosystem, the soil-mountainous and the hilly one. In addition, based on the land-use models, there are the agricultural ecosystem and the urban one.

(c) Diversity of Inland Fresh-water Basin Ecosystems

(i) Spring

2.92 This water basin is only distributed in the hilly and mountainous terrain or at the upper-stream of the major rivers. The endemic aquatic creatures are aquatic flora (macrophyta), the plentiful larva of the insects, Thiaridae, Viviparidae, small-fish species.

2.93 The rock-sticking alga species, which are the basic living conditions of many fish species and the invertebrate-fauna, develop well due to the great transparency. This ecosystem has great rate of the endemic species. Moreover, there are many species which are living within this ecosystem have not been discovered. The spring water-basin is distributed only in the hilly-zone of Soc Son district (at the location near Tam Dao mountainous zone).

(ii) River

2.94 This is an important living environment of the fish species. The riverbed fauna is very plentiful with shrimp, crabs, clams, snails. The flood season is the important time of many river fish species which has given their eggs out within, before or after the flood-season. Hanoi has Red River system of which the tributaries are Duong and Nhe; furthermore, there is Ca Lo River which is a tributary of Cau River at the northern area. However, with the urban features, Hanoi has also the system of the wastewater drainage-rivers, such as: To Lich, Kim Nguu, Set of which the environmental water quality is so bad; hence, the aquatic creature system is less abundant; there are mainly the low-level creatures which prefer to living in an anaerobic environment with great organic volume.

(iii) Rivulets, Canals and Culverts

2.95 The rivulets and canals are concentrated mainly in the rural areas to take the role in the irrigation. The aquatic creature system is less abundant and has no endemic species.

(iv) Lake

2.96 This is a specific feature of Hanoi. Depending on the topographic condition, Hanoi is the locality which has the greatest number of lake within Vietnam. According to the statistic data of Hanoi Water Drainage Company (the data of 2001), Hanoi has about 110 natural and artificial lakes and ponds. In the urban area, there are 24 lakes of which the total water-surface area is 765 ha and the total water volume is 12.5 million m³. The water-levels of lake are so different between the dry-season and the rainy-season (1 to 1.5 m), so the rainy-water regulation capacity of these lakes is relatively great. The roles of Hanoi's lakes are specified as below:

- Rainy-water regulation;
- Landscapes, historical Storing and supplying water for irrigation purposes;
- Supplementing for the ground-water source;
- Receiving and storing the deposited matters;
- Climate regulation;

- For sporty – entertainment – tourist activities;
- Wild animal sources, biodiversity;
- Aquaculture (fish, mollusca);
- Cultural features.

2.97 Among Hanoi's lakes, West Lake (Ho Tay) is the most significant. This one has 540 ha of the water-surface area and the most beautiful landscape. With the specific characteristics, the lake has itself specific creature system. The fish species are mainly the ones of which the foods are at or near the surface of lake. The lake-ecology is threatened with the migration of many strange fish species, pollution, eutrophication, water-level change.

(v) Ponds

2.98 The ponds' sizes are smaller much then the lakes' ones. Many ponds were dug to breed fish; besides, there are also many natural ponds which have been wild. The average depth of these ponds is around 1m; the pond-bed is mud layer of which the thickness is 20 to 40cm. The ponds contain a great nutrient volume. Within the pond environment, the overload aquatic creatures develop greatly. The pond-bed creature system is main Giun-it-to (Oligochaeta).

(vi) Wet-rice fields

2.99 This is specifically water-basin of the tropical area of ASIA. The water-level is shallow and depends on the seasons. The temperature of water environment is high, the aquatic creature system is less abundant, the dissolved oxygen concentration is small. The wet-rice fields are mainly distributed in the rural districts.

(vii) Reservoirs

2.100 These are the artificial water-basins. In the initial period of the overload water volume, these ones must perform the anaerobic stage and be polluted with some poisonous substances due to the terrestrial vegetation such as phan huy. As the survey data, there are some reservoirs only in Soc Son district.

(viii) Lagoons

2.101 The endemic one for this water-basin is Van Tri lagoon (in Dong Anh district). Due to the natural features, the temperature ratio within these lagoons is often higher and the dissolved oxygen concentration is smaller (compared with the indicators of the other water-basin types). Within the lagoon ecosystem, the developed aquatic-flora is the basic conditions of the invertebrate-animals developing plentifully at the lagoon-beds. Most of fish species living within the lagoons are the atmospheric-air-based breathing species, such as Siluriformes.

(2) Reasons of Biodiversity Degradation

(a) Over-exploitation, unsustainable utilization of biological resources

2.102 The municipal people in general and the ones in Soc Son district in particular have been utilized the biological resources (wood extraction, wild fauna hunting and catching, deforestation for firewood, etc.) with the destructive ways (electric and mine are used for fishing,). In recent years, the rural population increase rapidly; in addition, the consumption models of the urban people have been changed; the traffic network has developed. Thus, Hanoi has been accessible more and more for both the internal and the external markets. These great changes are causes of the over-exploitation on the biological resources that leads to the biodiversity degradation.

(b) Land-use Reform

2.103 In recent years, the socio-economic development demands have narrowed the area of the natural ecosystems which have great biodiversity or transferred this area into the secondary-ecoystems, such as: the developments of infrastructure, urban areas, etc. Therefore, the habitats of creature species have been separated or isolated into the small scattered zones that prevent the migration and the exchange between the wildlife groups. As the results, many tiny creature populations, which are in the great risk of being destroyed, have been formed.

(c) Environmental Pollution

2.104 Besides the global climate change (the increased temperature, the risen CO₂ volume), Hanoi's environmental quality have been urgent at some locations and sometimes. Most of lakes within Hanoi, the residential zones and the other urban area have been impacted with the eutrophication which are the cause of the phytoplankton blooms (alga bloom). It should be focused that the *Microcystis* spp., which is an hazardous alga affected to the habitats of many aquatic creature species as well as to the water environment, plays an important role in the phytoplankton blooms within the inland lakes.

2.105 In addition, the pesticides used for agricultural cultivation and the untreated wastewater discharged from the factories and enterprises have affected to the creature habitats as well as threatened to the human health.

(d) Imported Invasive Species

2.106 In recent year, many imported invasive flora seedlings have made up an economic efficiency. However, the uncontrolled introduction of some new seeds and pets can potentially affect to the indigenous species, which can be extinct since they had to compete and fight for the habitats and the food sources. Moreover, the new ones can bring with the epidemic diseases which will affect to the indigenous species.

(e) Weak management capacity

2.107 To assess on the shortcomings of environmental and biodiversity protection, Polictis Ministry's Resolution No. 41-NQ/TW indentified that "The natural resources have been over-exploited without plans at many locations; the

biodiversity is threatened seriously”. Besides the above mentioned reasons, the biodiversity protection and management has been weak; especially, it should be focused that the management on Hanoi’s lakes has not been synchronous. Depending on the functions of lakes (detention reservoirs, tourism, culture–history, etc.) the authorities are assigned to manage the lakes. There maybe 4 agencies/ sector which together manage Guom Lake (Hoan Kiem Lake). At present, the agencies which take part in management on Hanoi’s lakes are Ha Noi Water Drainage Co., Ho Tay Investment and Exploitation Co., PMU of The Project constructing the infrastructural facilities surrounding West Lake, Ha Thuy Co., Park Co., Hanoi Culture–Sport–Tourism Department, Hanoi Zoo, People’s Committees of districts as Ba Dinh, Hoang Kiem and Tay Ho.

(f) Others

2.108 Hanoi’s population has trend to be increased (both the natural population increase and the mechanical one) that will certainly make up a pressure which leads to the over-exploited natural resouces, especially the biological resources. On the other hand, the population growth also leads to the environmental pollution during the production and the consumption.

2.109 Hanoi is the capital as well as a developing economic hub of Vietnam. During the progress of economic development, industrialization and urbanization, the infrastructure has been developed rapidly (traffic network, power supply, services, tourism). The socio-economic development and the arisen waste discharging sources will certainly impact to the environment in general and to the biodiversity in particular. The construction of infrastructural facilities, especially the traffic lines (roads) has narrowed the habitats of wild animals as well as separate or isolate their continuous habitats.

(3) Change Trend of Biodiversity

2.110 During the socio-economic development, Hanoi’s biodiversity has made many important changes. Besides the positive activities of biodiversity, the risks threatening to the biodiversity have been increased, especially in the recent years, due to the socio-economic development pressures. Hence, Hanoi’s biodiversity has trend to be depredated, specifically as follows:

(a) Impacted Ecosystems

2.111 According to the studies on West Lake’s ecosytem, the lake has a great risk of organic pollution which is caused by the greatly N and P-nutrient contained waste-water from the residential zones. On the other hand, the solid waste is discharged without control at the watersides, especially at the locations along Thanh Nien street. The eutrophication within West Lake as well the other lakes often causes of the phytoplankton blooms. During the blooms, some algae species, especially *Microsystis*, discharge the toxns into the water environment. After the phytoplankton blooms, a huge volume of dead algae make seriously bad smell. The dead algae sink to the bottom of lakes and reduce the bottom oxygen, hence, many fish and aquatic species are killed.

(b) Both the and subaqueous ones

2.112 Forests are perfect home for most of wildlife species of terrestrial ecosystems, especially the vertebrates (mammals, birds, reptiles). According to the studies on Soc Son hilly ecosystems, the pressures of socio-economic development has destroyed the natural forests of this region; Soc Son has had only some areas of planted forests of which the biodiversity is not bad. The infrastructural developments at the hilly area where the biodiversity is great have separated and isolated the wild animal's habitats into the scattered narrow areas; so the fauna populations have high risk of extinction.

(c) Reduced Quantity of Flora and Fauna

2.113 As the result of studies and the statistic data, the quantity of many rare and precious species have been reduced remarkably. The reasons of this situation are the over-exploitation and the lost habitats of wildlife creatures.

(4) Countermeasures in Biodiversity Conservation

(a) Forest-Fire Prevention Measures

2.114 To conduct the forest fire fight effectively, the province has established a system of forest-fire fight and prevention boards which comprise one municipal one, seven district boards, 47 communal ones and 59 forest-fire fight and prevention teams. In addition, the province has developed the forest-fire forecast station, the reservoirs and 55 km of fire-prevention runways, etc. In recent years, there have not mostly been any forest-fire incidents; but there have been some small fires at the forest-edges (these were mainly by the local people's activities, such as; smoked bees and animal trapping. The forest-ranger staffs, the local government and people have made the great efforts to achieve the above mentioned results of the forest protection. However, it is necessary to invest more equipment and devices for the forest protection. Most of the fire-fighting equipment, devices and means are the rudimental ones which have not meet the requirements of the perennial and effective forest-fire prevention and fighting.

(b) Measures of Natural Forest Protection and Preservation

2.115 To supplement more the forest-ranger staffs who protect the special use forests and the protective forests, especially Ba Vi National Park and Huong Son-My Duc forest to protect effectively the available natural forest area, to maintain the precious and indigenous gene sources;

2.116 To educate and propagandize to enhance people's awareness of forest protection; To combine synchronously between the environmental protection and ecotourism;

2.117 To give out the strict sanction for the forest-related violations (exploiting, transporting, buying and selling the animals and wood illegally;

2.118 To invest to supplement more devices and means for preventing the forest-fires caused by human and natural conditions.

(c) Environmental Protection within the Special Use Forests

2.119 The special use forests play the major roles as the natural protectors, the national ecosystem standardized-models, the forestry flora-fauna gene sources,

the scientific study service, the historical – cultural relic and landscape preservation zones, the tourism zones. Hence, the special use forest environment protection takes an important part in the preservation and development of the forest ecosystem, the flora–fauna gene source, the forest animals as well as the scientific studies. Thus, the organizations and individuals who run the business of tourist services within special use forests have responsibilities to protect these ones (not deforesting cutting/ falling-down trees/ plants, not trapping and hunting the rare and precious wild animals, etc. as well as securing the sustainability of tourism environment.

(d) The Result of 5 Million Hectare Afforestation Project

2.120 The project “afforesting newly 5 million hectare of planted forest within Ha Tay (the old province) has been implemented since 1999 (as the report of Ha Tay DARD in Document No.41/SN-BCDA dated May 5th year 2008): Up to present, the project has planted 2,636.8 ha, taken care 10,560.8 ha, protected 30,094.4 ha. However, these ones have not the expected targets. These planted forests are located mainly in Huong Son, Ba Vi, Son Tay, Chuong My and No.1 Army Infantry General’s School. The forest management organizations are the local forest management boards, the households who have been allocated the forestry area for protection, the individuals or organizations who plant, take care or protect forests. The major flora species which are afforested within the planted forests are *Sau (Dracontomelon duperreanum)*, *Tram (Burseraceae)*, *Bo De (Styrax tonkinensis)*, *Lat-hoa (Chukrasia tabularis A. Juss)*, *Nhan (Euphoria Longana)*, *Vai (Litchi chinensis)*, etc. Furthermore, in these forests, there are also the supporting-trees of which the major ones are *Keo-tai-tuong (Acacia mangium)* or the agricultural crops. In the initial years, these forests were not covered with full-canopy.

(e) The Socio-Economic Achievements of the Project

2.121 The project has created jobs, improved the living standards of the labor force of communes as well as enhanced people’s awareness of forest protection and development.

2.122 Furthermore, the project has taken part in the green-covering of the bare-hills and mountains within Hanoi. The local people have been allocated to protect and developed; initially, they have used the allocated forest area effectively and in the right-purposes.

(5) To Enhance Afforestation in Period 2006–2010

2.123 To complete the targets covering the bare hills and mountains with greeneries, protecting the available forest area, preserving and developing the natural forests, rising the forest-covered rate from 7.4% to 8.6% as well as improving and minimizing the environmental pollution.

2.124 To plant the urban forests and trees within the historical – cultural relic and landscape preservation zones to make up the landscapes, to attract the both domestic and foreign tourists as well as to take part in the local economic development, the local people’s income improvement.

2.125 To research to plant the multi-function species which can protect the ecological environment and have great economic-values.

2.126 To protect 10,442 ha of the available forest area in Ba Vi and of the project 661 within Hanoi. To zone to preserve, protect, develop and restore 1,132 ha of special use forest in Huong Son. To afforest newly 3,500 ha of forests in Ba Vi, Chuong My, Son Tay and the the zone surrounding Huong Pagoda mountains.

2.127 To afforest to replace the available forest area which has not met the requirements of the protective forests, has bad quality or are the productive forests which it's time to be exploited.

2) Biodiversity in Ha Nam Province (Annual Environmental Status Report in 2010)

(1) Current Situation and Progress of Biological Diversification Recession

(a) Current Situation of Forest Area

2.128 Ha Nam has 7,550 ha forest square, of which 5,232 ha for natural forest, 2,318 ha for planted forest, 629,98 ha for planning land for forestry.

2.129 Thanh Liem and Kim Bang districts have special used forest and planted forest for greenery cover. Plants in these areas are raspberries, grass...and some long life plants or wooden plants. There have been many forest exploitations that did not follow forest protection regulation causing the reduction in land for forest.

2.130 However, there have been many programs on planting forest in order to cover the greenery; Ha Nam has implemented the program well. The planting and forest development activities have been concerned more thoroughly. In 2008, Ha Nam planted 56 ha, protected 4,380 ha, and developed 1,694 ha.

Table 2.1.19 Current Forest Area by Forest Type

Unit: Ha

No	Item	2000	2005	2006	2007	2008	Change in 8 years
1	Natural forest square	7,752	6,871	6,782	6,240	5,232	-2,520
2	Planted forest square	1,684	2,222	2,181	2,253	2,318	+634
3	Total forest square	9,436	9,093	8,963	8,493	7,550	-1,886

Source: Statistical Yearbook 2008

2.131 Reasons for biological diversification recession

- Over load natural resource exploitation makes the unbalanced ecological system
- Construction material processing industry in Hanoi has developed strongly in recent years. Limestone mountainous square is being narrowed to reduce land for coverage and lose the ecological system for limestone mountain.
- Wooden demand and wild animal hunting is increasing, leading to the biological diversification recession.
- Cultivation technology, vegetable protection in order to increase plant productivity
- Abuse vegetable protection chemicals and fertilizer to increase plant productivity lead to the loss of benefit microorganism and creature and cause biological diversification recession.

- Industrial development and urbanization
- The urban and industrial development narrow the agricultural land squares, which increase the urban waste, of which there is toxic and dangerous chemicals, cause the imbalanced ecological system.
- Ha Nam is suffered from big waste source from Hanoi city, which cause Nhue, Chau Giang and Day river pollution and effect to natural animals and plants.
- Forest fire effects to some valuable animals and plants.

(2) Plant Ecological System

2.132 Ha Nam has 4 typical natural ecological systems. Ha Nam has 51 species of plants at high level with different ecological amplitude.

(3) Forecast on Biological Diversification Recession

2.133 In coming years, construction material industry will become one of key economic sector in Ha Nam, it means the area of limestone mountains will be narrow and lead to the loss of ecological system on mountain as well as the animal or plants.

2.134 Industrial and urban development lead to the increase in waste water from Hanoi and other parts in Ha Nam flowing to rivers in Ha Nam. Surface water in Ha Nam rivers and lakes is polluted seriously, and many valuable plants as well as animals, plants are going to disappeared.

3) Biodiverstiy in Nam Dinh Province (5ECSR period 2005-2009 of Nam Dinh Province)

(1) Current Conditions and Changes in Biodiversity Degradation

2.135 In order to have an overall assessment current conditions and changes in biodiversity degradation in Nam Dinh Province, the report shall analyze the variety characteristics of species and gene pools in agricultural production; biodiversity of mangrove forests in Xuan Thuy national park and Nghia Hung coastal alluvial deposits; biodiversity in forest eco-system.

(a) Species and Gene Pools

2.136 For species which are selected to grow and breed:

2.137 Main food plants selected to cultivate include rice, corn, peanut, potato, soybean, etc.

Table 2.1.20 Production Volume of Plants in Nam Dinh Province

Unit: Ton

No	Output	2005	2006	2007	2008	2009
1	Rice	782,549	964,259	931,769	929,061	889,020
2	Corn	18,672	19,659	17,086	19,111	17,893
3	Peanut	22,722	24,855	24,232	25,729	21,170
4	Soybean	4,469	5,298	5,584	5,368	3,963
5	Potato	44,125	46,175	35,648	35,574	29,031
6	Other kinds of second crop plants	334,561	429,009	357,474	356,588	305,299

Source: Nam Dinh DARD

2.138 Domestic cattle are mainly: buffaloes, pigs, cows, and poultry, etc.

Table 2.1.21 Quantity of Poultry and Cattle in Nam Dinh Province

Unit: No. of Livestock

No	Domestic Cattle	2005	2006	2007	2008	2009
1	Pigs	774,975	832,205	810,558	748,025	747,068
2	Poultry	5,398,507	5,278,354	5,405,583	5,533,482	6,051,746
3	Cows and Buffaloes	48,026	53,893	55,547	48,173	43,631

Source: Nam Dinh DARD

2.139 In recent years, poultry herds tend to increase while the opposite trend is happening in herds of cows and buffaloes. In localities, there appears many farm models, extensive industrial farming model like: model of raising super lean pigs, super egg ducks.

2.140 Fresh water creatures, which are raised in ponds, swamps, lakes, are mainly species of high economic value like: grass carp, silver carp, carp, mud carp, crayfish, etc. Besides that, other types of marine creatures of high economic value like: trionychid turtle, frog, snake, Taiwan Tilapia, snakehead fish, spotted catfish, climbing perch, pangasius, are also being raised and developed in Giao Thuy, Hai Hau, Nghia Hung, Truc Ninh, My Loc.

2.141 Other marine creatures in brackish water and salt water are mainly prawns, clams, sea crabs. In recent years, a few species of high economic value are also being raised like: *glacilaria asiatica*, *bostrichthys sinensis*, *epinephelus*, *Litopenaeus vannamei*, male tiplapia, etc.

Table 2.1.22 Production Volume of Aquaculture at Nam Dinh Province

Unit: Ton

No	Output	2006	2007	2008	2009
1	Freshwater	17,239	18,327	19,923	22,460
2	Brackish water, Salt water	16,322	14,083	19,759	19,739

Source: DARD

2.142 Outstanding characteristics of biodiversity in agricultural eco-system are that there are only a few species due to mono-farming method. Selected species often have pre-eminent features in terms of productivity and quality. Therefore, breeds created by cross-breeding or imported from other places have led to the disappearance of local species.

2.143 At present, there has been a change in use purpose of cultivation land. Specifically in coastal areas like Giao Thuy, Hai Hau, Nghia Hung, rice fields and land for salt production have been shifted to aquaculture land (Nam Dinh provincial people's committee approved 2 projects on the production of aquaculture breeds and 18 projects on changing low productivity rice fields and sedge and salt production land to aquaculture farming land with total area of 953 ha); some places in Nam Dien commune have also implemented conversion of rice fields into land used for growing flowers, bonsai. Some places also changed agricultural land into industrial land. In addition, due to population growth, demand for housing land is growing. Change in land use purpose is the factor impacting output of agricultural production. Accordingly, the number of domestic cattle and plants has also changed to meet the demand for food of residents.

(b) Natural populations of animals and plants:

2.144 The overuse of pesticides has affected the helpful species and led to their reduction in number. Details are as follows:

- (i) There is a significant reduction in the number of fish, shrimp, and small shrimp in low-lying fields.
- (ii) Crabs, frogs, snakes, gastropods have become rare
- (iii) Helpful raptors have almost disappeared.
- (iv) Population of helpful insects have also decreased.

(c) Mangrove Forest

- Mangrove Forest in Xuan Thuy National Park:

2.145 Total area of Xuan Thuy national park: 7,100 ha, of which floating land with forest covering 3,100 ha while flooding land covering 4,000 ha. This is the 1st national park of our country participating Ramsar treaty. This area is known to the world not only for being the largest mangrove forest in Vietnam but also for being the largest “platform” in the Indochina area on the migration way to avoid winter of bird from the North to Australia and vice versa.

- Changes in Eco-system of Mangrove Forest:

2.146 The coverage of mangrove forest has increased due to afforestation in areas, which were deforested before. However, the increasing coverage does not result in an increase in biodiversity. Some species like: *Sonneratia*, *aegiceras*, bear’s breech develop rapidly. On the other hand, other species like *Ixora coccinea* fail to adapt to the environment. *Ixora coccinea* is very helpful for shrimp, fish and other living things in water. The reduction in *Ixora coccinea* has negative impacts on marine creatures in particular and living things in water in general.

2.147 Biodiversity has significantly reduced due to overexploitation and irrational aquaculture planning. The use of toxic chemical substances, the rapid development of shrimp ponds, and oyster farming have reduced the number of ephemera, badly affected habitats of living things like migrating birds and other marine creatures.

2.148 Biodiversity in marine creatures is also affected due to destructive exploitation and water contamination.

2.149 Biodiversity in planted trees grows due to the fact that local residents imported fruit trees and shadow trees from other places to the province. Structure of domestic cattle has also changed to increase productivity and quality.

2.150 Exploitation of medicinal plants in National Park happening at high scale has reduced the number of medicinal plants out in the nature.

(d) Forest Eco-system

2.151 Nam Dinh has 3 main forest eco-systems: mangrove forest, coastal protection forest, mountainous and hilly protection forest.

2.152 Mangrove forest and coastal protection forest are mainly located in Xuan Thuy national park and Nghia Hung alluvial deposit, among which Xuan Thuy national park is the largest mangrove forest in the north.

2.153 In Xuan Thuy national park, mangrove forest develops on muddy terrain while casuarina forest develops on sand mound. Natural forest area in Xuan Thuy national park is up to 2,000 ha; buffer zone has more than 1,000 ha mangrove forest. Xuan Thuy national park has flooding habitats like:

2.154 Habitat with mangrove wood trees: this kind of habitat has a complex of flora like: Sonneratia, aegiceras, bear's breech. Area: 1,596 ha.

2.155 Habitat on shrimp ponds: mainly distributed in the northern Con Ngan and a small area in the middle of Lu mound right next to Vanh Luoc dyke. Area: 182 ha.

2.156 Casuarina forest habitat: casuarina forest is planted in narrow forest strips right next to the sea. Casuarina forest can be used to protect mangrove forest from wave and sand. It is also the habitat of birds. Therefore, it is necessary to encourage forest protection and growing. Area: 97 ha.

2.157 Forest area in Nghia Hung coastal alluvial deposit is 2,000 ha. Casuarina protection forest is planted along dykes and Con Mo mound. Mangrove forest is planted on sandy mud strips or mud from coastal area of Nam Dien to Con Mo, creating habitat for krills.

2.158 Hilly and mountainous protection forests of Nam Dinh Province: not many mainly distributed in Vu Ban, Y Yen. Area: 100 ha. Main trees: acacia, pine, eucalyptus.

(2) Reasons of Biodiversity Degradation

2.159 Irrational exploitation and use of natural resources are the major reasons of biodiversity degradation. Detail is shown below.

(a) Population Pressure

2.160 Economic life of a majority of people, especially people living in coastal areas mainly depends on the exploitation of natural resources. As population grows, the use of natural resources, including biological resources at the top, is increasing. The overexploitation of natural resources is resulting in biodiversity degradation. In rural areas, economic development can be obtained mainly thanks to agricultural production development; therefore, the biggest pressure is the increasing demand for land used for cultivation, farming, aqua-culture. Such increasing demand leads to the shift in land use purpose, which brings about changes to biological habitats, causing significant impacts on natural eco-system. Rapid urban and industrial development has put some pressures on environment and biodiversity. The expansion of urban space and industrial zones have decreased agricultural land, changed land use structure and degraded biodiversity.

(b) Unsustainable Exploitation

2.161 The overexploitation of marine products and the use of destructive exploitation means are contributing to the decline in biodiversity. At present, despite prohibition from local authorities, people still secretly use electrical surge

methods to exploit marine products in lakes, ponds, ditches, canals, and low-lying fields. Fish catching by electrical surge is rather simple, which can help farmers collect a large quantity of fish and shrimps but can destroy a variety of other creatures. The exploitation by net with small loop can help collect even small marine creatures, which causes significant reduction in species of creatures.

(c) Environmental Pollution

2.162 Waste arising from economic and residential activities is causing more and more serious pollution. At present, in industrial activities, a majority of wastewater remains untreated before it is dumped into the environment; waste fails to be effectively treated especially in rural areas. Overuse of pesticides and fertilizers is also resulting in serious environmental pollution. Residential activities are dumping more and more waste. In addition, awareness of environmental protection remains low; the waste treatment and management proves to be ineffective. Environmental pollution can also originate from aquaculture ponds and boats, which dump waste water into environment; or natural disasters like storms and floods.

2.163 Toxic components of waste when spread into environment shall become a factor causing changes to habitats of creatures, which may lead to the death of creatures.

(d) Climate Change

2.164 According to reports of IPCC, people's health, eco-systems and socio-economic systems all are impacted by climate change. Vietnam is one of few countries mostly affected by climate change. Nam Dinh, being contiguous to the sea and being the downstream of the Red river delta, therefore, has to suffer from many impacts of natural disasters such as:

- (i) Destroy habitats; narrow down habitats of creatures; reduce a great number of species.
- (ii) Destroy sources of nutrition, water for creatures.
- (iii) Change characteristics, practices of a number of creatures.
- (iv) Relations between creatures in the ecosystem change due to impacts of natural disasters, especially when nutrition chains are broken.
- (v) Natural disasters can cause variation in a number of species of creatures especially low level creatures. Therefore, new species of creatures can appear.

(3) Forecast of Changes in Biodiversity Degradation

2.165 Natural species shall experience a reduction: living things populations reduce due to overexploitation and overuse of pesticides.

2.166 Changes in plants and domestic cattle: new breeds of plants with high productivity accounts for increasing area. Local breeds are narrowed down and can be lost if not used.

2.167 Area and quality of mangrove forests shall be reduced: the shift in land use purpose in coastal flooding areas to agricultural production land, aquaculture land has made mangrove land, natural resources especially living things reduce.

4) Biodiversity in Ninh Binh Province (5ECSR period 2005–2009)

(1) Changes in Bio-Diversity

2.168 Ninh Binh is the province with diversified and rich ecosystems, divided into five distinguishing systems: forests on limestone mountains ecosystem, hilly ecosystem, delta ecosystem, marine ecosystem, and coastal ecosystem. Each of these ecosystems is featured by typical characteristics in terms of species and population, which determine biodiversity.

2.169 Marine plants and animals include species living in water bodies (lakes, ponds, swamps, rivers, springs, and coastal submerged areas)

2.170 Floating plants: 187 species identified, including 88 species in fresh water (under 4 algae phylums) and 99 species in coastal areas.

2.171 Marine animals include 30 floating species, 45 bedding animals (fresh water). For coastal area, there are about 30 floating species, 188 bedding species, more than 100 sea fish species.

(a) Terrestrial Plants and Animals

(i) **Plants:** there are about more than 2000 species, including 230 families, of about 436 species of wood trees with trunk diameters of 30-100 cm, 226 species of herb trees, 145 species of decoration trees, 98 species of rare and specious trees, many of these listed in the World and Vietnamese Red Book.

(ii) **Animals:** 233 species of vertebrate animals, 64 species of mammals, 140 species of birds, 40 species of reptiles, 20 species of amphibians, 1,800 species of insects. 40 species are listed in Vietnamese Red Book

(b) Summarized Main Reasons for Recent Degrades are as Follows:

2.172 Unplanned land use: conversion of forest lands and submerged areas into agricultural land and aquatic farming areas; urban expansion and infrastructure development has have led to destruction of ecosystem and habitats. Fresh-water submerged land is now facing threats from irrigational system and conversion into rice fields. Urban space expansion has cause the shrinking of agricultural and forestry land, the change in land use structure and also reducing biodiversity. Narrowed greeneries and water surface have caused serious consequences of several species of creatures.

2.173 Unsustainable use of bio-resources: poverty is one of the reasons for such unsustainable usage. Poverty may often lead to:

(i) Over exploitation of aquatic resources, usage of mass-killing means

(ii) Unplanned wood logging

(iii) Hunting and trading of wild animals in an uncontrollable manner.

2.174 Intrusion of foreign species: the intrusion of foreign species such as pomacea caniculata and Eichhoriacrassipes is just a serious threat to local bio-diversity. Their drastic growth have caused negative impacts on the environment, over dominating local species, destroying crops and reducing productivity of plants and husbandry.

2.175 Environment pollution: Environment pollution caused by various sources is

believed the reason to threat local bio-diversity: leading to death and reduction of animal population, destroying local structure and habitats as well as living environment of creatures.

2.176 Forest fire: Forest fires often have serious impacts on living environment and bio-diversity for local areas.

2.177 Besides, due to tourism development orientation set forth by the province, eco-tourism has been the priority for the province. If tourism development plan is inappropriate, tourism activities can even cause destruction of natural landscape, and reducing bio-diversity in that sense.

(2) Forecasts and Measures

2.178 In the near future, Ninh Binh will become an attractive tourism destination at national and regional levels, and will also have several industrial zones and clusters put into operation. The issues on landscapes and ecosystem as well as biodiversity will be even hotter due to more serious impacts. For protection, there is a need for integrated measures in environmental protection framework. It is also important to implement strictly the plan for mining and natural resource extraction, which has been approved. It is also important to carefully consider before conducting mining projects that may have impacts on the environment.

2.179 Forests, especially for rocky mountain forests, are under various types of negative impacts which caused reduced quality, reduced diversity and damaged ecosystems. According to statistics of DONRE in 2005–2009, 38 illegal deforestation cases were found which damaged 454.4 ha of forests and also during this period 23 forest fires occurred, taken down 11.66 ha. For that reason, failed implementation of plans can be expected if the recent rate of forest fire and violations keeps its pace as it was seen in 2005-2009 period. In the future, in that scenario, Ninh Binh will likely lose 93.2 ha. However, it is important to note that the use of natural resources, including forest and rocky mountains, for socio-economic development is unavoidable. The question is how to use them most effectively and efficiently to avoid depletion and degrading.

2.180 As the bio-diversity values are mostly in the three mentioned special-use forests, it is necessary to protect these three zones in order to preserve genetic diversity, bio-diversity.

2.181 For the case of Cuc Phuong National Park, it is firstly to develop a plan for resettlement of existing people out of the area. At the moment, 650 persons have been relocated to buffer zone (from forest core). However, about 2,000 persons are still living in the areas along Buoï River, and 50,000 others are in the buffer area. Production, hunting, logging activities – despite certain control – are still threats to the park.

2.182 For the case of Van Long Conservation Zone, in order to protect biodiversity, it is necessary to minimize impacts from mining activities (limestone) in service of constructions and cement productions in the nearby. Strict inspections must be conducted over air emissions and air pollution prevention efforts in regards of industrial units in Gian Khau industrial parks.

2.183 Hoa Lu forest is now under operation as tourism destination, and it is

considered a necessary action, but the following issues must be addressed: to minimize impacts on ecosystem and biodiversity, especially on fauna system. Noise-generating sources such as automobiles and vessels must not be allowed freely in the forest core; not to hold cultural activities and events (performance, camping) in the forest, not to hold feeding services in the forests; not to develop resorts in the forest core.

- (i) To share profits from tourism with preservation efforts
- (ii) To spend more on practical efforts and work for bio-diversity and environmental protection
- (iii) To enhance public awareness to ensure local people and visitors understand the importance and role of bio-diversity and protection measures, and to promote their active participation in conservation efforts in the province.

5) Biodiversity in Thanh Hoa Province (5ECSR Period 2005–2009 of Thanh Hoa)

(1) Biodiversity Status in Thanh Hoa

(a) Terrestrial Ecosystems

- **Flora**

2.184 Thanh Hoa province's forest system is mainly comprised of deciduous tropical forests, semi-evergreen tropical forests, secondary forest or grassland, scrub and planted forest, with rich and diversified flora, fauna species. There are various rare and precious wooden species, e.g. Lat, Pmu, Samu, Lim Xanh, Tram Huong, Tau, Sen, Vang Tam, Doi, De, Cho Chi, etc. Moreover, there are also various bamboo species, rattan species, etc. Thanh Hoa forest quality was degraded seriously due to over-extraction in the last decades. Rare and precious species now only exist in high mountainous and remote zones and in national parks.

- **Fauna**

2.185 Thanh Hoa forest fauna used to be abundant and rich. However, they are degraded seriously. Comparing to other provinces in the north, the fauna system is still rich in Thanh Hoa, comprising many species of reptiles, deer, monkeys, birds, mammals, and others. Especially, there are various precious species in Thuong Xuan area, including, tiger, panther, bear, pheasant. The fauna system is rich and diversified in Ben En National Park and Xuan Lien, Pu Luong, Pu Hu natural reserves, comprising many special species: *Callosciurus erythraeus*, *Bos gaurus*, *Polyplectron bicalcaratum*, *Trachypithecus francoisi delacouri*, *Ursus thibetanus*. Many of them are in Vietnam and World's Red Book.

- **Timber Reserves**

2.186 According to experts, the forest of Thanh Hoa is below average category, having estimated reserves of about 16.6 million m³ of timber and more than 900 million bamboo trees. More than 90% of the current timber forest is categorized as young and poor forest. Rich and average forest area accounts for only 6.6% and is distributed scatteredly on the mountains in Vietnam-Lao border zone and in Pu Ma, Pu Ring, Pu Kha, Pu Luong, Pu Hu at elevation of 700m-1,200 m, far from roads and residential areas, mainly

comprising of watershed, protective forests. Poor forest prevails in <700 m elevation hilly zones near roads and residential quarters.

(b) Natural Reserves and National Parks System

2.187 Thanh Hoa has four conservation areas, namely Pu Luong, Pu Hu, Xuan Lien and Sem Tam Quy) and two national reserves (Ben En and Cuc Phuong). Natural reserves are mainly distributed in western mountainous area. They are characterized by lower mountainous forest and lowland forest (tropical rain forest on the Lower Mountain and lowland forest on Limestone Mountains). There are several rare and precious species, e.g. *Bos gaurus*, “*Mang Roosevelt*”). The rare species include endemic (*Gaur*, *Bring Roosevelt*, *Trachypithecus francoisi delacouri*, *Cunninghamia lanceolata*, *Fokienia*, *Burretiodendron hsienmu*, *Camellia pleurocarpa*, *Erythrophleum fordii*, etc.

(c) Effects of Biodiversity Degradation

- **Forest Ecosystem**

2.188 Thanh Hoa forest coverage ratio has been increasing in recent years. However, the provincial forest is mainly comprised of planted forest and poor forest where biodiversity is poor.

- **Wetland Ecosystem**

2.189 Aquaculture in the coastal districts has severely affected to mangrove forest and coastal wetland zone in recent years, causing loss of habitat for many aquatic species and degrading the ecological features of the lagoon. The lagoon is changed, altering water regulating function, causing salinity intrusion, affecting to people’s life.

2.190 River and lake ecosystems are also excessively exploited, degrading aquatic resources. In large-scale reservoirs, e.g. Yen My Lake, Muc River Lake, unsustainable fishing threatens habitat of many aquatic species, degrading aquatic resources. A number of some species have been reduced significantly in Ma and Chu Rivers.

- **Marine Ecosystem**

2.191 Most of the pelagic ecosystem of Thanh Hoa is in decline. Causes are primarily due to overexploitation of fisheries resources, particularly by destructive tools. In addition, the marine ecosystem is severely threatened by wastewater, sediment and oil spill.

2.192 Ecosystems of coastal and shallow seas are also vulnerable. Marine environment is polluted by waste from industrial activities, agriculture, aquaculture and municipal waste. Declining water quality led to the decline in the number of species. Some species may be locally extinct.

- **Degraded Natural Species**

2.193 According to the latest survey of the project "Conservation of Pu Luong - Cuc Phuong limestone landscape", some species in Pu Luong nature reserve is severely degraded. Especially *Trachypithecus francoisi delacouri* - an endangered threatened species in global level) is declining in population structure as well as quantity. Some rare and endemic plant species are serious decline, such as *Cunninghamia lanceolata* and *Fokienia* in Xuan Lien natural rserve, *Erythrophleum fordii* in Ben En National Park and *Camellia pleurocarpa* in Hoi Xuan, Quan Hoa.

(2) Cause of Biodiversity Degradation

(a) Population Growth, Poverty and Urbanization

- **Population Growth**

2.194 Population growth imposes both positive and negative impacts on biodiversity. Proper Population growth imposes both positive and negative impacts on biodiversity. Proper population distribution and well awareness on environment preservation and biodiversity development will affect positively to biodiversity protection.

2.195 In the contrary, improper population distribution and poor awareness will alter biodiversity since their livelihood depends on natural resources and excessive utilization will degrade habitat and growth of species.

- **Poverty**

2.196 The poor, especially those living in areas with low production of agricultural products, subject directly to the genetic diversity, species diversity and ecosystem diversity. Significant role of biodiversity for life is reflected in the following aspects: to contribute to ensuring the health and supplying nutrition, reduce vulnerability, development of crop varieties and livestock, use of resources that could not be produced among others. However, because of the economic benefits, the poor do not care about the greater benefits from biodiversity and have to pay for these actions that degrade biodiversity.

2.197 Man is a product of both nature and the subject's creative natural environment; Human are social environment product and also the society subject. Natural environment and social environment have dialectical relationship in the human existence and development. Therefore, poverty reduction should be conducted in parallel and combined in harmony with biodiversity conservation.

- **Urbanization**

2.198 The province's urban population to total population has been increased from 9.8% in 2005 to 10.4% in 2009. The expansion of Thanh Hoa urban space, urban construction and Nghi Son industrial zone causes decrease in agricultural and forestry land, changing the structure of land use, narrowing green area and water surface which are habitat of many species.

2.199 Rapid urban development, while the urban infrastructure is not adequately developed, causes increasing environmental problems, negative impacts on natural ecosystems, altering vitality and fertility production of many species.

(b) Industrial development and infrastructure construction

2.200 Thanh Hoa industrial growth rate reached 12.9% per year averagely in 2005-2009 period.

2.201 Industrial development and infrastructure construction are one of the causes of environmental pollution. Pollutions such as smoke, dust, gas, wastewater, solid waste have great impact on the structure of populations, communities, making the change in species in the ecosystem in unsustainable manner.

2.202 Mining, development of large water reservoirs, hydropower plants e.g. Cua Dat hydropower plant in Thuong Xuan district causes great change in landscape, affecting to ecological system of Xuan Nhien Natural Reserve: more than 5,000 ha of protected areas were flooded when water is retained in the reservoir. Development of Trung Son hydropower plant, Ba Thuoc 1 and 2 hydropower plants will also cause extinction of some species.

(c) Trade and Tourism Services Development

2.203 The output value of provincial commercial production, services and tourism has been increased 8-9%/year recently. Commercial activities, services and tourism have various impacts to biodiversity.

2.204 Thanh Hoa has great potentialities for tourism development, especially eco-tourism (Muc River lake basin of Ben En National Park, Cam Luong fish spring, Pu Luong, Xuan Lien and Sen Tam Quy Natural reserves. Biodiversity is the physical basis and foundation for ecotourism development. Proper tourism development in combination with biodiversity conservation will generate resources for sustainable development.

2.205 However, if tourism activities are not planning, managing properly, they will cause negative impacts to biodiversity, such as destruction of biological resources and polluting the environment.

(d) AFF Sector Development

2.206 AFF sector development can have positive and negative impacts on biodiversity. Appropriate biodiversity protection will contribute to increase productivity, agricultural, forestry and fisheries production outputs.

2.207 Production value of agriculture, forestry and fisheries in the province has been increased 7.3% per year in recent years. Besides the remarkable contribution of agriculture, forestry and fisheries in the province's economic growth, they also cause considerable adverse impacts on biodiversity degradation. Landuse conversion for expanding agricultural land is causing pressure on natural resources, especially mangroves foresty area in the Nga Son, Hau Loc, Hoang Hoa and Quang Xuong district due to expansion of shrimp breeding farms; a considerable area of natural forest in the mountainous districts are also cleared for

development of rubber, sugarcane and cassava farms; the development of Cua Dat hydropwer plant in Thuong Xuan district also occupied a considerable forest land.

2.208 In agriculture, the transformation of plant varieties and animal breeds are promoted aiming to diversify production, improve the efficiency of agricultural production. However, it also causes negative impacts due to change of food sources of species. Some species were extinct. Some species are imported, causing change of ecological structure.

2.209 Improper and excessive use of chemical pesticides in agricultural production contaminates water, soil, air environment, killing various useful species in the agricultural ecosystem, especially the insects that feed on pests, toxic to livestock, poultry, leaving pesticide residues in agricultural products cause food poisoning, toxic directly to humans.

2.210 Fertilizers are important factors to increase crop yields. However, chemical fertilizers often have negative impacts on biodiversity, reducing number of species in some ecosystems.

(e) Unsustainable Exploitation and Use of Biodiversity Resources

2.211 Biodiversity is developed following natural laws. The use and exploitation of resources that are contrary to the natural growth will affect to the sustainability of the system, altering biodiversity. Moreover, inappropriate exploitation and use of biodiversity will degrade and destroy biodiversity.

2.212 Current status of improper mining and mineral resources extraction:

(i) **Excessive Hunting and Overfishing:** hunting is a major threat for a number of endemic and in danger species. Currently, illegal hunting of wildlife still occurs in protected areas, e.g. Phu Luong, Pu Hu, Xuan Nien natural reserve and Ben En national park, which cause of biodiversity degradation in this area.

(ii) **Illegal Logging:** Although the rangers of the province have made great efforts in forest protection, illegal logging is still taking place in many localities. According to the management committee of Pu Luong Nature Reserve, illegal logging in the core area of protected area has often happened in recent times. Green iron wood extraction has been occurred in Ben En National Park in 2007-2009.

(iii) **Wildlife Species Trading:** The environment police in close cooperation with relevant bodies have inspected establishments that illegally breed wild animals in Thanh Hoa City, Tho Xuan, Nong Cong and Dong Son districts. It is found that 1 establishment is illegally breeding *Varanus salvator* (a rare and precious wild animal category IIB) and 1 establishment stored wood illegally. In 2009, two cases of wild animal breeding were detected in Thach Thanh district. One case also was detected in Van Ha town, Thieu Hoa district.

2.213 In five months of 2010, the authorities inspected 24 wild animal breeding establishments, 9 wild animal meet processing bases in Thanh Hoa City, sanctioning 4 business, confiscating 11.3 kg snake, 8.6 kg *Varanus salvator*, 5 kg *Viverra zibetha* Linnaeus and 25 kg wild pork meat.

(f) Exotic Species

2.214 “Mai duong” tree invasion is taking place seriously in mountainous districts of Thanh Hoa Province, especially in Yen My reservoir, Nhu Thanh district.

2.215 Exotic species are great potential threats to agriculture production and environment.

(g) Environmental Pollution

2.216 Environmental pollution (i.e., waste water, air emission and solid waste) is the direct threat to biodiversity, causing decrease in number of individuals, indirectly destroying habitats of wildlife species.

2.217 Rapid industrialization and urbanization in coastal areas causes adverse impacts on the environment, coastal resources and in the oceans. The industrial parks, hotels, motels, restaurants in the coastal areas discharge large amounts of untreated waste water and solid waste into rivers and the sea, polluting water environment. Consequently, marine and coastal ecosystems are degrading. In recent years, a large area of mangroves in the coastal districts was dismantled to develop shrimp breeding ponds. The coastal sand is also used for shrimp culture causing serious degradation of biodiversity in coastal and tidal areas.

(h) Forest Fire

2.218 It is reported that forest fires are reducing in recent years: from 6 cases in 2006 on 17,602 ha; to 4 cases in 2007 on 4.98 ha, 3 cases in 2008 on 7.5 ha, 3 cases in 2009 on 1.4 ha, respectively. However, 18 cases occurred in the first 6 months of 2010, covering 53.71 ha. Forest fire often occurs in Muong Lat district (8 cases), Dong Son district (2 cases), Ha Trung districts (2 cases), Tinh Gia districts (4 cases) and Thanh Hoa City (1 case).

2.219 Forest fires causes not only economic damage but also adverse impacts on the environment, causing flash floods, biodiversity decrease and landscape altering as well as adverse impacts on national security among other.

2.220 Besides natural causes such as prolonged dry weather, human activities in economic development planning and practices as well as flame cultivation agriculture, forestry practices, burn cultivation, hunting, gathering forest products are also altering forest sustainability. Forest dismantlement for mobile cultivation is still prevailing in mountainous districts (Quan Hoa, Ba Thuoc, Quan Son, Nhu Xuan and especially in Muong Lat district).

(i) Natural Disasters

2.221 It is reported that Thanh Hoa Province is often hit by an average of 0.63 storms and tropical low pressure. Moreover, flash flood also occurs in western mountainous districts of the province. Flooding in the lowland area (Ha Trung, Nong Cong, Thieu Hoa, and Yen Dinh) is increasingly, affecting to ecosystems and biodiversity resources.

2.222 Natural disasters have negative impacts on many aspects of biodiversity components as: destruction of habitat, narrowing habitat of the species, reducing the number of individuals significantly.

2.223 Source of nutrition, drinking water sources being destroyed also affect the

lives of many species.

2.224 The relationships between species in ecosystems are altered by the effects of natural disasters, especially when nutritional chain is broken.

2.225 Natural disasters may also cause the variation in some species, especially bacteria and micro-organisms, creating new species.

(3) Biodiversity Degradation Forecast

2.226 Thanh Hoa is one of the rich biodiversity zones due to complex climate conditions and terrain diversity. So far, 11,373 vascular plants, about 1,030 species of moss, 2,500 species of algae and fungi are recorded in Thanh Hoa. There are about 3% of special plant species family number (e.g. *Vietnamosasa*, *Colobogyne* in Thanh Hoa. However, number of special species accounts for only about 33 many endemic species are found in a very narrow zone with small individual number. These species are rare because the forests here are usually divided into small pieces and exploited vigorously.

2.227 Besides, due to structural features, the humid tropical forest types generally do not have obvious dominant species, the number of individuals of each species is often limited and especially when not properly exploited, typically the current state of some rare wooden species (*Afzelia xylocarpa*, *Sindora siamensis*, *Coptis chinensis*, and some species who are rare and in danger of extinction as *Cupressus torulosa*, *Calocedrus macrolepis*, *Madhuca Pasquieri*, *Kokiena hodginsii*, *Nageia fleuryi*).

2.228 It is projected that Thanh Hoa Province will significantly reduce the level of degradation of biodiversity, conservation and development of diversity fauna and flora capital if the nature conservation is implemented properly. Rare and precious species are mainly distributed in preserved zones and national parks, e.g. Ben En and Cuc Phuong National Parks, 4 natural protected areas (Hu Pu, Pu Luong Xuan Lien, and Tam Sen Quy). In addition, there are tens thousands of reptiles species in shallow, marine and fresh waters. Vegetation, populations of several endemic species shall be protected properly, including rhinoceros, wild cow and buffalo, tiger, bear, monkey, etc.

(4) Biodiversity Conservation by 2015 and Orientations till 2020

(a) Provincial targets up to 2015 are as follows:

- **Terrestrial Biodiversity Conservation and Development**
 - To raise the forest coverage ratio from 46.7% to approximately 52-53% in 2015;
 - To protect, restore and develop rare, precious and endanger species properly
- **Wetland and Coastal Land Biodiversity Conservation and Development**
 - To increase the area of protected wetlands, maintained biological diversity area to 13%;
 - To strictly protect 30% area of Me archipelago in 2015;
 - To study and propose plans to expand the existing protected marine areas and launched a new protected marine areas;
- **Agricultural biodiversity Conservation and development**

- To disclosure and complete development of the conservation system in order to effectively conserve crop varieties, indigenous precious and rare agricultural animals and microorganisms.
- **Sustainable use of Biological Resources**
 - Formulate and develop sustainable use models of biological resources, control, prevent, deter and eliminate the exploitation, trading and consumption of wild rare and endangered animals.
 - Monitor, evaluate and prevent exotic species;
 - To inspect imported genetic sources properly.
- **Strengthening State Management on Biodiversity and Biosafety**
 - To enhance technical infrastructure, focus on training and staff capacity development to meet professional requirements and conservation and development of biodiversity and biosafety management;
 - To raise awareness of the district, commune and people on biodiversity values, conservation and sustainable development of biodiversity and attract the participation of the people;
 - To ensure that 100% of genetically modified organisms and products and goods originating from genetically modified organisms are allowed to circulate on the market and were evaluated risks in Vietnam and they shall be tagged, monitored, supervised in compliance with existing laws and regulations.

(b) Provincial orientation to 2020 is planned as follows:

- To raise the forest coverage rate of over 60% of the province;
- To increase the area of protected wetlands, biodiversity maintenance over 17%;
- To elaborate the development plan to expand the protected marine area, and conduct investigation, survey as well as to establish and operate a new protected marine areas in the province;
- To preserve, develop and sustainably use biodiversity in terms of genetic sources, species and ecosystem richness of the province; manage bio-safety effectively.
- To develop and improve the policies and institutional arrangement as well as legal system for biodiversity and bio-safety properly.
- To fulfill the international commitments on biodiversity and biosafety to which Vietnam is a member.

6) Biodiversity in Nghe An Province (5ECSR Period 2005–2009 of Nghe An DONRE)

(1) Current Conditions and Changes in Biodiversity Degradation

2.229 Living things are very important natural resources, the basis of life, prosperity and development of human beings. However, we are facing the reduction in this type of natural resources, which is called biodiversity degradation.

2.230 Nghe An is a large province of Northern Central Area with the largest forest area in the entire country, and high potential for socio-economic development. Forest

and forest land are the advantage of Nghe An. Biodiversity is diversified in terms of gene pool and species.

2.231 However, almost every natural ecosystem is badly damaged by socio-economic development.

(a) Degradation in Natural Eco-system

2.232 The western Nghe An is recognized by UNESCO to be the world's biosphere reserves, the only area in the ASEAN remaining primary forests. However, under people's influence, biodiversity in national park Pu Mat is being seriously reduced.

2.233 Eco-system of natural forest is experiencing many big changes over the last few years. Coverage area increases, however, the increase is due to afforestation of new plants, therefore, biodiversity is not high. Remaining natural forest is being seriously degraded. Unaffected areas of primary forest only exist in small forest areas in mountainous areas of the western Nghe An. This is the major threat to forest biodiversity.

2.234 Exploitation of mineral resources like gold, precious resources in rivers, streams has destroyed natural landscape and biodiversity. In the exploitation of mineral resources, many wood trees were cut down to be used as a column in mines; as a result, structure of forest and land was broken. In recent years, exploitation of mineral resources has happened in a variety of forms. Unplanned exploitation by a wide range of economic participants have made environment, which is already easy to be degraded, suffer from serious pollution and degradation.

2.235 Most of scarce wild animals are in danger. According to estimation, such reptiles as snakes, tortoise, etc. are being traded in large quantity.

2.236 Flooded area is sensitive area, which is easy to be affected. Total forestry land in coastal area of Nghe An is 8,503.9 ha with main plants like: acacia, aegiceras, pine (260 ha), cypress forest (111.1 ha); mainly concentrated in Quynh Luu district (4,202.5 ha), Nghi Loc (2,684.1 ha) and Dien Chau.

2.237 Sea eco-system has been seriously degraded. The overexploitation without attention to size of each species, and the use of massive destruction have led to significant reduction in marine creatures. Some species facing remarkable reduction include: *Nemalalosa nasus*, *Hilsa reveesi*, *Clupanodon thrissa*. In addition, sea eco-systems are also heavily polluted by oil spill, sea tourism development without integrated planning.

(b) Reduction in Natural Species

• **Agricultural Eco-System and Affected Plants and Domestic Cattle**

2.238 New breeds with high productivity are being used widely and account for large area. As a result, land for local breeds is being narrowed down with precious gene pool, which can resist insects.

2.239 Among planted crops, rice is the most popular. The number of upland rice breeds decreases, some specialty breeds has also disappeared. Similarly, typical breeds of corn, bean, root crops, tea, jute, fruit trees are gradually

reducing, and replaced by new breeds.

2.240 Traditional domestic cattle breeds have decreased in large number, with complete disappearance of many species, reduction in quantity of many species, mixture of many species of poultry and waterfowl.

2.241 The import and export of several crop breeds have brought about high economic profit over the last few years. In the crop structure, in many places, new breeds account for 70–80% and can bring about high productivity. However, the unplanned and uncontrolled import and export can pose a danger to lose local breeds.

- **Increase in Forest Area and Decrease in Forest Quality**

2.242 Biodiversity decreases despite increasing forest area. Natural forest still faces with reduction in land area while planted forest area has already recovered.

2.243 Forest coverage increases (from 47% in 2005 to 50% in 2008) but forest quality has yet to be improved. The majority of natural forests are poor forest; primary forests are concentrated in biosphere reserves. In spite of previous impacts by neighboring residents, primary forest is still of high value both in economic and biodiversity terms thanks to attention of the state and local competent authority.

2.244 Industrial planted forest includes mainly industrial plants, as a result, biodiversity is low.

- **Decreasing Area, Quality of Flooded Area**

2.245 Over the last few years, the decrease in area of mangrove forests and flooded land has led to biodiversity degradation (changes in land use purpose: forest land is converted to agricultural land, aquaculture land, land for hotel and hostel construction, intrusion of land for house construction, land for coastal tourism area construction, land for the construction of dyke systems in such communes as Quynh Lap, Quynh Phuong (Quynh Luu district). In these communes, the deforestation happened to spare land for shrimp farming from 2000 to 2008, which remarkably reduced coastal forests; in such communes as Dien Thanh, Dien Thinh, Dien Kiem, Dien Bich, Dien Hai, in communes like Dien Thanh, Dien Thinh, Dien Bich, Dien Hai, Dien Hung, Dien Trung (Dien Chau District) protection forest land is converted to land used for the construction of hotels, hostels, shrimp farming, land used for agricultural plant is converted to land used for dyke, Hon Cau tourism area, and other purposes; in Nghi Huong ward, casuarina forest was destroyed to construct entertainment area.

2.246 These activities have decreased flooded land, natural resources, resulting in natural hazards like: deposition, land slide and environmental pollution.

2.247 Previously, mangrove forest covers an area running along the coast line however, at present, this area has been significantly reduced, causing degradation of mangrove forest.

2.248 Mangrove forests are mainly located in rivers (Hoi river mouth – the Ca river, Van river mouth – the Bung river, Lach Quen river mouth, Lach Con river mouth – the Mai Giang river) and several canal mouths with small area. Flora system includes such plants as *Aegiceras corniculatum*, Rhizophoraceae, Sonneratiaceae and a number of other plants like *Bruguiera hainessii* C.G.Rogers, *Ixora coccinea* in small quantity. At present, area of mangrove forest: 569.9 ha; protection forest: 473.9 ha; poduction forest: 96.0 ha. There are 449.6 ha mangrove land need investing and afforesting. Over the last few years, the situation of converting mangrove land (used for forestry purposes) into other land use purpose is common, which has caused a number of bad impacts.

Table 2.1.23 Area of Mangrove Land

No	Types of Land/Forest	Mangrove (ha)		
		Total	Protection Forest	Production Forest
	Forestry Land	1,019.5	870.3	149.2
I	Land with forest	569.9	473.9	96.0
1	Natural Forest	111.1	111.1	
-	Natural Cypress	111.1	111.1	
2	Planted Forest	458.8	362.8	96.0
-	Aegiceras	356.8	260.8	96.0
-	Rhizophoraceae	48.0	48.0	
-	Cypress	54.0	54.0	
II	Vacant Land	449.6	396.4	53.2
-	Bare land (Ia)	449.6	396.4	53.2

Source: Nghe An DARD 2008.



Source: Nghe An DONRE/2008

Figure 2.1.2 Resource Exploration on River (site photo)

Table 2.1.24 Changes in the Area of Protection Forest, Mangrove Forest and Coastal Planted Forest

No	Districts	Forest Area (ha)		
		2005	2008	Notes
1	Quynh Luu	3,024.7	3,244.1	Decline
2	Dien Chau	1,055.7	883.7	Decline
3	Nghi Loc	2,044.2	2,257.2	Rise
4	Cua Lo	332.2	166.2	Decline
5	Dao Mat	124.6	124.6	Stability
6	Dao Ngu	60.8	60.8	Stability
7	Vinh	54.9	54.9	Stability
Total		6,697.10	6,791.50	Rise

Source: Nghe An DARD

(2) Causes of Degradation

(a) Direct Causes

- **Intrusion of Agricultural Cultivation**

2.249 The encroachment of forest land for agricultural cultivation, the destruction of mangrove forests for shrimp farming has led to a decrease in biodiversity. Mangrove forests like Quynh Luu, Dien Chau, and Hung Hoa are being intruded upon and destroyed to construct shrimp ponds. In recent years, the province has invested in shrimp industry zone Quynh Luu, Dien Chau, nghi Loc, Hung Hoa with total shrimp farm of 1,127.9 ha.

2.250 A typical example of the loss of mangrove forests in Nghe An is the loss of cypress forest along Ta Lam dyke, the section passing through Nghi Loc commune. Cypress forest along the dyke has an area of 50ha and is the habitat of many flora and fauna species. From 2004 to present, the residents have destroyed 5 ha for shrimp ponds. Besides, urbanization is also a cause for biodiversity decline.

- **Wood Exploitation**

2.251 Illegal wood exploitation without control has led to the disappearance of many types of precious wood. Annual wood exploitation reaches 4,000m³, of which 17% is exploited by local residents to construct houses, the rest is used for illegal trading. According to statistics of DARD, main types exploited to trade include *Fokienia hodginsii*, *Hopea mollissima*, *Dipterocarpus spp* It is the overexploitation that makes those species become rare and scarce. According to reports from Environment Public Security Department – nghe An public security, within the 1st half of 2009, forest products smuggle has increased, especially through road and water way. Besides that, the exploitation of forest products except for wood has also become popular. Over the last few years, the commercialization of value of non-wood products, many products have been traded and become goods right in villages, districts, towns, which has become the main reason for people to strengthen the wood exploitation.

- **Exploitation of Mineral Resources, Water Resources, Marine Resources**

2.252 The exploitation of mineral resources in Nghe An has happened

strongly. The exploitation itself has decreased biodiversity. Other kinds of exploitation like gold exploitation, precious mineral resources exploitation have destroyed natural landscapes, rivers and biodiversity along 2 sides of rivers and streams.

2.253 Tuong Duong district is the typical case of biodiversity reduction due to gold exploitation. Gold exploitation in the upstream Lam River has polluted water sources and changed flows as well as soil structure. Living things in this water area have declined. In addition, forests in two areas namely Yen Tinh, Yen Hoa of Tuong Duong district are also being dug by residents to discover gold.



Source: dantri.com.vn

Figure 2.1.3 Illegal Hunting

- **Overexploitation**

2.254 Due to high profit of scarce and rare animals trading, local residents as well as people from other provinces are also participating in illegal hunting. It is estimated that reptiles are being traded in the largest number. Snake accounts for 40% the amount of animals being traded (among which cobra accounts for the highest percentage), tortoise is standing at the 2nd rank (Cuora galbinifrons is in danger according to Vietnamese Red book). Varan is also popular for its medicinal use. Among mammals, red-face monkeys and gibbons are mostly traded, chinese laughing thrush and parrot are also hunted for trading.

2.255 According to reports from Environment Public Security–Nghe An Public Security, in the 1st half of the year, illegal hunting and trading of wild animals commonly happened. In the 6 month period, the police caught 10 cases and 16 criminals for illegal trading of forest products, of which two cases were illegal trading of scarce animals, increasing by 2 cases compared with the same period last year. The most typical case is trading of 3 tibetan bears with each bear being 70 kg heavy together with 60 kg cobra.

- **Wild Animals Trading**

2.256 The widespread import and export of a variety of species into and from Nghe An can lead to the degradation of local species. Some local rice breeds have disappeared, some species can cause serious diseases like yellow snails, mimoso pigra.

(b) Indirect Causes

- **Poverty and Population Growth**

2.257 Poverty issue facing residents living near forests and buffer zones have bad impacts on forest resources. The total number of poor households in the country is 2.8 million, among which Nghe An mountainous area accounts for more than 30%. Poverty is the reason for deforestation and degradation in biodiversity.

- **Environment Pollution**

2.258 Population growth, industrialization and urbanization have caused bad impacts to environment, marine resources. The consequence is serious damage to marine and coastal eco-system, putting marine creatures in jeopardy.

- **Natural Disasters**

2.259 Located in the Central Area, Nghe An has to suffer from many natural disasters like: storm, typhoon, flood, forest fire, which destroy environment, narrow down habitats of flora and fauna, damage nutrition sources, water sources, changes practices, causing mutation in many living things. Natural disasters can even destroy a large area, leaving only rocks, waste behind, killing all biodiversity. According to statistics until 8/2009, Nghe An had to suffer from 4 tornadoes in Ky Son, Que Phong, Tan Ki,. In Quynh Luu, there are tornadoes in sea. In Tuong Duong, there was flash flood.

- **Low Awareness of Community**

2.260 Forest area, animals or mineral resources in Nghe An is mainly distributed in mountainous areas, where people with low education level are living. Outdated cultivation, and living mainly on nature have speeded up the biodiversity degradation.

2.261 Accordingly, the process of land slide, land subsidence, desertification has also been boosted. Soil degradation made it difficult for vegetation to recover, which in its turns cause more natural disasters.

2.262 To sum up, biodiversity decrease can be caused by objective and subjective factors. However, the main reason for biodiversity decrease is activities of people.

(3) Impact to Biodiversity Degradation

(a) Impact to Species

2.263 A large of primary forest in Nghe An is remained. It is the place possessing high biodiversity. However, at present due to impacts by many factors (mainly human activities), biodiversity has significantly decreased. This has made

some species exposed to the danger of extinction. Components of species have also considerably changed. Local activities like burning and destroying forests have taken away and degraded habitats of flora and fauna, posing a serious threat to the environment and biodiversity. Accordingly, there are situations of lack of nutrition, erosion, inability to retain water, which happened at the same time and made biodiversity degradation worse.

2.264 The overexploitation of species of high economic value is an important factor leading to a significant decrease in the number of species and biodiversity.

2.265 The import of other species into the area is also causing degradation. Imported species often take advantages over local species; eliminate endemic species, therefore, mixing ecological process.

(b) Impact to Socio-Economic

2.266 Biodiversity is a base for prosperity and economic stability. It is also a base for maintaining ecological services, people health and industrial productivity. The loss of biodiversity can lead to delay in ecological services, affecting people health, life as well as other economic activities.

2.267 Biodiversity improves quality of life. It is a source of information provided to a wide range of fields: culture, sports, education and training, etc.

(c) Impact to Eco-systems

2.268 The main threat to biodiversity is the destruction of eco-systems which takes away habitats of many living things. Tropical rain forest plays an important part in biodiversity because a majority of species are living in this type of forest. Biodiversity decreased in proportional to the destruction of forest eco-system.

2.269 Mangrove forest eco-system is also being threatened. Mangrove forest is of vital importance because it provides food for many species of shrimps, fishes, and also the habitat of many species. It also supplies natural resources like wood and materials for other industries. In addition, mangrove forest has another function of protecting coastal areas, retaining alluvium. Mangrove forest is also playing an important part in preventing waves, landslide and erosion, salinity intrusion etc. However, over the last few years, mangrove forests have been destroyed, with its land use purpose being changed, resulting in more serious landslide.

2.270 Biodiversity contributes to maintain important ecological services. Roles of eco-systems, especially flora system are to supply foods for other living things in the eco-system chain. Biodiversity also helps improve productivity of plants. Hydro-meteorological regime in the watershed forest is protected by biodiversity.

(d) Impact to Human Being

2.271 Biodiversity is also contributing to the protection of people's health. Medicinal plants and animals are of great help. If biodiversity and eco-systems are degraded, food supply, hygiene, water shall be affected, undermining ability to prevent diseases. Ecological degradation changed relations between species.

(4) Forecast of Changes in Degradation

2.272 Biodiversity degradation is happening rapidly and widely in the entire province, especially in mountainous areas. Biodiversity degradation includes: the loss of species, decrease in gene pool, intrusion of strange species, and degradation of natural eco-systems. The main reason is human activities. Migration, high population, low education, deforestation and illegal hunting are still commonly happening. The overcultivation and overuse of pesticides have also resulted in degradation in biodiversity. Environmental pollution, urbanization, industrialization, modernization and high population growth have also affected biodiversity. Biodiversity has been happening strongly, encouraging the export of agricultural, aquaculture and marine products as well as medicinal materials. It is the reason leading to deforestation to spare land for growing industrial plants for export. If there are no effective methods, it can lead to the loss of biodiversity.

2.273 In addition, annually, Nghe An has to suffer from natural disasters. Floods and storms are often happening, causing damages to people and eco-systems. Climate change together with lasting drought, extreme heat, flash floods, and landslide are also reasons for environmental degradation.

2.274 It is estimated that GDP in 2010 shall reach 7%/year. Economic growth shall be accompanied by an increase in exploitation, and consumption of natural resources, which beyond doubt shall cause environmental pollution and degradation.

2.275 Besides that, agricultural land, forest land and quality of forests are being undermined. Migrating residence and cultivation are long time practices of many ethnic minorities in Nghe An, leading to soil degradation. Mangrove forests, lagoon are also being overused. Habitats of flora and fauna are being narrowed down. Such animals as: grey cow, tiger, rhino, white headed langurs, *Rhinopithecus avunculus*, *Panax vietnamensis*, *Paphiopedilum delenatii* are in danger of extinction.

2.276 The exchange and import of some species have brought about high economic value. Some species account for 70-80% in some places and brought about high productivity. However, unplanned import of new species without control methods is posing danger to local species.

2.277 Illegal hunting has made some species exposed to danger of extinction: *Cuora galbinifrons*.

2.278 Flooded land is sensitive eco-system. Total forestry land in the coastal area of Nghe An is 8,503.9 ha with main plants including casuarina, pine trees, acacia, Rhizophoraceae, *Aegiceras corniculatum* (260 ha), Sonneratiaceae (111.1 ha); mainly concentrating in Quynh Luu district (4,202.5 ha), Nghi Loc (2,684.1 ha) and Dien Chau.

2.279 Sea eco-system is also suffering from serious degradation. In Nghe An sea, there are 600 marine living things, of which there are 267 species of fish with reserves of 800 ton. There are also a wide range of shrimp. However, the trading in the gates of rivers, canals, ports and oil spill have degraded biodiversity. The overexploitation without attention to size of marine living things is also causing biodiversity degradation.

2.280 In addition, marine eco-system is also heavily polluted by waste water, alluvial deposition and oil spill as well as tourism

(5) Current Situation of the Implementation of Strategy for Biodiversity Protection

(a) Systematization of Natural Resources in Nghe An

2.281 In Nghe An, many new animals, which is scarce in the world, have been discovered. It is forecasted that Nghe An is still keeping many secrets in biodiversity, which have yet to be discovered.

2.282 It is necessary to study non-wood forestry products in terms of market price, sustainable exploitation and use capacity, and capacity for growing and raising high economic species, species of reserves value, production to support forest protection and study local forest trees which is helpful both in economic value and ecological value to replace imported species casuarina, acacia, etc.

2.283 It is necessary to promote biological stock-taking, construct national database of flora and fauna system: concentrate on systematically study scarce species recorded in Vietnam Red book; apply technology serving sustainable exploitation of flora and fauna system; encourage the use of local knowledge in the protection of biodiversity; educate young staff.

(b) Good Management of Preservation Areas and Watershed Forest

2.284 At present, in the province, there are national park Pu Mat, Pu Huong nature reserves, Pu Hoat nature reserves. However, it's important to pay attention to the buffer zone to improve life of people, helping them to sustainably use available natural resources in the area.

2.285 It is necessary to strengthen legal regulation; encourage people to participate in natural protection and sustainable use of natural resource; draw up suitable land use.

2.286 It is necessary to strengthen regulations on forest protection; strictly punish cases of violating laws. It is also important to focus on vital areas of protected areas through nature reserves system with participation of local people as shareholders and on building up the management system from central to local level.

2.287 It is necessary to strengthen monitoring plan for forest exploitation. In addition, check forest standards. Decentralize forest administration; allocate forest to districts and communes for their management.

2.288 On May 13, 2009, Nghe An people's committee issued Decision 2053/QĐ-UBND regarding the issue of action plan on biodiversity protection and biological safety until 2010 and orientations until 2020 with a view to developing biodiversity, sustainably using natural resources and improving state administration capacity in terms of biodiversity in the entire province.

(c) Constructing Model of Sustainable Use of Natural Resources

2.289 Natural resources in Nghe An is assessed to be rather diversified, which a majority of residents are living on. It is also a precious factor in the socio-economic development. However, it is the human activity that results in the extinction of many species, the destruction of biodiversity; these natural resources

are gradually depleted.

2.290 It is time planted forest land was allocated to community for good management. Farming economy should be developed in combination with local socio-economic development planning. On the other hand, it is possible to choose a model in the direction of using output as materials with farms being considered as socio-economic core of each region.

2.291 It is necessary to construct and invest in highly feasible models like agriculture-forestry farm, forest economy model, community economic model, model of developing a variety of sectors.

(d) Supporting Residents For Socio-Economic and Cultural Development

2.292 In order to create stimulus to socio-economic growth, it is necessary to incorporate Program 327 and Program 661, and programs on stable residence and cultivation, poverty reduction and hunger elimination, agricultural and forestry encouragement to increase investment efficiency.

2.293 Strengthen staff engaging in agricultural and forestry encouragement, propagating and universalizing technology transfer, technique transfer in agricultural production, forestry and fishery in mountainous areas, constructing typical models to provide effective instructions.

2.294 Boost the shift in the structure of planted trees and domestic cattle, apply technical advance to cultivation, enhance production and processing of agricultural and marine products; restore traditional craft villages, come up with specific plans for urbanizing and industrializing mountainous areas.

2.1.8 Flora and Fauna

2.295 The flora and fauna in the north priority section is rich in protected areas mostly in the mountainous area and some in the coastal area. It is reported that the degradation of flora and fauna in such protected areas is serious due to the human activities.

Table 2.1.25 Characteristics of Flora and Fauna

No	Province/City	Available documents	Description
1	Ha Noi	Report No./SNN-KH dated Oct. 10, 2011 in response to JST request for information on environmental and social considerations, pages 8-9 Environmental Current Status Report of Hanoi City in 2008, chapter III, pp.301-311.	Recorded species - Higher flora: 655 - Lower flora: 569 - Reptile: 24 - Amphibian: 9 - Bird: 103 - Mammal - Insect: 595
2	Ha Nam	Annual Environmental Status Report, Chapter 6, Heading 6.2.2, pp.47-48.	Ha Nam has 4 typical natural ecosystems (such as: the tropical forest on limestone mountains, the grassland and shrub on ground, the grassland and shrub on limestone mountains, the ecosystem within freshwater) and the artificial ecosystem.
3	Nam Dinh	The Environmental Status Report period 2005-2009., Chapter VI, pp 94 - 100	Flora system: There are 116 species, 99 genus and 42 families Fauna system: There are 9 species of 5 families, 4 phylum; 215 species of birds of 41 families, 13 phylum, 10 species of reptiles and frogs of 5 families, 2 phylum; 107 species of fish of 44 families, 12 phylum; 84 species of

No	Province/City	Available documents	Description
			crustacean of 13 families, 38 classes; 40 species of Bivalvia of 13 families, 24 classes
4	Ninh Binh	Five Year Environmental Status Report period 2005-2009, Chapter 7, pp.102-110	Ninh Binh is one of the provinces with high forest coverage and rich of bio-diversity in the country. This is especially for special forests, including Cuc Phuong National Park, Van Long Conservation Zone, Hoa Lu Forest (culture – history- environment), and the bio-sphere reserve zone in coastal area of Kim Son
5	Thanh Hoa	List of protected areas including special use forest and protection forest and list of rare species in the province. Summary list of biodiversity in special use forests in Thanh Hoa Province. List of flora and fauna in Xuan Lien, Pu Luong and Ben En National Park.	Flora: forest system is mainly comprised of deciduous tropical forests, semi-evergreen tropical forests, secondary forest or grassland, scrub and planted forest, with rich and diversified flora, fauna species. Fauna: Thanh Hoa forest fauna used to be abundant and rich. However, they are degraded seriously. Comparing to other provinces in the north, the fauna system is still rich in Thanh Hoa, comprising many species of reptiles, deer, monkeys, birds, mammals, and others
6	Nghe An	Environmental current status report 2005- 2009, p100	Flora and fauna in Nghe An Province live mostly in Pu Mat, Pu Luong and Pu Hoat National Parks. Flora and fauna populations are now facing downward trend with more and more species being in danger of extinction.

Source: Five year environmental status report/2005-2009 of and Annual environmental status reports 2008, 2010 (DONRE of City/Provinces), compiled by JICA Study Team

1) Flora and Fauna in Hanoi City (Environmental Current Status Report of Hanoi City in 2008)

(1) Biodiversity within the Terrestrial Ecosystem

(a) Flora

- **High-level Flora**

2.296 Based on the summarization on the flora reports of Hanoi, there are 655 high-level flora species (covering 5.7% of total high-level flora species (11,373 species) which have been identified within Vietnam). As the survey result, the greeneries species of Hanoi are so abundant and play a greatly important role.

- **Low-Level Flora**

- Up to present, Hanoi has identified and described 569 low-level terrestrial flora species of the philliums as Nghanh-nam-nhay (*Myxomycota*), Nghanh-nam-noan (*Oomycota*), Nghanh-nam-co (*Chytridiomycota*), Nghanh-nam-tiep-tap (*Zygomycota*), Nghanh-nam-nang (*Ascomycota*), Nghanh-nam-bat-toan (Microsporic fungi), Nghanh-nam-gia (*Basidiomycota*).

- Nghanh-nam-nhay (*Myxomycota*): 3 species of 3 families have been discovered and described. The Myxomycota mainly parasites on the decayed leaves and wood.

- Nghanh-nam-noan (*Oomycota*): 13 species of 3 families have been discovered and described. The Oomycota mainly parasites on some plant species, such as: the orange-family (*Rutaceae*), Cabbage-family (*Brassicaceae*), Curcubit-family (*Cucurbitaceae*), Pean-family (*Fabaceae*), Egg-plant familia (*Solanaceae*), etc. Many species of Oomycota affect negatively to the production, because they are causes of

many diseases of many flora species.

- Nganh-nam-co (Chytridiomycota): Only one species has been discovered. It is *Physoderma zeae-maydis* Schw. which is cause of Zea mays L. disease of maize.
- Nganh-nam-tiep-tap (*Zygomycota*): 02 species which have been discovered and described are *Glomus agragatum* N.C. Schenck & G.S.Sm and *G.fasiculatum* (Thaxt.) Gerd & Trappe. These two species belong to *Glomaceae* familia; they share the symbiosis with the flora species of Keo genus (*Acacia*) of Pean familia (*Fabaceae*).
- Nganh-nam-nang (*Ascomycota*); 36 species of 18 familias have been discovered and described. Some of them live on the trees/ plants, decayed wood or the living creatures (sugar-cane, tobacco trees, soy-been trees, banana trees, orange trees, etc.).
- Nganh-nam-bat-toan (Microsporidic fungi): 223 species of 52 genuses have been discovered and described. Their living environments are so plentiful. Many of them have great value, since they are used to produce the major antibiotics; on the contrast, many of them are the major causes of some diseases of the plants and animal, such as: *Gloeosporium* genus (of *Melanconiaceae* familia), *Phyllosticta* genus and *Macrophomina* one (of *Sphaeropsidaceae* familia). Especially, some species of the familias as *Fusarium*, *Helminthosporium*, *Piricularia*, and etc. are the major causes of the diseases on the rice in Vietnam.
- Nganh-nam-gia (*Basidiomycota*): 291 species of 42 familias have been discovered and described. Their living environments are so plentiful. They can live in the humus, decayed dead-plants, animal shit or parasite on the planted wooden trees and on the naturally growing ones. Many of them are distributed within the forest ecosystem, the scrubs, the lawns; these ones are the major decaying wood species in Vietnam. Especially, many species can be utilized as the food supplied for the human, such as: Wood-ear-mushroom (*Auricularia* spp.), nam-moi (*Termitomyces eurhisus*), nam-mo (*Agricus bisporus*), straw mushroom (*Volvariella volvacea*), nam-xop (*Russala cyanoxantha*), nam-trung (*Calvatia lilacina*), etc. However, there are many poisonous mushroom species, such as Nam-doc-nau (*Amanita partherina*), Nam-tan-trang (*A. verna*), Nam-phien-dom-buom (*Panaeolus cyanescens*), ect.

(b) Fauna

- **Vertebrate Animal**
- **Reptile–Amphibians**

2.297 As the statistic data, there are 24 reptile species and 9 Amphibian species in Hanoi. For reptilia–amphibian species compositions, Hanoi's species cover 7.2% of the national ones, the familias cover 36.4% of the national ones, the ordoes cover 50% of the national ones. Hence, Hanoi's reptile–amphibian species compositions are very poor. Besides, the reptile–amphibian distributions are so different by-habitat.

- **Urban Habitat**

2.298 There are totally 22 species. The most popular one in households is *Thach-sung-duoi-san (Hemidactylus frenatus)*. In the newly developed urban area, there is *Coc-nha (Bufo melanostictus Schneider)* which lives in the crevices of houses or the vegetable gardens; *Than-lan-bong-duoi-dai (Mabuya longicaudata)*, *Than-lan-bong-hoa (Mabuya multifasciata)*, *Ran-giun*, *Ran-soc-dua (Dendrelaphis pictus)*, *Ran-bong-trung quoc*, *Ran-bong-chi*, *Ran-khiem-dai-loan*, *Ran-rao (Ptyas korros)*, *Ran-hoa-co-nho*, *Ran-nuoc (Colubridae)*, *Ran-cap-nong (Naja-naja L .)*, *Ran-cap-nia-bac*, *Ran-ho-mang (Naja Naja)*, *Ba-ba-tron (Pelodiscus sinensis Wegmann 1835)*. There are also 8 frog species which are not as popular as the above mentioned species. Especially, in Guom Lake, there is *Swinhoei tortoise (Rafetus swinhoei)* which is named with Vietnamese name as *Rua-Ho-Guom*, this is such as rare and precious animal which needs to be protect strictly.

- **Communal Habitat**

2.299 There are totally 24 species of lizard group (*Mabuya sp.*) and snake one which include sufficiently 4 species of poisonous snake and most of frog species. However, the quantity of these species is not high.

- **Field Habitat**

2.300 There are 19 species. At the bed of water basins, there are 02 species of *Ran-bong*; while at the locations near the water-basins, there are most of the frog species. Moreover, at the lawns there are *Than-lan-chan-ngan (Lygosoma quadrupes)*, *Than-lan-bong-duoi-dai (Mabuya longicaudata)*, *Ran-giun*, *Ran-cap-nong (Naja-naja.)*, *Ran-cap-nia-bac*, *Ran-ho-mang (Naja Naja)*.

- **Hilly Zones**

2.301 There are 22 species; excluding the species living in the above mentioned habitats, there are some popular species, such as: *Nhong-xam*, *Ran-roi*, *Ran-sai-thuong (Amphiesmoides)*, *Ran-ho-dat-nau (Psammodynastes pulverulentu)*.

- **Birds**

2.302 As the statistic data, Hanoi has 103 bird species which are distributed within 23 families of 13 ordoes.

2.303 At West Lake and its neighbouring areas, there are 30 bird species (covering 29% of total bird species) of 18 families (covering 50% of total bird families) which are distributed within 10 ordoes (covering 77%). At Bach Thao Park and its surrounding areas, there are 22 bird species (covering 21%) of 14 families (covering 38%) within 4 ordoes (31%). Moreover, in Nam Hong commune and Van Noi one (of Dong Anh district), there are 70 bird species (68%) of 35 families (97%) within 13 ordoes (100%). Furthermore, in Phu Linh commune of Soc Son district, there are 90 bird species (87%) of 36 families (100%) within 13 ordoes (100%).

2.304 Since the forest-covered area rates of the different locations are not the same, so the food sources and the birds' living habitats are different either; hence, the species distribution and compositions are different, too. In addition, the

impacts by the human's living activities affect to the species quantity of these locations much.

- **Mammal**

2.305 Based on the statistic data and the available documents, Hanoi has 40 mammal species (covering 17.4% of the total national ones) of 16 families within 6 orders. Among the mammal compositions, the small mammal species cover most of the total species (11 bat species, 10 species of Rodentia).

2.306 Among 2 big mammal orders of Hanoi, the *Carnivora* comprises 9 species, the *Artiodactyla* comprises only 2 species. There have not been any species of Primates, which were distributed within Hanoi, left excluding the one imported from the other locations. The quantity of species of the Chiroptera and the Rodentia covers a great rate; while the one of Carnivora and Artiodactyla cover a very small rate. It is forecasted that the big mammal species will be reduced, because their habitats has been narrowed regularly. They will be extinct, if the left locations are not protected seriously (Soc Son, Gia Lam, Dong Anh, Thuong Tin, etc.).

2.307 The rare and precious mammal species: Although, Hanoi's mammal has a relatively simple composition of species, the mammal has taken part in the biodiversity preservation with 7 rare and precious mammal species (covering 17.5% of total identified species of Hanoi) which are be threaten to be extinct in Vietnam (in particular) and in the world (in general). Among, 4 species are named in "Red Book of Vietnam" (year 2000) – 2 species of V-level and 2 species of R-level; 2 species of VU-level are named in The Red List of IUCN (year 2004); 6 species (2 species of IB group and 4 species of IIB group) are named in the list of Resolution No.48/2002/ND-CP (year 2002).

2.308 Invertebrate fauna (Invertebrata)

- **Insect**

2.309 There have been 595 species discovered and described. These ones are distributed within 101 families of 13 orders.

- **Animal Living on the Ground**

2.310 Up to present, 50 species of Collembola of 13 families and 11 species of Annelia have been discovered within Hanoi.

(2) Biodiversity of the Aquatic Ecology

2.311 The fauna and the flora living in the fresh-water basin within Hanoi is so diversified. These ones, which comprise Microalgal, alga, waterlogged-flora, invertebrate and pisces, perform the characteristics of the flatland.

(a) Microalgae (Phytoplankton, Phytobenthos)

2.312 There have been 476 species of 6 phyllums discovered and described. Chlorella (Pyrenoisoda) has the most plentiful species for which Cyanobacteria is ranked at the second position. Among the water-basins, sedentary water-basins (lakes, reservoirs, ponds) has the most abundant species composition. In Red river, the species of Microalgae are less plentiful; the most popular one in this water-basin is *Silic alga (Bacillariophyceae)* which grows within the natural water-basins, Silic alga covers 50% of the total overloading-flora (*Phytoplankton*).

2.313 In addition, at the river water-basins which contain the waste water or in lakes and ponds, Pyrenoidales have the most plentiful of species, the second-ranked position is Cyanobacteria, the third one is Euglenophyta. The other group has few species and small densities. In these water-basins, there are many the indicator-species of the organic polluted water-basin samples, such as: *Scenedesmus*, *Tetrastrum*, *Oosystis*, *Distiosphaeria*, *Ankistrodesmus* which are the genera of *Chroococcales*; *Oscillatoria*, *Anabaena*, *Microsystis*, *Merismopedis*, *Dactylococopsis* of Cyanobacteria as well as *Euglena* of Euglenophyta.

(b) High-Level Aquatic Flora (Macrophyta)

2.314 There have been 35 species as the statistic data. According to the surveys on Tracheobionta which grows within Ho Tay (West Lake) and its neighbouring locations, there are totally 33 species of 19 families, such as: Quyet (*Pteridophyta*) and *Spermatophyta*. Among the aquatic flora species, the most significant is *Spermatophyta* with 27 species. The aquatic flora species exist within 3 models. One is the Emergent which comprises species of lotus (*Nelumbonaceae*), water-lily (*Nymphaeaceae*), the other is Subergent which concerns alga species and the left one is floating which covers with the water-fern species. The species which have the large densities and the great quantity are *Rong-la-he* (*Blyxa aubertii* Rich), *Rong-duoi-cho* (*Ceratophyllum demersum*), *Rong-duoi-chon* (*Nyriophyllum verticillatum*), *Rong-mai-cheo* (*Vallisneria spiralis*), *Rau-muong* (*Ipomoea aquatica*), *Beo-Nhat-Ban* (*Eichhornia crassipes*). Among the above mentioned species, some of them play an important role in creating landscape, such as *Eichhornia crassipes* which is the invasive creature and was imported from Japan in 1930. Most of the left species are the ones which have existed in the lake for along time. However, since the expansion of the lake and the great volume of waste water which is discharged directly into the lake daily, so far, the density and quantity of the above mentioned species has been narrowed and reduced remarkably. There have been few of locations, where the aquatic flora species have grown; these locations are concentrated mainly at the lake's northern area where the water environment as well as the habitat of many species has not been affected seriously with the waste water from the residential zones and the construction activities of facilities, entertainment zones, etc. Up to present, the lotus (*Nelumbonaceae*) has been grown at the location of West Lake's Temple.

(c) Invertebrata

2.315 Up to present, 76 species of floating mammal species, 9 species of crabs and shrimps, 40 species of Mollusca have been discovered and described.

2.316 Based on the analysis results of the supplemented samples and the available data, 40 species of potable-water oyster and crew of 12 families; the river oyster familia (*Unionidae*) comprises the most plentiful of species (9 species – covering 22.5%); the *Viviparidae* comprises 6 species (15%). *Ampullariidae* and *Corbiculidae* comprise 5 species (12.5%). So far, there are 117 potable-water oyster and crew species discovered and described. Soc Son hilly zone which is the junction-zone between the middle-land area and the high-land area; so the zone is the habitat of the endemic species of both the mountainous fauna (such as: *Thiara scabra*, *Angulyagra duchieri*) and the flatland water-basin fauna (*Sinotaia aeruginosa*, *Cipangopaludina leicythoides*). Among the species of

Mollusca living within Hanoi, only *Cristaria bialata* is named in Red Book of Vietnam, this one is classified with VU-level.

2.317 In addition, 9 species of Crustaceans of 4 families which live at the bed or water-basins have been described. Up to present, 6 species of Hanoi's potable-water shrimps and crabs are the popular ones in Northern Region. Among, 2 species of Amphipola have just been discovered in Northern Region. The samples of Crustaceans, which were so popular in West Lake before, have not been collected to be studied.

(d) Fishes

2.318 There are 118 fish species of 36 families within 14 orders described; among, 50 species are the river fishes, 12 species are the rare and precious ones which have named in Red Book of Vietnam. The species and the quantity of fishes have been reduced due to the urbanization and industrialization as well as the water pollution. Within Hanoi's fish species, it should be focused on some new invasive ones.

2.319 Foreign pleasure-fishes: As the statistic data, Hanoi has 48 foreign pleasure-fishes of 18 orders; 23 of them are from Neotropical and 12 are from Oriental. The food-fishes and the pleasure-ones not only take part in creating Hanoi's fish diversity, but also affect to the indigenous fishes.

Table 2.1.26 The Biodiversity of Creatural Species of Hanoi

Creatures	Defined species of Hanoi (SH)	Defined species of Vietnam (SV)	The rate between SH and SV (%)
Terrestrial ecosystem			
Tracheophyta	655	11,400	5.7
Fungi	569	826	68.9
Insects	595	7,750	7.7
Collembola	50	140	35.7
Earthworms	11	-	-
Reptilia	24	260	9.2
Amphibia	9	120	7.5
Aves	103	840	12.3
Mammal	40	310	12.9
Aquatic ecosystem			
Floating flora	476	1,438	33.1
Aquatic flora	35	60	58.3
Floating fauna	76	250	30.4
Crabs and shrimps	9	49	18.7
Mollusca	40	126	31.7
Fishes	118	700	16.8

Source: Hanoi DONRE/2008

(3) Biodiversity of Huong Son Special Use Forest

2.320 There are 197 fauna species of 23 orders of 72 families; among 36 mammal species (of 8 orders divided into 18 families), 107 aves species (of 12 orders distributed in 38 families), 34 Reptilia species (of 2 orders within 12 families), 20 frog species (of 1 order of 4 families). In Huong Son, there are many rare and precious animals, such as: *Khi-vang (Macaca Mulatta)*, *Vooc-quan-dui-trang (Trachipthecus delacouri)*, *Cay-giong (Viverra zibetha)*, *Cu-li-nho (Nycticebus pymaeus)*, *Cay-gam*

(*Prionodon pardicolor*), *Te-te-vang* (*Manis pentadaetyla*), *Soc-bay-lon* (*Hylopetes spadiceus*), *Ga-loi-trang* (*Lophura nyethemera*), *Ga-tien-mat-vang* (*Polyplectron bicalcaratum bicalcaratum bicalcara*), *White-rumped shame* (*Copsychus malabaricus*), *White-collared Yuhina* (*Carrulax leycolophus*), *Khieu-bac-ma* (*Garrulax chenensis*), *Tac-ke* (*Gekko gekko*), *Ran-ho-mang* (*Naja Naja*), *Ran-ho-chua* (*Ophiophagus hannah*), *Tran-dat* (*Python molurs*), *O-ro-vay* (*Acanthosauna lepidogaster cuvier*), *ech-xanh* (*Odorrana livida*), and etc.

2.321 According to the studies of Geo-environment and Terrain Structure Center, there are 823 flora species (covering 7.9% of the total flora species of Vietnam) of 540 genuses of 182 families (covering 59.6% of the total flora families of Vietnam) which are distributed in 6 phillums of Tracheophyta. Some of above mentioned species are the rare and precious ones which are *Trai-li* (*Pagraea fragrans*), *Khuyet-la-thong* (*Psilotum nudum*), *Tac-ke-da* (*Drynaria boniii* Christ.), *Sua* (*Dalbergia tonkinensis*), *Binh-voi-hoa-dau* (*Stephania cepharatha*), *Binh-voi* (*Stephania*), *Nghien* (*Burretiodendron hsienmu*), *Lan-kim-tuyen* (*Anoectochilus*), *Lan-mot-la* (*Nervilia fordii* (Hance) Schltr.), *Tho-phuc-linh* (*Smilax glabtax*), and etc.

2.322 Huong Son special use forest acts the role in environmental protection and ecotourism.

(4) Ba Vi National Park

2.323 According to the data supplied by the management board of Ba Vi National Park, the biodiversity of Ba Vi is presented specifically as below.

(a) Biodiversity of Flora

2.324 For the flora, there are 812 species of *Tracheopyta* distributed in 472 genuses of 99 families.

2.325 By surveying at the high biological-belt of Ba Vi National Park, there are 483 species distributed in 323 genuses of 136 families of *Tracheopionta*; among:

- *Lycopodiaohita*: 4 species distributed in 2 genuses of 2 families;
- *Pteridophyta*: 31 species divided into 23 genuses of 15 families;
- *Gymnospermae*: 5 species distributed in 5 genuses of 5 families;
- *Angiospermatophyta*: 377 species divided into 293 genuses of 114 families.

2.326 Rare and precious wood-supplying plants: 18 species, such as: *Bach-xanh* (*Calocedrus macrolepis*), *Thong-tre* (*Podocarpus neriifolius*), *Sen-mat* (*Madhca pasquieri*), *Gioi-la-bac* (*Michelia cavaleriei*), *Vang-tam* (*Magliatia fordiana*), *Tram* (*Aquylaria crassna* Pierre), *Lat-hoa* (*Chukkrasia tabularis*), *Re-huong* (*Cinnamomuum incrs* Reinw), *Phi-ma-mui* (*Cephalotaxus manii*), *De-tung-soc-trang* (*Amentotaxus oliver*), *Vu-huong* (*Cinnamomuum balansae* Lec), *Mac-lieng* (*Eberhardtia tonkinensis*), *Lim-xanh* (*Erythrofloeum fordii* Il.Lec), *Dinh-thoi* (*Hernandia brilletti* Steenis), *Tau-mat-quy* (*Hopea* sp), *Thiet-dinh* (*Markhamia stipullata* Seem), *Gioi-xanh* (*Michelia mediocris* Dandy); *Gioi-gang* (*Paramichelia baillonii* (Pierre) Hu);

2.327 The endemic flora of Ba Vi: 8 species, such as: *Mua-Ba-Vi* (*Allomorpha baviensis*), *Thu-hai-duong-Ba-Vi* (*Begonia baviensis*), *Xuong-ca-Ba-Vi* (*Tabernaemontana baviensis*), *Cau-rung-Ba-Vi* (*Pinanga baviensis*), *Luoi-vang-lang-co* (*Lasianthus langkokensis*), *Sat-bavi* (*Fargesia baviensis*), *Mo-Ba-Vi* (*Maglolia*

baviensis), *Coi-tui-Ba-Vi/ Kiet-Ba-Vi (Carex bavicola Raym)*;

2.328 The flora species of which names are combined with Ba Vi: 02 species, such as: *Ca-lo-Ba-Vi (Caryodaphnopsia baviensis)*, *Boi-loi-Ba-Vi (Litsea baviensis)*;

2.329 The species which have timber value: 185 species;

2.330 The flora which have medicinal value: 503 species (distributed in 118 families of 321 genres). These ones can cure 33 diseases. Some of them are the rare and precious medicinal species, such as: *Hoa-tien (Asarum maximum)*, *Huyet-dang (Sargentodoxa cuneata)*, *Bat-giac-lien (Podophyllum tonkiensis)*, *Rau-hum (Tacca chantrieri)*, *Hoang-dang (Fibraurea tinctoria)*, and etc.

(b) Biodiversity of Fauna

2.331 There are 45 mammal species (of 8 orders comprising 22 families), 134 species of aves (distributed in 18 orders of 40 families), 61 species of reptilia (comprising 3 orders of 12 families), 27 species of amphibia. The rare and precious species are *Cay-van-bac (Chrotogale owstoni)*, *Cay-gam (Prionodon pardicolor)*, *Cu-li-lon (Nycticebus coucorg)*, *Gau-ngua (Selenarctor thibetanus)*, *Beo-lua (Felis temminski)*, *Chon-bac-ma (Melogale personata)*, *Cay-muc (Artictis binturong)*, *Son-duong (Capticonis sumatrensis)*, *Ga-loi-trang (Lophura nycthemara)*, *Du-di-phuong-dong (Ketupa zeylonensis)*, *Tac-ke (Gekko gekko)*, *O-ro-vay (Acanthosaira lepidogasta)*, *Rong-dat (Thygrathus coeini)*, *Ky-da-hoa (Varanus salrator)*, *Ran-ho-mang (Maja maja)*, *Ran-luc-nui (Trimeresurus monticola)*.

2.332 552 insect species distributed in 65 families of 14 orders have been discovered. Among, 7 of them are named in Red Book of Vietnam, such as: *Bo-ngua-xanh-thuong (Mantis religiosa Linnaeus)*, *Ca-cuong (Lethocerus indicus L. et S.)*, *Buom-khe (Attacus atlas Linnaeus)*, *Ngai-mat-trang (Actias selene ningpoana Felde)*, *Buom-rong-duoi-trang (Lamproptera curius Fabricius)*, *Buom-phuong-Helen (Troides helena Linnaeus)*, *Buom-duoi-kiem (Graphium antiphates Cramer)*.

(5) List of Species in Vietnam Red Data Book

2.333 The list of endangered species of Hanoi City in Vietnam Red Data Book is shown in Table 2.1.27 on flora, and in Table 2.1.28 on fauna. Though it means the existence of these precious species within Hanoi City, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 2.1.27 Endangered Species in Hanoi City (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Hanoi
I	1	Magnoliophyta	NGÀNH MỘC LAN			
I.1	1.1	Magnoliopsida	LỚP MỘC LAN			
18	33	<i>Rauwolfia serpentina (L.) Benth.ex Kurz</i>	Ba gác hoa đỏ	CR	A1c,c,B1+2b, c	Y
I.2		Liliopsida	LỚP HÀNH			
II		Pinophyta	NGÀNH THÔNG			
III		Polypodiophyta	NGÀNH DƯƠNG XỈ			
IV		Lycopodiophyta	NGÀNH THÔNG			
V		Rhodophyta	NGÀNH RONG ĐỎ			
VI		Phaeophyta	NGÀNH RONG NẤU			
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable. Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

Table 2.1.28 Endangered Species in Hanoi City (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Hanoi
I		Animal				
1	2	<i>Cynopterus brachyotis</i>	Đơi chó tai ngắn	VU	A1c,d B2a,e	Y
2	12	<i>Macaca assamensis</i>	Khỉ mốc	VU	A1c,d	Y
3	36	<i>Lutra Lutra</i>	Rái cá thường	VU	A1c,d C1+2a	Y
4	61	<i>Cervus Nippon</i>	Hươu sao	EW		Y
II		Birds				
5	113	<i>Aquila clanga</i>	Đại bàng đen	EN	C2a D	Y
III		Reptile -amphibian				
III.1		Reptile				
		Bò sát				
6	178	<i>Ptyas Korros</i>	Rắn ráo thường	EN	A1c,d	Y
7	179	<i>Ptyas mucosus</i>	Rắn ráo trâu	EN	A1c,d	Y
8	180	<i>Bungarus fasciatus</i>	Rắn cạp nong	EN	A1c,d	Y
9	181	<i>Naja naja</i>	Rắn hổ mang	EN	A1c,d	Y
10	202	<i>Rafetus swinhoei</i>	Giải thượng hải	CR	C1+2a	Y
III.2		Amphibian				
		Lưỡng cư				
11	220	<i>Clupanodon thrissa</i>	Cá mèi cờ hoa	EN	A1a,d B1+2a,b,c	Y
12	226	<i>Anguilla japonica</i>	Cá chình nhật	EW		Y
13	249	<i>Channa maculate</i>	Cá chuối hoa	EN	A1c,d	Y
IV.2		Sea fish				
V		Spiniless				
		Động vật không xương sống				
V.1		Freshwater Spiniless				
		Động vật không xương sống nước ngọt				
V.1.1		Crutacean				
		Giáp xác				
V.1.2		Soft species				
		Thân mềm				
	320	<i>Cristaria bialata</i>	Trai cánh mỏng	VU	B2a,b,e+3a,d	Y
14	324	<i>Sinohyriopsis cumingii</i>	Trai điệp	VU	B2a,b,e+3a,d	Y
V.2		Sea Spiniless				
		Động vật không xương sống ở biển				
V.2.1		Coral				
		San hô				
V.2.2		Echinoderm				
		Da gai				
V.2.3		Crutacean				
		Giáp xác				
V.2.4		Soft species				
		Thân mềm				
V.3		Insects				
		Côn trùng				
15	387	<i>Lethocerus indicus</i>	Cà cuống	VU	A1 c,d,e C2b,c,e	Y

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable. Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

2) Flora and Fauna in Ha Nam Province (Annual Environmental Status Report in 2010)

(1) Flora

(a) Natural Flora

2.334 Ha Nam has 4 typical natural ecosystems (such as: the tropical forest on limestone mountains, the grassland and shrub on ground, the grassland and shrub on limestone mountains, the ecosystem within freshwater) and the artificial ecosystem. Based on The Report summarizing on the priority scientific study projects of Hanoi National University (Code: QGTD 0603), Ha Nam has 51 tracheophyta species which have the different ecological amplitudes and are divided into the following groups:

- (i) The flora living within the water environment: *rong-mai-cheo* (*Potamogetonaceae*), *rau-mac-thon* (*Alismataceae*), *rau-bat*, *rong-duoi-cho* (*Ceratophyllaceae*). These species are the indicator flora of the freshwater environment. These ones are distributed major at the river upper-stream basin and the un-polluted water environment, especially at the upper-stream of Day river.
- (ii) The flora floating on the water-surface: *beo-tay* (*Eichhornia crassipes*), *beo-cai* (*Pistia stratiotes* L.), *beo-ong* (*Salviniales*), *beo-tai-chuot* (*Salvinia molesta* D.S. Mitchell), *rau muong* (*Ipomoea aquatica* Forsk), *rau ngo* (*Limnophila aromatica*). These species deposit the solid waste floating within the water which flows through Nhat Tuu Drain with their roots. However, the growth of these species also reduces the flows; thus, the flows are limited, when the waste water is discharged into the water environment; therefore, the waste water pollution spreads to the riparian lands.
- (iii) The floodable flora: these species form the most unique flora communities (both in the ecology and the landscape development of the area). Some species have been maintained in the riparian flooding trips, where there are the deposited alluvial layers, which are considered as the remained native communities; while some other species form the secondary communities in the seriously polluted areas.

2.335 Ha Nam's natural ecosystems are generally the poor ecosystems which are majorly not protected. The quantity and the quality of these ecosystems have been reduced rapidly.

(b) Artificial Ecosystem

2.336 This ecosystem comprises the agricultural ecosystem (wet-rice and crop ecosystems), the residential ecosystem (the urban and industrial residential ecosystem and the rural residential ecosystem), the afforested forest ecosystem. Ha Nam has some special crops as below.

- (i) Dai Hoang banana (Dai-Hoang *Musa paradisiaca*) in Ly Nhan district:

2.337 This is the special banana gender. When the banana ripe; it has the orange-yellow color, its stem is green. The bananas have the thin peels, the yellow fragrant and sweet flesh. This banana kind was offered respectfully to King, so it has named as Dai Hoang.

- (ii) Nhan Hau Kaki (Nhan-Hau *Diospyros kaki* L.) in Ly Nhan district

2.338 This kaki gender has big balanced-shape fruits which are red (changing from the bright red to the dark red) when they ripe. Besides, these ripen fruits have non-wrinkle, no black-streak and fine thin skin. Inside the fruits, there are not the degraded hyaline pips only but also the soft sweet flesh (looking like the jelly). This is such a special fruit of Ha Nam, it has been conversed, grown and developed.

- (iii) Van Ly mandarine (Van-Ly *Citrus Deliciosa* Tenore) in Ly Nhan district

2.339 This kind has been being exported to Russia and some Eastern European countries. There are many mandarine species; however, Van Ly mandarine has special fragrant, oblate shape, moderately thin and crunchy

skin which turns into the yellow when the fruits ripe.

(2) Fauna

- (a) Natural fauna: comprising some species as *mammalia* {*cay-huong* (*Viverricula indica*), *cay-dong, doi* (*Chiroptera*), *soc* (*Sciuridae*), *chuoat* (*Mus*), etc.}, *reptile* {*ran* (*snake*), *than-lan* (*Mabuya sp.*), *tac-ke* (*Gekko gekko*), etc.}, *birds* {*chim-sau* (*Dicaeidae*), *chim-sao* (*Sturnidae*), etc.}, *fish* {*ca-qua* (*Ophiocephalus Striatus*), *ca-chuoi* (*snake-head*), *ca-tre* (*Clariidae*), *ca-tram* (*grass carp*), etc.}, *oyster, shellfish, mussel, etc.* Some species often occurred in rivers before; however, they have mostly disappeared now because of the polluted rivers (lile ca-ngan)
- (b) Cattle and poultry: buffalo, cow, goat, chicken, and etc. Ha Nam has a special precious chicken gender as Ga-mong-tien-phong (in Duy Tien district). This kind is famous of its productivity and meat quality. This kind of chicken is named in Vietnam Red Book.

(3) List of Species in Vietnam Red Data Book

2.340 The list of endangered species of Ha Nam Province in Vietnam Red Data Book is shown in Table 2.1.29 on flora, and in Table 2.1.30 on fauna. Though it means the existence of these precious species within Ha Nam Province, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 2.1.29 Endangered Species in Ha Nam Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Ha Nam
I		Magnoliophyta	NGÀNH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
1	27	<i>Melodinus erianthus</i> Pitard	Giom lá chụm	VU	A1c, B1+2b,c	Y
2	34	<i>Rauwolfia verticillata</i> (Lour.) Baill.	Ba gác vòng	VU	A1a,c	Y
3	91	<i>Markhamia stipulata</i> (Wall.) Seem. ex Schum var. <i>kerrii</i> Sprague	Đinh	VU	B1+2e	Y
4	96	<i>Bursera tonkinensis</i> Guillaum	Rằm	VU	A1a,c,d+2d, B1+2a	Y
5	134	<i>Sauropus bonii</i> Beille	Bò ngót bon	VU	B1+2e	Y
6	137	<i>Callerya speciosa</i> (Champ. ex Benth.) Schot	Cát sâm	VU	A1a,c,d	Y
7	176	<i>Illicium difengpi</i> B.N. Chang	Hôi đá vôi	VU	B1+2b,c,e	Y
8	210	<i>Tsoongiodendron odorum</i> Chun	Giôi lụa	VU	A1c,d+2c,d	Y
9	253	<i>Murraya glabra</i> (Guillaum.) Guillaum.	Vương tùng	VU	A1a,c,d	Y
10	255	<i>Sinoradkofera minor</i> (Hemsl.) F. G. Mey	Bông mộc	EN	A1a,b,c	Y
II.2		Liliopsida	LỚP HÀNH			
11	285	<i>Amorphophallus interruptus</i> Engl. & Gehrm.	Nưa gián đoạn	LR	/cd	Y
12	313	<i>Curculigo orchioides</i> Gaertn	Ngải cau	EN	A1a,c,d	Y
13	360	<i>Habenaria praetermissa</i> Seidenf. ex Aver.	Hà biện praetermiss	EN	B1+2b,c	Y
II		Pinophyta	NGÀNH THÔNG			
III		Polypodiophyta	NGÀNH DƯƠNG XỈ			
IV		Lycopodiophyta	NGÀNH THÔNG			
V		Rhodophyta	NGÀNH RONG ĐỎ			
VI		Phaeophyta	NGÀNH RONG NẤU			
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
 Source: Vietnam Red Data Book, 2007

Table 2.1.30 Endangered Species in Ha Nam Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Ha Nam
I		Animal	Thú			
1	12	<i>Macaca assamensis</i>	Khỉ mốc	VU	A1c,d	Y
II		Birds	Chim			
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
2	180	<i>Bungarus fasciatus</i>	Rắn cạp nong	EN	A1c,d	Y
III.2		Amphibian	Lưỡng cư			
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
3	249	<i>Channa maculata</i>	Cá chuối hoa	EN	A1c,d	Y
IV.2		Sea fish	Cá biển			
4	264	<i>Elops saurus</i>	Cá cháo biển	VU	C1	Y
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crutacean	Giáp xác			
V.1.2		Soft species	Thân mềm			
5	320	<i>Cristaria bialata</i>	Trai cánh mỏng	VU	B2a,b,e+3a,d	Y
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
V.2.2		Echinoderm	Da gai			
V.2.3		Crutacean	Giáp xác			
V.2.4		Soft species	Thân mềm			
V.3		Insects	Côn trùng			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
 Source: Vietnam Red Data Book, 2007

3) Flora and Fauna in Nam Dinh Province (5ECSR period 2005–2009)

(1) Xuan Thuy National Park

(a) Flora System

2.341 There are 116 species, 99 genus and 42 families. Details are as follows:

Table 2.1.31 High-Level Flora in Xuan Thuy National Park

Phylum	Family	Genus	Species
Psilotophyta	4	6	6
Angiospermae	38	93	109
Dicotyledones	32	68	85
Monocotyledones	6	25	34
Total	42	99	116

Source: Nam Dinh DONRE/2009

In Xuan Thuy national park, there are 14 species of wood trees, of which, there are only 6 species participating in concentrated mangrove forests including: *Avicennia marina*, *Aegiceras corniculatum*, *Kandelia candel*, *Rhizophoraceae*, *Sonneratia caseolaris*. These species cover a large area of mangrove forests. The remaining wood species are mainly plants planted sparsely at small number. Herbaceous plant has a variety of species. This kind of plant is growing under casuarina shadow, on fixed sand mound, or on the side of shrimp pond.

(b) Fauna System

2.342 There are 9 species of 5 families, 4 phylum; 215 species of birds of 41 families, 13 phylum, 10 species of reptiles and frogs of 5 families, 2 phylum; 107 species of fish of 44 families, 12 phylum; 84 species of crustacean of 13 families, 38 classes; 40 species of Bivalvia of 13 families, 24 classes.

- (a) **Mammals:** mainly rodents, inclusive of 9 species and 2 species yet to be defined namely dolphin and *Orcaella brevirostris*. These species can be seen in stormy season (from August to October). Otter species are recorded in Vietnam Red Book at vulnerable level.
- (b) **Bird:** Coastline of the Red river Delta (especially Xuan Thuy National Park) is the destination of many migrating bird species to live in winter. Xuan Thuy national park is an important “platform” for birds to stop by and save energy for a long journey. At migrating time, in national park, there can be seen up to 30 to 40 thousand birds (according to statistics in 2002), among which there are 11 species of birds in danger and about to be in danger.
- (c) **Reptiles:** 11 species, of which 4 species are recorded in Vietnam Red book.
- (d) **Fish:** 107 species, of which there is only one cartilaginous fish, the rest are bony fish. *Perch* kingdom is the main component of the fish system, including 21 families (49%) and 60 species (56%). Fish in this area is divided into 3 groups: freshwater fish, salt water fish and brackish water fish.
- (e) **Crustacean:** 84 species, of which crab phylum has the highest number of species, accounting for 82% (69 species); shrimp phylum has 11 species (13%); *Cirripedia* and *Branchiopoda* accounting for 5%.
- (f) **Gastropoda:** *Potamididae*, *Melampidae*, *Neretidae* are families having the highest number of species. The rest do not have many species with only 1 or 4 species.
- (g) **Bivalvia:** the number of species of this group living mangrove forest is not high because this group can only adapt to water environment, which changes all the time and rich in organic mulch. The bottom of mangrove forest is often exposed when the tide goes down. Only a few species can adapt to the bottom living conditions and some species attach to the root and body of trees in mangrove forests like *Ostrea*.

(2) Nghia Hung Mangrove Forest

(a) Rare Species

2.343 Flora and fauna system in Nghia Hung mangrove forest is rather diversified. Up to present, there are 669 species, 431 breeds of 6 main groups of living things. Benthic fauna has the highest number of species (26.4%), floating fauna (15.6%); bird class accounts for 14.3% and mangrove flora accounts for 3.1%. Rare species recognized in Nghia Hung mangrove forest are as follows

- a. **Fish:** *Clupanodon thrissa*, *Tylosurus strongylurus*, *Bostrichthys sinensis*.
- b. **Bird:** *pelecanus philippenensis*, *Platalea leucorodia*, *Tringa guttifer*, *Limnodromus semipalmatus*, *Larus saundersi*.

- c. Marine creatures need exploiting and protecting: **Crustacean:** shrimps of all types, crabs and flower crabs and **Mollusks:** surf clam, oyster, blood cockle, king crab.

(b) Flora System

2.344 Mangrove Flora: there are 21 flora species of 14 breeds, 16 families, 2 classes among which bicotyledon class has 16 species, accounting for 76%. The rest are unicotyledon. Aegiceras develop strongly, creating a population which can help other plants grow.

2.345 Floating flora: Nghia Hung alluvial deposit surrounded by 2 large estuaries has diversified floating flora system. In Ninh Co, there are 106 species, Cua Day: 99 species. Silic accounts for the highest percentage in the number of species.

(c) Fauna System

2.346 Floating fauna: in Ninh Co: 88 species, Cua Day: 59 species, Copepoda has the highest number of species (28 species), Cladocera has 2 species, Rotifera has 6 groups, each group has only one species.

- a. **Benthic Fauna:** 171 species, 112 genus, 62 families, 13 orders, 4 classes, 4 phylum.
- b. **Oligochaeta phylum:** 15 species, 8.8%
- c. **Arthropoda phylum:** 77 species, 45%
- d. **Mollusks:** 78 species, 45.6%
- e. **Brachiopoda:** 1 species, 0.6%
- f. **Crustacean:** 77 species of 45 genus, 21 families, 6 orders. Majority of crustacean are decapoda
- g. **Mollusks:** this is the most important species in Nghia Hung alluvial deposit with 78 species of 51 genus, 33 families, 6 orders, 2 phylum. Bivalvia (surf clam) has 40 species, accounting for 51.3%; gastropoda: 38 species (48.7%)
- h. **Gia be:** 1 species of brachiopoda, living sparsely at the bottom.
- i. **Fish:** there are 162 species of fish of 113 genus, 53 families. Brackish water and salt water fish have 125 species (77.2%), the rest are freshwater fish (37 species)
- j. **Bird:** 96 species of birds of 55 genus, 27 families, 13 orders

4) Flora and Fauna in Ninh Binh Province (5ECSR period 2005-2009)

2.347 Ninh Binh is one of the provinces with high forest coverage and rich of biodiversity in the country. This is especially for special forests, including Cuc Phuong National Park, Van Long Conservation Zone, Hoa Lu Forest (culture–history–environment), and the bio-sphere reserve zone in coastal area of Kim Son, among others.

(1) Cuc Phuong National Park

2.348 Cuc Phuong National Park is a nature conservation zone, a special-use forest located on the border of three zones: Northwest Region, Red River Delta and North

Central Coast, covering areas of three provinces of Ninh Binh, Hoa Binh and Thanh Hoa. This National Park has rich flora and fauna diversity characterized by tropical rainforest. Many plant and animal species endangered by extinction have been discovered and preserved here. This is also the first national park in Vietnam, which covers 22,200 ha in total, including 11,350 ha in Ninh Binh Province, 5,850 ha in Thanh Hoa and 5,000 ha in Hoa Binh. By coordinates, the province is seated at 20°14'–20°24' North and 105°29' – 105°44' East.

2.349 Cuc Phuong Forest is rich of ecosystem, home to more than 2,000 species of insects, 110 species of reptiles and amphibians, 65 species of fish, 117 species of mammals, and 313 species of birds, 280 species of butterflies. Many of these are endangered, including *delacour*, *trachypithecus delacouri* and several are on the edge of being endangered, such as *Owstons' Hemigalus Owstoni*.

2.350 Cuc Phuong is the habitats of a number of important mammal communities in need of preservation, including several primates on the edge of extinction on global scale, such as *Trachypithecus delacouri* (seriously endangered level) and *Chrotogale owstoni* (globally endangered), *Panthera pardus* (endangered at national level). About 40 other species have also been recognized here.

2.351 Recently, *Panthera pardus* have been found in Cuc Phuong forest. Due to illegal hunting and shrinking habitats in the forest, a number of mammal species have disappeared, including *Panthera Tigris* and *Hylobates Leucoengys*.

2.352 Cuc Phong is the north-most area of an exclusive bird-zone for lowland in the North Central Region. However, only one species has been found within the boundary of the forest: *Jabouilleia danjoun*. Cuc Phuong has been recognized as an important bird-zone in Vietnam.

2.353 A number of bird species in Cuc Phuong National Park have been listed as precious and rare, namely *Scimitar Babbler Jabouilleia Dajouni*. Several other groups of creature have been surveyed on too in Cuc Phuong, including gasteropod. About 111 species of gasteropod have been identified in a recent survey, including 27 species exclusively found in the forests. Fish in ground caves have been also surveyed on, and at least one species has been identified as unique to the limestone mountain zone, namely Cuc Phuong Siluru. Here, 280 species of butterflies have been identified, with 7 of them seen the first time in Vietnam, in 1998.

2.354 Cuc Phuang flora carpet is characterized by location on limestone. In forests, upto five clearly distinguished canopies can be established, and the top can reach beyond 40m. Due to steep landscape, the canopies are not continuous in most of the cases, and in certain areas, there is no visible boundary. Many of the plants developed special types of roots to adapt with the thin fertile layer of soil on top. The national park is now home to several big wood trees species, including *Terminalia myriocarpa van Henrek et Muell*, *Parashorea chinensis* etc. These are under protection now for tourism purposes. This forest is, beside, rich of wood trees and herb plants. Cuc Phuong is characterized by diversified flora. Scientists have listed about 2000 species of Tracheophyta, under 887 genus, 221 families of plants. The riches families in Cuc Phuong are *dai-kich*, *hoa-thao*, *dau*, *thien-thao*, *cuc*, *dau-tam*, *nguyet-que*, *coi*, *lan* and *o-ro*. The flora system in Cuc Phuong is set by flora-geography, including China Hymalaya – India – Myanmar and Malesia. Up to know, three unique species of Tracheophyta have been identified for Cuc Phuong system,

namely *hồ trăn*, *mua* and *cui*. The national park of Cuc Phuong has also been identified as one of the seven flora-diversity centers of Vietnam.

(2) Van Long Watershed Natural Conservation Zone

2.355 Covering 2643 ha to the northwest of Gia Vien District, the zone covers seven communes of *Gia Hung*, *Lien Son*, *Gia Hoa*, *Gia Tan*, *Gia Van*, *Gia Lap* and *Gia Thanh*. There are three sub-zones: strict protection, eco-recovery, and administrative service. In terms of forest resources and land, this area is divided into protection forest and production forest.

2.356 The Van Long Conservation Zone is at the edge between mountainous and plain areas surrounded by Day River (northeast) and Boi – Hoang Long River (southwest), and thus bio-diversity is rich both on land and in water. Land eco-systems have been formed on karst, while water-borne systems were established with characteristics of fresh-water swamps in the Red River Delta. Three types of eco-systems can be distinguished:

- (a) Land ecosystem: secondary forest on limestone mountain, bare limestone mountains, grass and bushes on limestone mountain, planted forests (*keo*, *bạch đàn*), vegetable and crops fields, caves.
- (b) Water-borne ecosystem: swamps, water rice fields, rivers, streams, underground caves
- (c) Residential Ecosystem

2.357 Each of the ecosystem types has their own uniqueness, and from conservation viewpoint, the secondary forest on limestone mountain and swamps are valuable.

2.358 The secondary forest on limestone mountain is habitat of *trachypithecus delacuri* (*voọc mông trắng*), while the water-borne ecosystem is home to unique water-borne creatures in the Red River Delta, and immigration places for water birds from the north.

- (a) **Flora:** The plant carpet on limestone mountain covers 1,856 ha (65% of total area of the conservation zone), grass behind fields 113 ha (4%), submerged land 422 ha (14.7%), bare rock mountains 145.87 ha (5%). By flora system, angiosperms covers 95% of total species, including 7 listed in the Red Book, 3 species recognized the first time in Vietnam. Statistics show that here there are 266 out of 457 Tracheophyta.

2.359 Species of plants on limestone mountains: as a result of uncontrolled logging for decades, many of big wood trees are no longer around. Recent surveys show that the number of land-borne plants is 488 species under 342 genus and 135 families. Bryophyte has some species. Ferns has also a number of representatives (*cay-don*). Gymnosperms, too, are also available (*cay-tue*, *cay-gam*). Angiosperms (both *monocots* and *eudicots*) are plenty. Wood trees are also plenty still (*cay-nhoi*, *loc-vung*, *sung*, *goi*, *ghe*, *chan-chim*, *than-mat*, *thi*, *da*, *nguyen*, *lim-xet*, *lat-hoa* etc.) This is also the area of *Dalbergia tonkinensis* (*cây sưa*), a precious tree. Bush trees include *ô-rô*, *duoi*, *co-ke*, *bung-buc* etc., while grass includes *co-lao*, *co-tranh*, *co-lan* (*lan-dat*). In this conservation zone, planted forests are in vacant lands, including *bạch đàn*, *keo tai tượng*, *tre*. In recent years, plantation of *Dalbergia tonkinensis* has been under

testing for replication.

2.360 Of the plants living on limestone mountains, herbs should be paid attention to. In fact, local people would come to harvest them for treatment activities. It has been reported that 266 plants can be used as herbs, including *xuong-rong*, *vu-bo*, *ke-hoa-vang*, *com-nguoi* (bush trees), *rau-mai*, *ha-thu-o-trang*, *tau-bay*, *don-buot*, *thuoc-bong* (grass), *nui-nac*, *canh-kien*, *sau*, *sung*, *de*, *gao* (wood) etc.

2.361 Another group of plants for conservation is those for decoration purposes. About 20 species of these have been identified here, including orchids, ficus, ráng, *Pteridophyta*, pines etc.

2.362 **Species of water-borne plants in swamps:** In the conservation zone, almost 1000 ha of the swamp is still in pristine state. About 39 species of water-borne plants have been identified, including *he-nuoc* (shallot), *rau-bo* (duckweed), *beo-ong* (Floating-moss), *rau-mac*, *beo-cai* (*Pistia stratiotes*), *beo-tam* (water lentil), *coi* (Sedge), *rau-muong* (Morning glory), *sen* (Lotus), *sung* (Water lily), *trang*, *nghe* (Knotweed) *au* (*Caltrop*) and etc). These plants grow densely during summer, while in cold weather of winters – when water is dried up – they grow less. These plants are considered important part of any submerged areas in the Red River Delta

2.363 **Micro Algae in Swamps:** Micro algae are found in rich population in the swamps. 258 taxon have been identified, belonging to five groups: *tảo mắt*, *tảo lục*, *tảo silic*, *tảo ánh vàng* and *tảo hai rãnh*. Of these, *tảo lục* (*Pyrenoidosa*) is the most popular in terms of species. Micro algae and the water-borne plants in swamps play important role in material process, particularly by photosynthesizing CO₂ and energy to release organismic matter – the basis food for animals and also oxygen to the atmosphere.

(b) **Fauna:** in the zone, there are 9 species of animals listed the Vietnamese Red Book. Especially, statistics show that there are 100 *trachypithecus delacuri* (*voọc móng trắng*) in Van Long – the largest population of their kind in Vietnam.

- **Land Animals**

- **Insects:** Preliminary surveys show that there are 79 species, including 11 species under *Hemiptera* (*canh-nua*), 14 under *Coleoptera* (*cánh cứng*), 5 under *Orthoptera* (*canh-thang*), 8 under *Odonata* (*chuon-chuon*), 41 under *Lepidoptera* (*canh-vay*). Butterflies are rich with 8 families, including 8 species under *Papilionidae* (*buom-phuong*), 5 species under *Satyridae* (*buom-mat-ran*), 7 species under *Nymphalidae* (*buom-giap*), 7 species under *Pieridae* (*buom-phan*), 8 species under *Lycaeridae* (*buom-tro*), 4 species under *Danaidae* (*buom-dem*), 4 species under *Hesperidae* (*buom nhay*), and 1 species under *Acreaidae*.

- **Reptiles and Amphibians:** In the conservation zone there are 32 species under 13 families, 4 orders and 2 classes. Snakes are plenty with 14 species, while frogs come with 7 and turtles 4 species.

2.364 Birds are found with 72 species under 33 families and 14 orders. Typical characteristic of birds in this zone is the dominance of water birds while land birds are more found at the edges between mountainous and plains areas. Unfortunately, over-hunting has cause the rare appearance

of big birds, such as *Accipitriformes (Bo-ung)*, *Phasianidae (Ho-tri)*, *Rallidae (Ho-ga-nuoc)*, *ho-ga-loi-nuoc*, *Columbidae (ho-bo-cau)*.

- **Mammals:** Surveys show that there are 39 species of mammals, under 19 families and 8 orders in the Conservation Zone. However, in reality they are not easy to meet in natural conditions, especially for big mammals, such as *Ursus thibetanus (gau-ngua)*, *Naemorhaedus griseus (son-duong)*, *Sus scrofa (lon-rung)*, *Neofelis nebulosa (bao-gam)*, among others, due to over hunting beyond recovery, except for *trachypithecus delacuri (vooc-mong-trang)*, which is under protection.

- **Water Animals**

2.365 The swamps are a rich world of water animals with great diversity. Smaller size are those which cannot be seen with naked eyes, and medium size population is featured by crabs, shrimps, snails, fish, while bigger size are turtles., etc.

2.366 Surveys in 2001–2003 show that backbone-less animals in the Conservation Zone are 102 species under 61 families (80 living at swamp bed). There are also representatives from *Rotifera* (trùng bánh xe), soft bodies, armored-bodies and water insects.

- i. Fish is important water animals of the swamp. Surveys results show 54 species of 17 families and 9 orders. All of the fishes in this zone are typical for water bodies of the Red River Delta. The two exceptions include the fact that there recently appears a few species of fishes migrating from the sea (*ca-lanh-chanh*, *ca-ngam*), and few from mountainous rivers and springs (*ca-ram-xanh*, *ca-nhang* etc.).
- ii. Amphibians and reptiles are also diversified in the water zones. Frogs are in 7 species, while turtles are 9 species. Varans are also found here.
- iii. Birds and mammals are also strongly related to the swamps, including water-hunting birds and otters.

- **Rare and unique species of plants and animals**

2.367 In the Van Long Zone, there are now 38 rare and precious species of plants and animals, listed in Vietnamese Red book, including 11 plant species and 27 animal species.

- i. The rare and precious plant species include *Sua (Dalbergia tonkinensis prain)*, *son-dich (Aristolochia indica)*, *nghien (Excentrodendron tonkinense)*, *lat-hoa (Chukrasia tabularis)*, *tue-da-voi (Cycas elongata)*, *bo-cot-toai (Drynaria fortunei)*, *chan-danh (Euonymus chinensis)*, *rau-sang (Melientha suavis)*, *khuyet-la-thong*, *ra-tien-tan*, *bach-bo (Stemonaceae)*, and *bo-cap-nui (Scorpiones)*.
- ii. The rare and precious animal species include *oc-van-hinh-thap (Epitonidae)*, *trai-coc-hinh-tai (Lamprotula Leai)*, *trai-coc-tron Lamprotula nodulosa*, and *trai-canh mong (Cristanria bialata)*.
- iii. Rare water insects include *ca-cuong (Lethocerus indicus)*
- iv. Rare and precious fish includes *ca-ram-xanh (Sinilabeo lemassoni)*

- v. Rare and specious reptiles include *ran-ho-mang* (*Naja Naja*), *ran-ho-mang-chua* (*Ophiophagus hannah*), *ran-soc-khoanh* (*Orthriophis moellendorffii*), *ran-rao-trau* (*Ptyas mucosus*), *ran-cap-nong* (*Bungarus fasciatus*), *ran-rao-thuong* (*Ptyas korros*), *tac-ke* (*Gekko gecko*), and *ky-da-hoa* (*Varanus salvator*)
- vi. Rare and specious birds include: white pheasant
- vii. Rare and specious mammals include: *doi-cho-tai-ngan* (*Cynopterus brachyotis*), *cu-li-lon* (*Nycticebus bengalensis*), *khi-mat-do* (*Macaca arctoides*), *vooc-mong-trang* (*Trachypithecus delacouri*), *gau-ngua* (*Ursus thibetanus*), *rai-ca-thuong* (*Lutra lutra*), *cay-muc* (*Arctictis binturong*), *cay-van-bac* (*Hemigalus owstoni*), *bao-gam* (*Pardofelis nebulosa*), *bao-hoa-mai* (*Panthera pardus*), *son-duong* (*Capricornis sumatraensis*), and *te-te* (*Manis javanica*).

2.368 The dominant landscape is karst landscape. Karst process is frequent and strong due to limestone compositions in the structure, high rainfall, high temperature background and rich surface water. Limestone structures are diversified and created both on the surface and underground. The surface limestone structures include mounts and sides of karst mountains, collapsed holes, the underground limestone structures include cave.

2.369 Peak and sides of karst mountains are the popular limestone structure in the Conservation Zone. Peaks of these structures are normally pointed and sharp, while the sides are often quite steep and marked by collapsed rocks. Mountain tops range is between 100–500 m high, including Ba Non (428m), Dong Quyen (328 m), Mao Ga (308 m), Nui Sum (233 m), Meo Cao (206 m), Nui May (128 m), Nui Luong (128 m), and Co Tien (116 m).

2.370 Karst collapsing holes are also quite popular, 2–3 holes/valleys per km². The size of these are normally a few ha, rarely 10 ha. They include Can, Dam Bai, Quen Ca, Hoa Lu, Dong Rong, Gieng Meo valleys.. These valeys/holes are shaped with right-angle walls, flat beds and surrounded by cliffs. Soil in these is fertile, quite favorable for fruit trees.

2.371 Karst Caves: The karst caves in the Zone are plenty but not in big size, short and low-ceiling. There have not been much surveys on local caves. Most of the caves are at mountain bottoms. Probably, before dyke development (1963 – 1964), these caves were quite dried. After the dyke development, as these areas are for water reservoirs, a number of caves are submerged the whole year round, namely Ca, Vong, Bong etc. in Gia Van communes.

2.372 Within the Conservation Zone, there are beautiful caves, such as Hang Ca, Hang Bong, Hang-Thanh-Son, Hang-Nui-Tho, Hang-Ba-Nghiep, Hang-Tranh, Hang-Da-Do, Hang-Thung-Doi. . Of these, the Hang Ca and Hang Bong are submerged, while other caves are non-submerged ones.

2.373 Karst landscape with peaks and slopes as well as collapsing holes in the Zone is the typical feature for the karst landscape in the karst zone left bank of Da River.

(3) Hoa Lu Culture–History–Environment Forest

2.374 This forest is a part of Hoa Lu Ancient Capital City and Tam Diep- Bich Dong, lying on the southern edge of the Red River Delta, the meeting place of flora migration from the south, north and west, from the sea, interleaved within the two tectonic structure of Diep Tan Lac (earth mountains) and Diep Dong Giao (concave, and limestone mountains). This is also the transition place between various types of landscapes: from river-originated delta and plains, to low-land submerged water rice fields. High and complicated bio-diversity is expected in this area.

2.375 Surveys show that in Hoa Lu forest there are 618 high-class plant species, 40 big plant species, 36 fern species, 4 pine species, 536 orchid species and 88 floating plant species. Rare and specious plants include *Kien-kien (Hopea pierrei)*, *dinh (Markhamia stipulata)*, *sen (Madhuca pasquieri)*, *lat (Chukrasia tabularis)* and *hoang-dan (Pauldopia ghorta)*. Ten of the species are listed in Vietnamese Red Book for protection, where two species are at endangered level, one at rare level, two at to-be-endangered level, and three at threatened level.

2.376 In terms of animals, there are 39 backboneed species, 62 species of birds, 26 reptile species, 6 amphibian species, and 44 fish species. The rare and specious species include tigers, panthers, bears, apes, elephants, and birds (peacock, *yeng*, *parrots*, *seu*, *co sao*, *khuou*. etc.). There are here 30 floating species and 45 bed species, and several species of insects.

(4) List of Species in Vietnam Red Data Book

1.1 The list of endangered species of Ninh Binh Province in Vietnam Red Data Book is shown in Table 2.1.32 on flora, and in Table 2.1.33 on fauna. Though it means the existence of these precious species within Ninh Binh Province, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 2.1.32 Endangered Species in Ninh Binh Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Ninh Binh
I		Magnoliophyta	NGÀNH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
1	3	<i>Alangium tonkinense</i> Gagnep.	Thôi chanh bạc	VU	A1c, B1+2a,b,c,d	Y
2	17	<i>Mitrephora calcarea</i> Diels ex Ast	(Cây) Đội mũ	VU	A1a,c,d	Y
3	20	<i>Polyalthia praeflorens</i> Ban	Quần đầu hoa sớm	EN	B1+2d+3c	Y
4	27	<i>Melodinus erianthus</i> Pitard	Giom lá chụm	VU	A1c, B1+2b,c	Y
5	34	<i>Rauwolfia verticillata</i> (Lour.) Baill.	Ba gác vòng	VU	A1a,c	Y
6	63	<i>Sarcostemma acidum</i> (Roxb.) Voigt	Tiết cần	EN	B1+2a	Y
7	78	<i>Vernonia bonapartei</i> Gagnep.	Cúc bạc đầu	VU	A1a,c, B1+2a,b,c	Y
8	81	<i>Balanophora Cucphuongensis</i> Ban	Dó đất Cúc Phương	EN	D1	Y
9	82	<i>Balanophora laxiflora</i> Hemsl.	Nấm đất	EN	B1+2b,c,e	Y
10	83	<i>Rhopalocnemis phalloides</i> Jungh	Son dương	VU	A1a,b,c	Y
11	91	<i>Markhamia stipulata</i> (Wall.) Seem.ex Schum var. <i>kerrii</i> Sprague	Đinh	VU	B1+2e	Y
12	93	<i>Pauldopia ghorta</i> (Buch.-Ham.	Đinh cánh	EN	B1+2e	Y

		<i>Ex G.Don) Steem</i>				
13	96	<i>Bursera tonkinensis</i> Guillaum	Rễ m	VU	A1a,c,d+2d, B1+2a	Y
14	97	<i>Canarium tramdenum</i> Dai & Yakovl	Trám đen	VU	A1a,c,d+2d	Y
15	103	<i>Codonopsis javanica</i> (Blume) Hook.f	Đang xam	VU	A1a,c,d+2c,d	Y
16	106	<i>Euonymus chinensis</i> Lindl	Đỗ trọng tía	EN	A1b,c,d	Y
17	108	<i>Reissantia setulosa</i> (A.C. Smith)	Dây húc nhám	EN	A1a,b,c	Y
18	122	<i>Hopea mollissima</i> C.Y.Wu	Sao mặt quỷ	VU	A1c,d	Y
19	126	<i>Vatica subglabra</i> Merr.	Táo nước	EN	A1c,d	Y
20	141	<i>Sophora tonkinensis</i> Gagnep.	Hồ bắc bộ	VU	B1+2e	Y
21	147	<i>Castanopsis lecomtei</i> Hickel & A. Camus	Cà ôi sa pa	VU	A1c,d	Y
22	176	<i>Illicium difengpi</i> B.N. Chang	Hôi đá vôi	VU	B1+2b,c,e	Y
23	177	<i>Annamocarya sinensis</i> (Dode) J. Leroy	Chò đái	EN	B1+2c,d,e	Y
24	187	<i>Cinnamomum balansae</i> H. Lecomte	Gù hương	VU	A1c	Y
25	188	<i>Cinnamomum cambodianum</i> H. Lecomte	Re cambốt	VU	B1+2b,e	Y
26	198	<i>Strychnos umbellata</i> (Lour.) Merr.	Mã tiền tán	VU	A1a,c	Y
27	210	<i>Tsoongiodendron odorum</i> Chun	Giôi lưa	VU	A1c,d+2c,d	Y
28	212	<i>Aglaia spectabilis</i> (Miq.) Jain & Bennet	Gội nếp	VU	A1a,c,d+2d	Y
29	213	<i>Chukrasia tabularis</i> A.Juss.	Lát hoa	VU	A1a,c,d+2d	Y
30	215	<i>Dysoxylum cauliflorum</i> Hiern	Đinh hương	VU	A1a,c,d+2d	Y
31	216	<i>Dysoxylum loureiri</i> (Pierre) Pierre	Huỳnh đường	VU	A1a,c,d+2d	Y
32	222	<i>Ardisia silvestris</i> Pitard	Lá khô	VU	A1a,c,d+2d	Y
33	223	<i>Embelia parviflora</i> Wall. ex A. DC	Thiên lý hương	VU	A1a,c,d+2d	Y
34	230	<i>Melientha suavis</i> Pierre	Rau sắng	VU	B1+2e	Y
35	249	<i>Rothmannia vietnamensis</i> Tirveng	Dành dành Việt Nam	VU	A1c, B1+2c	Y
36	253	<i>Murraya glabra</i> (Giullaum.) Giullaum.	Vương tùng	VU	A1a,c,d	Y
37	255	<i>Sinoradlkofera minor</i> (Hemsl.) F. G. Mey	Bông mọc	EN	A1a,b,c	Y
38	258	<i>Kadsura heteroclita</i> (Roxb.) Craib	Xun xe tạp	VU	A1c,d	Y
II.2		Liliopsida	LỚP HÀNH			
39	285	<i>Amorphophallus interruptus</i> Engl. & Gehrm.	Nưa gián đoạn	LR	/cd	Y
40	287	<i>Amorphophallus verticillatus</i> Hett.	Nưa hoa vòng	LR	/cd	Y
41	291	<i>Calamus platyacanthus</i> Warb. ex Becc.	Song mật	VU	A1c,d+2c,d	Y
42	296	<i>Disporopsis longgifolia</i> Craib	Hoàng tinh cách	VU	A1c,d	Y
43	307	<i>Scirpus kimsonensis</i> K. Khoi	Cò ngan	EN	B1+2a,b,c,d	Y
44	313	<i>Curculigo orchioides</i> Gaertn	Ngải cau	EN	A1a,c,d	Y
45	351	<i>Dendrobium wardianum</i> R.	Ngũ tinh	VU	B1+2e	Y
46	366	<i>Nervilia aragoana</i> Gaudich	Chân trâu xanh	VU	B1+2b,c,e	Y
47	389	<i>Smilax elegantissima</i> Gagnep.	Kim cang nhiều tán	VU	B1+2b,c	Y
48	395	<i>Stemona saxorum</i> Gagnep.	Bách bộ đứng	VU	B1+2b,c	Y
II		Pinophyta	NGÀNH THÔNG			
49	413	<i>Cycas multipinnata</i> C.J. Chen & S. Y. Yang	Tuế xê lông chim nhiều lần	VU	A1a,c	Y
III		Polypodiophyta	NGÀNH DƯƠNG XỈ			
50	427	<i>Drynaria bonii</i> C. Chr.	Tắc kè đá	VU	A1a,c,d	Y
IV		Lycopodiophyta	NGÀNH THÔNG			
V		Rhodophyta	NGÀNH RONG ĐỎ			
VI		Phaeophyta	NGÀNH RONG NÂU			
VII		Mycophyta	NGÀNH NẤM			
51	445	<i>Cantharellus cibarius</i> Fr.	Nấm mèo gà	EN	A1a,c, C1	Y

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable, Y: Yes (existing)

Source: Vietnam Red Data Book, 2007

Table 2.1.33 Endangered Species in Ninh Binh Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Ninh Binh
I		Animal	Thú			
1	2	<i>Cynopterus brachyotis</i>	Đơi chó tai ngắn	VU	A1c,d B2a,e	Y
2	3	<i>Rhinolophus paradoxolophus</i>	Đơi lá quạt	VU	D1	Y
3	4	<i>Rhinolophus thomasi</i>	Đơi lá Tôma	VU	B2a	Y
4	6	<i>Scotomanes (IA IO)</i>	Đơi iô	VU	A1c,d B2b,c,e	Y
5	8	<i>Myotis siligorensis</i>	Đơi tai sọ cao	LR	nt	Y
6	9	<i>Nycticebus pygmaeus</i>	Cu li nhỏ	VU	A1c,d	Y
7	12	<i>Macaca assamensis</i>	Khỉ mốc	VU	A1c,d	Y
8	21	<i>Trachypithecus delacouri</i>	Voọc mông trắng	CR	A1c,d C1+2a	Y
9	25	<i>Trachypithecus barbei</i>	Voọc xám	VU	A1c,d	Y
10	39	<i>Arctictis binturong</i>	Cây mực	EN	A1c,d C1	Y
11	61	<i>Cervus Nippon</i>	Hươu sao	EW		Y
II		Birds	Chim			
12	107	<i>Aythya Beeri</i>	Vịt đầu đen	DD		Y
13	114	<i>Aquila heliaca</i>	Đại bàng đầu nâu	CR	C2a D	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
14	167	<i>Physignathus cocincinus</i>	Rồng đất	VU	A1c,d	Y
15	169	<i>Varanus salvator</i>	Kì đà nước	EN	A1c,d	Y
16	173	<i>Orthriophis moellendorffi</i>	Rắn sọc khoanh	VU	B1+2a,b,c	Y
17	178	<i>Ptyas Korros</i>	Rắn ráo thường	EN	A1c,d	Y
18	179	<i>Ptyas mucosus</i>	Rắn ráo trâu	EN	A1c,d	Y
19	180	<i>Bungarus fasciatus</i>	Rắn cạp nong	EN	A1c,d	Y
20	181	<i>Naja naja</i>	Rắn hổ mang	EN	A1c,d	Y
21	182	<i>Ophiophagus hannah</i>	Rắn hổ chúa	CR	A1c,d	Y
22	200	<i>Palea steindachneri</i>	Ba ba gai	VU	A1c,d+2cd	Y
III.2		Amphibian	Lưỡng cư			
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
23	249	<i>Channa maculata</i>	Cá chuối hoa	EN	A1c,d	Y
IV.2		Sea fish	Cá biển			
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crutacean	Giáp xác			
24	307	<i>Potamiscus CUCPHUONGENSIS</i>	Cua suối Cúc Phương	LR	cd	Y
25	310	<i>Ranguna Kimboiensis</i>	Cua suối Kim Bôi	VU	D2	Y
V.1.2		Soft species	Thân mềm			
26	312	<i>Brotia swinhoi</i>	Ốc mút hình tháp	DD		Y
27	324	<i>Sinohyriopsis cumingii</i>	Trai điệp	VU	B2a,b,e+3a,d	Y
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
V.2.2		Echinoderm	Da gai			
V.2.3		Crutacean	Giáp xác			
V.2.4		Soft species	Thân mềm			
V.3		Insects	Côn trùng			
28	386	<i>Phyllium succifolium</i>	Bọ lá	VU	B2b,c,e+3b C2a	Y
29	387	<i>Lethocerus indicus</i>	Cà cuống	VU	A1 c,d,e C2b,c,e	Y
30	406	<i>Troides helena cerberus</i>	Bướm phượng cánh chim chấm liền	VU	A2a,c,d B2b,d,e+3b,c,d	Y
31	407	<i>Troides aeacus aeacus</i>	Bướm phượng cánh chim chấm rời	VU	A1a,c,d B2b,d,e+3b,c,d	Y

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)

Source: Vietnam Red Data Book, 2007

5) Flora and Fauna in Thanh Hoa Province (5ECSR, period 2005-2010)

(1) Flora

2.377 Thanh Hoa Province's forest system is mainly comprised of deciduous tropical forests, semi-evergreen tropical forests, secondary forest or grassland, scrub and planted forest, with rich and diversified flora, fauna species. There are various rare and precious wooden species, e.g. *Lat (Chukrasia tabularis)*, *Pmu (Fokienia hodginsii)*, *Samu (Cunninghamia konishii)*, *Limxanh*, *Tram-huong (Aquilaria crassna)*, *Tau (Vatica subglabra)*, *Sen (Madhuca pasquieri)*, *Vangtam*, *Doi*, *De*, *Cho-chi (Parashorea chinensis)*, etc. Moreover, there are also various bamboo species, rattan species, etc. Thanh Hoa forest quality was degraded seriously due to over-extraction in the last decades. Rare and precious species now only exist in high mountainous and remote zones and in national parks.

(2) Fauna

2.378 Thanh Hoa forest fauna used to be abundant and rich. However, they are degraded seriously. Comparing to other provinces in the north, the fauna system is still rich in Thanh Hoa, comprising many species of reptiles, deer, monkeys, birds, mammals, and others. Especially, there are various precious species in Thuong Xuan area, including, tiger, panther, bear, pheasant. The fauna system is rich and diversified in Ben En National Park and Xuan Lien, Pu Luong, Pu Hu natural reserves, comprising many special species: *Callosciurus erythraeus*, *Bos gaurus*, *Polyplectron bicalcaratum*, *Trachypithecus francoisi delacouri*, *Ursus thibetanus*. Many of them are in Vietnam and World's RedBook.

(3) Flora and Fauna in Protected Areas in Thanh Hoa Province

(a) Xuan Lien

- **Flora System**

2.379 Xuan Lien has 752 high-level vascular plants, belonging to 440 genus, 130 families; 38 species of plants are recorded in Vietnam and global red book including: *Fokienia hodginsii*, *Cunninghamia lanceolata*, *Calocedrus macrolepis*, *Amentotaxus argotenia*, *Dacrycactus imbricartus*, etc... Especially, there are 4 endemic species of Vietnam inclusive of *Cinamomum balanseae*, *Colona poilanei*, *Croton boniana*, *Macaranga balansae*. Flora system possesses some typical species, creating population different from that of nature reserves and national parks.

- **Fauna System**

2.380 In Xuan Lien, 387 species have been listed (Do Tuoc, 1999), of which animal kingdom has 55 species (among which 20 species are recorded in Vietnam and international red book with such big animals as: *Tiger*, *Gaur*, *Roosevelt Muntiacus*, *Ursus thibetanus*, *Helarctos malayanus*, etc and primates including: *Nomascus leucogenys*, *Trachypithecus phayrei crepusculus*, *Macaca arctoides*, *Macaca assamesis*, *Macaca mulatta* and two species of *Nyctiebus coucang*. Bird kingdom has 136 species with 8 species recorded in the red book of Vietnam and international red book, among which

there are 4 endemic species in Vietnam and the Indochina; 53 reptiles and amphibian species, 15 species are recorded in Vietnam and the world red book.

(b) Pu Luong

- **Flora System**

2.381 There are 1,109 species of 447 genus, 152 families, among which there are many scarce species like: *Pinus dalatensis*, *Amentotaxus yunnanensis* H. L. Li, *Amentotaxus argotaenia*; 160 orchideae species of 59 genus, especially, 5 new species have been detected and named as Pu Luong fauna: *cầu chuối Pu Luong orchid*, *La bong ba thuy orchid*, *Mo Pu Luong orchid*, *Lui vi dan*.

- **Fauna System**

2.382 There are 598 fauna species belonging to 130 families, 31 orders, among which there are 51 scarce invertebrate animals recorded in Vietnam red book and the world red book including 26 species of animal kingdom; 5 bat species; 9 bird species; 5 fresh water fishes, 6 reptile species, 158 butterfly species of 10 families, of which, there is 1 butterfly species endemic to Pu Luong nature reserves only. There are 55 fresh water fishes, of 17 families and 5 orders. Cuc Phuong Silurus is endemic species of Pu Luong – Cuc Phuong mountain range. There are 24 bat species of 4 families, of which there is 1 species recorded in Vietnam red book at scarce level. This is the nature reserves ranked the 2nd in terms of the number of *Trachypithecus francoisi delacouri* after Van Long nature reserves in Ninh Binh Province.

(c) Ben En

- **Flora System**

2.383 There are 1,357 flora species (accounting for 12.7% of Vietnam flora system), belonging to 902 genus, 196 families of 6 high level orders (based on basic survey on Ben En national park in the period 1996-2000) including: *Phylotophyta* (1 species); *Lycopodiophyta* (4 species); *Equisetophyta* (1 species); *Polypodiophyta* (101 species), *Gymnospermae* (8 species) and *Angiospermae* (1,242 species). At present, there are 33 scarce flora species like: *Syzygium aromaticum*, *Cinnamomum balansae*, *Garcinia fagraeoides*, *Parashorea chinensis*, etc. This is also the habitat of *Erythrophleum fordii*, which in some places accounts for 40% of natural forests.

2.384 Flora system in Ben En national park belongs to Southern China – Northern Truong Son flora system. Ben En is also the transitional area between 2 systems of flora system in the southern and northern Vietnam; as a result, it is impacted by southern flora system to some extent. The impacts are as follows: Such species as *Caesalpiniaceae*, *Magnoliaceae*, *Meliaceae*, *Sapindaceae* are representatives of local flora system, *Fagaceae* is representing northern flora system, such families as *Dipterocarpaceae* and some species of *Lythraceae* are representing southern flora system.

2.385 In Ben En forest, there is a wide range of specialties like:

- Plants providing materials for the production of art furniture: *Daemonoropes draco*, *Calamus poilanei*
- Plants providing oil and essence: *Madhuca pasquieri*, *Vernicia Montana*, *Litsea cubeba*
- Medicinal plant: *Strychnos nux-vomica*, *Amomum*
- Bonsai plants: *Orchidaceae*, *Begonia*.

- Based on above information, it can be concluded that, flora system in Ben En national park is worth protecting, especially, semi-evergreen forest type with *Erythrophleum fordii*, *Lagerstroemia tomentosa* taking advantages, which are typical for southern and northern flora system.

- **Forest Resources**

2.386 Ben En area has a variety of forest types with high coverage rate, which are abundant food sources and good habitat for a wide range of fauna systems. Ben En lake covers a wide area, containing diversified sources of living things. It is also rich in food sources, therefore, facilitates the development of natural fishes.

2.387 According to basic survey in 1997–2000, in Ben En, there are 1,004 species (accounting for 17.3% of Vietnam fauna system); among which, there are 91 animal species, 261 bird species, 54 reptile species, 31 amphibians species, 68 fishes, and 499 insect species.

2.388 Ben En fauna system is rather diversified and typical for Northern Truong Son and Tay Bac fauna system. In Ben En, there are a high number of scarce and rare species with 93 species recorded in Vietnam red book.

(d) Pu Hu

- **Flora System**

2.389 Flora system: there are 508 flora species of 323 genus, 102 families, 6 orders. Advantageous plants are: *Poaceae*, *Euphorbiaceae*, *Asteraceae*, etc. In terms of gene pool protection, in Pu Hu nature reserves, according to basic surveys, there are 28 scarce species recorded in Vietnam red book and in the list of scarce forest flora and fauna in Decree No. 48/2002/ND-CP: *Madhuca Pasquieri*, *Chukrasia Tabularis*, *Nageia Fleuryi*.

- **Fauna System**

2.390 Fauna system in Pu Hu nature reserves is diversified in terms of species. In addition, the number of species is also concentrating in high density. Details are as follows: Animal class: 8 orders, 20 families, 62 species; Bird class: 13 orders, 41 families, 162 species; amphibian class: 1 order, 4 families, 14 species; Reptile class: 02 orders, 14 families, 28 species. There are up to 47 scarce species according to standards of IUCN (among which, animals: 22 species, bird: 4 species; reptile: 21 species). Besides that, this is also the habitat of many scarce species like: tiger, gaur, bear, monkey, cougar, Phasianidae, Polyplectron, etc.

Table 2.1.34 Flora and Fauna inat the Specia -Use Forests in Thanh Hoa Province

No.	Names of Special-Use Forests	Plants		Animals	
		Total Number of Plants	Plants in IUCN Red list	Total Number of Species	Species in IUCN Red List
1	Ben En National Park	1,357	33	237	57
2	Cuc Phuong National Park	2,406	27	536	64
3	Pu Hu Natural Reserve	508	28	270	27
4	Pu Luong Natural Reserve	1,109	39	598	51
5	Xuan Lien Natural Reserve	752	38	104	7

Source: Thanh Hoa DONRE/2009, compiled by JICA Study Team

(5) List of Species in Vietnam Red Data Book

2.391 The list of endangered species of Thanh Hoa Province in Vietnam Red Data Book is shown in Table 2.1.35 on flora, and in Table 2.1.36 on fauna. Though it means the existence of these precious species within Ninh Binh Province, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 2.1.35 Endangered Species in Thanh Hoa Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Thanh Hoa
I		Magnoliophyta				
I.1		Magnoliopsida				
1	14	<i>Goniothalamus macrocalyx</i> Ban	Màu cau trắng	VU	A1a,d, B1+2b,c,e	Y
2	44	<i>Acanthopanax trifoliatum</i> (L.) Voss.	Ngũ gia bì gai	EN	A1a,c,d+2c,d	Y
3	72	<i>Cirsium japonicum</i> Fish.ex DC	Đại kê	VU	A1a,c, B1+2b,c,d	Y
4	91	<i>Markhamia stipulata</i> (Wall.) Seem.ex Schum var.kerrii Sprague	Đình	VU	B1+2e	Y
5	97	<i>Canarium tramdenum</i> Dai & Yakovl	Trám đen	VU	A1a,c,d+2d	Y
6	98	<i>Protium serratum</i> (Wall. Ex Colebr.) Engl. In DC	Cọ pèn	VU	A1a,d+2d, B1+2a	Y
7	101	<i>Sindora tonkinensis</i> A.Chev.ex K.&S.S. Larsen	Gụ lau	EN	A1a,c,d+2d	Y
8	103	<i>Codonopsis javanica</i> (Blume) Hook.f	Đang xâm	VU	A1a,c,d+2c,d	Y
9	114	<i>Trichosanthes kirilowii</i>	Qua lâu	VU	A1c,d, B1+2c	Y
10	119	<i>Dipterocarpus retusus</i> Blume	Chò nâu	VU	A1c,d+2c,d, B1+2b,e	Y
11	122	<i>Hopea mollissima</i> C.Y.Wu	Sao mặt quý	VU	A1c,d	Y
12	126	<i>Vatica subglabra</i> Merr.	Tấu nước	EN	A1c,d	Y
13	153	<i>Lithocarpus bonnetii</i> (Hickel & A. Camus) A. Camus	Sồi đá tuyên quang	VU	A1c,d	Y
14	154	<i>Lithocarpus cerebrinus</i> (Hickel & A. Camus) A. Camus	Dẻ phẳng	EN	A1c,d	Y
15	156	<i>Lithocarpus finetii</i> (Hickel & A. Camus) A. Camus	Dẻ đầu đứng	EN	A1c,d	Y
16	159	<i>Lithocarpus mucronatus</i> (Hickel & A. Camus) A. Camus	Dẻ quả nùm	VU	A1c,d	Y
17	176	<i>Illicium difengpi</i> B.N. Chang	Hôi đá vôi	VU	B1+2b,c,e	Y
18	177	<i>Annamocarya sinensis</i> (Dode) J. Leroy	Chò đái	EN	B1+2c,d,e	Y
19	188	<i>Cinnamomum cambodianum</i> H.	Re cambốt	VU	B1+2b,e	Y

		<i>Lecomte</i>				
20	195	<i>Strychnos ignatii Berg.</i>	Mã tiền lông	VU	A1a,c	Y
21	205	<i>Manglietia dandyi (Gagnep.) Dandy</i>	Vàng tâm	VU	A1c,d	Y
22	206	<i>Michelia balansae (DC.) Dandy</i>	Giôi lông	VU	A1c,d	Y
23	212	<i>Aglaia spectabilis (Miq.) Jain & Bennet</i>	Gội nếp	VU	A1a,c,d+2d	Y
24	213	<i>Chukrasia tabularis A.Juss.</i>	Lát hoa	VU	A1a,c,d+2d	Y
25	222	<i>Ardisia silvestris Pitard</i>	Lá khô	VU	A1a,c,d+2d	Y
26	230	<i>Melientha suavis Pierre</i>	Rau sắng	VU	B1+2e	Y
27	233	<i>Fallopia multiflora (Thunb.) Haraldson</i>	Hà thủ ô đỏ	VU	A1a,c,d	Y
28	244	<i>Fagerlindia depauperata (Drake) Tirveng</i>	Chim trích	VU	A1c, B1+2b,c	Y
29	253	<i>Murraya glabra (Giullaum.) Giullaum.</i>	Vương tùng	VU	A1a,c,d	Y
30	257	<i>Madhuca pasquieri (Dubard) H.J. Lam</i>	Sến mật	EN	A1a,c,d	Y
31	270	<i>Camellia pleurocarpa (Gagnep.) Sealy</i>	Trè hoa quả bệt	EN	B1c+2b,c	Y
32	271	<i>Aquilaria crassna Pierre ex Lecomte</i>	Trầm hương	EN	A1c,d, B1+2b,c,e	Y
II.2		Liliopsida	LỚP HÀNH			
33	292	<i>Calamus poilanei Conrard</i>	Song bột	EN	A1c,d+2c,d	Y
34	293	<i>Guihaia grossefibrosa ((Gagnep.) J. Dransf., S. K. Lee & Wei</i>	Hèo sợi to	EN	B1+2e	Y
35	298	<i>Peliosanthes teta Andr.</i>	Sâm cau	VU	A1c,d	Y
36	375	<i>Paphiopedilum malipoense S. C. Chen & Z. H. Tsi</i>	Hài xanh	EN	A1a,c,d+2d	Y
37	395	<i>Stemona saxorum Gagnep.</i>	Bách bộ đứng	VU	B1+2b,c	Y
II		Pinophyta	NGÀNH THÔNG			
38	400	<i>Cephalotaxus mannii Hook.f.</i>	Đinh tùng	VU	A1c,d, B1+2b,c	Y
39	419	<i>Pinus Kwangtungensis Chun ex Tsiang</i>	Thông Pà cò	VU	A1a,c,d, B1+2b,c,e	Y
40	422	<i>Taxus chinensis (Pilg.) Rehd.</i>	Thông đỏ bắc	VU	A1a,c, B1+2b,c	Y
41	424	<i>Cunninghamia konishii Hayata</i>	Sa mộc đầu	VU	A1a,d, C1	Y
III		Polypodiophyta	NGÀNH DƯƠNG XỈ			
42	428	<i>Drynaria fortunei (Kuntze ex Mett.) J. Smith</i>	Cốt thoái bỏ	EN	A1c,d	Y
IV		Lycopodiophyta	NGÀNH THÔNG			
V		Rhodophyta	NGÀNH RONG ĐỎ			
43	433	<i>Hypnea japonica Tanaka</i>	Rong đông mốc cầu	VU	A1a,c,d	Y
VI		Phaeophyta	NGÀNH RONG NẤU			
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable. Y: Yes (existing)

Source: Vietnam Red Data Book, 2007

Table 2.1.36 Endangered Species in Thanh Hoa Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Thanh Hoa
I		Animal	Thú			
1	1	<i>Cynocephalus variegatus</i>	Chồn doi	EN	A1c C1	Y
2	4	<i>Rhinolophus thomasi</i>	Đoi lá Tôma	VU	B2a	Y
3	9	<i>Nycticebus pygamaeus</i>	Cu li nhỏ	VU	A1c,d	Y
4	11	<i>Macaca arctoides</i>	Khi mặt đỏ	VU	A1c,d B1+2b,c	Y
5	12	<i>Macaca assamensis</i>	Khi mốc	VU	A1c,d	Y
6	17	<i>Pygathrix nemaus nemaus</i>	Chà vá chân nâu	EN	A1a,c,d B2b	Y
7	21	<i>Trachypithecus delacouri</i>	Voọc mõng trắng	CR	A1c,d C1+2a	Y
8	23	<i>Trachypithecus hatinhensis</i>	Voọc gầy trắng	EN	A1c,d	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Thanh Hoa
9	25	<i>Trachypithecus barbei</i>	Voọc xám	VU	A1c,d	Y
10	26	<i>Nomascus concolor</i>	Vượn đen	EN	A1c,d C2a	Y
11	28	<i>Nomascus leucogenys leucogenys</i>	Vượn đen má trắng	EN	A1c,d C2a	Y
12	39	<i>Arctictis binturong</i>	Cây mực	EN	A1c,d C1	Y
13	44	<i>Prionodon pardicolor</i>	Cây gấm	VU	A1c,d	Y
14	47	<i>Catopuma temminckii</i>	Báo lửa	EN	A1c,d C1+2a	Y
15	54	<i>Elephas maximus</i>	Voi	CR	A1cB1+2b,c,e C1+2a	Y
16	58	<i>Tragulus Javanicus</i>	Cheo nam dương	VU	A1a,d C1	Y
17	61	<i>Cervus Nippon</i>	Hươu sao	EW		Y
18	68	<i>Bos gaurus</i>	Bò tót	EN	A1c,d B1+2a C1+2a	Y
19	72	<i>Capricornis sumatraensis</i>	Sơn dương	EN	A1c,d B1+2a,b C2a	Y
20	76	<i>Belomys pearsoni</i>	Sóc bay lông tai	CR	A1+2c,d C1+2a	Y
II		Birds	Chim			
21	118	<i>Ichthyophaga ichthyaetus</i>	Diều cá lớn	VU	B2a C1	Y
22	126	<i>Lophura nycthemera</i>	Gà lôi trắng	LR	cd	Y
23	129	<i>Poluplectron bicalcaratum</i>	Gà tiền mặt vàng	VU	A1 a,c C2a	Y
24	141	<i>Carpococcyx renauldi</i>	Phướn đất	VU	A1 a,b,c C2a	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
25	166	<i>Leiolepis reevesii</i>	Nhông cát- Rivo	VU	A1d	Y
26	167	<i>Physignathus cocincinus</i>	Rồng đất	VU	A1c,d	Y
27	169	<i>Varanus salvator</i>	Kỳ đà nước	EN	A1c,d	Y
28	178	<i>Ptyas Korros</i>	Rắn ráo thường	EN	A1c,d	Y
29	180	<i>Bungarus fasciatus</i>	Rắn cạp nong	EN	A1c,d	Y
30	181	<i>Naja naja</i>	Rắn hổ mang	EN	A1c,d	Y
31	189	<i>Platysternon megacephalum</i>	Rùa đầu to	EN	A1d+2d	Y
32	191	<i>Cuora Galbinifrons</i>	Rùa hộp trán vàng	EN	A1d+2d	Y
33	193	<i>Cuora trifasciata</i>	Rùa hộp ba vạch	CR	A1d+2d	Y
34	197	<i>Indotestudo elongata</i>	Rùa núi vàng	EN	A1d+2d	Y
35	198	<i>Manouria impressa</i>	Rùa núi viên	VU	A1c,d+2d	Y
36	200	<i>Palea steindachmeri</i>	Ba ba gai	VU	A1c,d+2cd	Y
37	201	<i>Pelochelys cantorii</i>	Giải khổng lồ	EN	A1d+2d	Y
38	202	<i>Rafetus swinhoiei</i>	Giải thượng hải	CR	C1+2a	Y
III.2		Amphibian	Lưỡng cư			
39	210	<i>Bufo galeatus</i>	Cóc rừng	VU	B1+2a,b,c,d	Y
40	216	<i>Rhacophorus Kio</i>	Ếch cây Kio	EN	B1+2a,b,c,d	Y
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
41	220	<i>Clupanodon thrissa</i>	Cá mèi cờ hoa	EN	A1a,d B1+2a,b,c	Y
42	221	<i>Tenualosa reevesii</i>	Cá chấy bắc	EN	A1 d B2a,b,c	Y
43	236	<i>Ochetobius elongatus</i>	Cá chày tràng	VU	A1c,d B1+2a,b	Y
44	240	<i>Semilabeo obscurus</i>	Cá anh vũ	VU	A1c,d B2a,b	Y
45	242	<i>Sinilabeo lemassoni</i>	Cá râm xanh	VU	A1c,d B2a,b	Y
46	243	<i>Sinilabeo tonkinensis</i>	Cá hỏa	VU	A1c,d B2a,b	Y
47	244	<i>Tor(folifer) brevifilis</i>	Cá ngra bắc	VU	A1a,c,d B1a,b,c	Y
48	246	<i>Hemibagrus guttatus</i>	Cá lăng	VU	A1c,d B2a,b	Y
49	248	<i>Bagarius rutilus</i>	Cá chiên	VU	A1c,d B2a,b	Y
50	249	<i>Channa maculata</i>	Cá chuối hoa	EN	A1c,d	Y
IV.2		Sea fish	Cá biển			
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crutacean	Giáp xác			
V.1.2		Soft species	Thân mềm			
V.2		Sea Spiniless	Động vật không xương sống ở biển			

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Thanh Hoa
V.2.1		Coral	San hô			
51	339	<i>Porites lobata</i>	San hô khối đầu thùy	VU	A1a,c,d B2e+3b	Y
V.2.2		Echinoderms	Da gai			
V.2.3		Crustacean	Giáp xác			
V.2.4		Soft species	Thân mềm			
52	376	<i>Pteria penguin</i>	Trái ngọc nữ	VU	C1 D2	Y
V.3		Insects	Côn trùng			
53	387	<i>Lethocerus indicus</i>	Cà cuống	VU	A1 c,d,e C2b,c,e	Y

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

6) Flora and Fauna in Nghe An Province (Environmental Current Status Report Period 2005–2009)

(1) Overall situation of Flora and Fauna

2.392 Flora and fauna populations are now facing downward trend with more and more species being in danger of extinction.

2.393 Up to now, there are up to 1,144 vascular plant species recognized to be distributed in Pu Mat, among which there are 3 new species for science: *Cleistanthus spp. nov.*, *Phyllagathis spp. nov.* and *Phrynium pumatensis*.

2.394 The most typical forest is evergreen forest on low land with an outnumbering appearance of such species as *Dipterocarpaceae* (*Hopea spp.* and *Dipterocarpus spp.*), *Fagaceae* (*Quercus spp.*, *Lithocarpus spp.* and *Castanopsis spp.*) and *Lauraceae* (*Cinnamomum spp.* and *Litsea spp.*).

2.395 In this area, there 4 oriental endemic fauna species: *Pseudoryx nghetinhensis*, *Nesolagus spp. nov.*, *Hylobates leucogenys*, and *Hylobates gabriellae*. In addition, there are other species such as: large cobra, Truong Son cobra, brown douc langur, tiger, elephant, striped mongoose.

2.396 There are 259 bird species discovered, among which 22 species are in danger of extinction, including *ocellata*, etc.

2.397 In addition to Pu Mat national park, in Nghe An, there are Pu Huong and Pu Hoat national parks. Pu Mat only can be typical representative for the entire western Nghe An mountainous areas and the Northern Truong Son mountain system.

2.398 Wild animal trading is the reason for a significant decrease in fauna system.

2.399 Among flora resources of Nghe An, when compared with Vietnam Red Data Book 2000 there are up to 81 species need to be preserved at different levels. Among 81 species, there is 1 species in EN, which is (*Aquilaria crassna*), 23 species about to be in danger, 25 in scarce level, 18 species under threat and 14 species in data deficient situation. Those species are mostly wood of high economic value.

(2) List of Species in Vietnam Red Data Book

2.400 The list of endangered species of Nghe An Province in Vietnam Red Data Book is shown in Table 2.1.37 on flora, and in Table 2.1.38 on fauna. Though it means the existence of these precious species within Nghe An Province, it does not

necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 2.1.37 Endangered Species in Nghe An Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Nghe An
I		Magnoliophyta	NGÀNH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
1	13	<i>Enicosanthe plagiocarpum</i> (Diels) Ban	Nhọc trái khớp lá thuôn	VU	A1a,c,d	Y
2	24	<i>Ichnocarpus jacquetii</i> (Pierre ex Spire Middleton)	Mần trây lông	EN	A1a,c	Y
3	34	<i>Rauvolfia verticillata</i> (Lour.) Baill.	Ba gác vòng	VU	A1a,c	Y
4	44	<i>Acanthopanax trifoliatum</i> (L.) Voss.	Ngũ gia bì gai	EN	A1a,c,d+2c,d	Y
5	45	<i>Evodiopanax evodiifolium</i> (Franch.) Nakai	Thù du gia bì	VU	A1c,d	Y
6	97	<i>Canarium tramdenum</i> Dai & Yakovl	Trám đen	VU	A1a,c,d+2d	Y
7	98	<i>Protium serratum</i> (Wall. Ex Colebr.) Engl. In DC	Cọ phèn	VU	A1a,d+2d, B1+2a	Y
8	101	<i>Sindora tonkinensis</i> A.Chev.ex K.&S.S. Larsen	Gụ lau	EN	A1a,c,d+2d	Y
9	103	<i>Codonopsis javanica</i> (Blume) Hook.f	Đảng xâm	VU	A1a,c,d+2c,d	Y
10	122	<i>Hopea mollissima</i> C.Y.Wu	Sao mặt quý	VU	A1c,d	Y
11	126	<i>Vatica subglabra</i> Merr.	Tấu nước	EN	A1c,d	Y
12	140	<i>Pterocarpus macrocarpus</i> Kurz	Giáng hương	EN	A1a,c,d	Y
13	142	<i>Castanopsis carlesii</i> (Hemsl.) hayata	Cà ôi nhỏ	VU	A1c,d	Y
14	143	<i>Castanopsis ferox</i> (Roxb.) Spach	Cà ôi Vọng phu	VU	A1c,d	Y
15	145	<i>Castanopsis hystrix</i> A. DC	Cà ôi (lá) đỏ	VU	A1c,d	Y
16	146	<i>Castanopsis kawakamii</i> Hayata	Cà ôi quả to	VU	A1c,d	Y
17	147	<i>Castanopsis lecomtei</i> Hickel & A. Camus	Cà ôi sa pa	VU	A1c,d	Y
18	150	<i>Lithocarpus amygdalifolius</i> (Skan) Hayata	Dê hạnh nhân	VU	A1c,d	Y
19	152	<i>Lithocarpus balansae</i> (Drake) A. Camus	Sồi đá lá mác	VU	A1c,d	Y
20	153	<i>Lithocarpus bonnetii</i> (Hickel & A. Camus) A. Camus	Sồi đá tuyên quang	VU	A1c,d	Y
21	154	<i>Lithocarpus cerebrinus</i> (Hickel & A. Camus) A. Camus	Dê phảng	EN	A1c,d	Y
22	156	<i>Lithocarpus finetii</i> (Hickel & A. Camus) A. Camus	Dê đầu đứng	EN	A1c,d	Y
23	158	<i>Lithocarpus hemisphaericus</i> (Drake) Barnett	Dê bán cầu	VU	A1c,d	Y
24	169	<i>Quercus platycalyx</i> Hickel & A. Camus	Sồi đĩa	VU	A1c,d	Y
25	186	<i>Cinnadenia paniculata</i> (Hook.f.) Kosterm.	Kháo xanh	VU	A1	Y
26	188	<i>Cinnamomum cambodianum</i> H. Lecomte	Re cambốt	VU	B1+2b,e	Y
27	190	<i>Endiandra hainanensis</i> Merr. & Mect.ex Allen	Khuyết nhị hải nam	EN	A1+2c,d	Y
28	205	<i>Manglietia dandyi</i> (Gagnep.) Dandy	Vàng tâm	VU	A1c,d	Y
29	206	<i>Michelia balansae</i> (DC.) Dandy	Giôi lông	VU	A1c,d	Y
30	210	<i>Tsoongiodendron odorum</i> Chun	Giôi lụa	VU	A1c,d+2c,d	Y
31	212	<i>Aglaia spectabilis</i> (Miq.) Jain & Bennet	Gội nếp	VU	A1a,c,d+2d	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Nghê An
32	213	<i>Chukrasia tabularis</i> A.Juss.	Lát hoa	VU	A1a,c,d+2d	Y
33	215	<i>Dysoxylum cauliflorum</i> Hiern	Đình hương	VU	A1a,c,d+2d	Y
34	216	<i>Dysoxylum loureiri</i> (Pierre) Pierre	Huỳnh đường	VU	A1a,c,d+2d	Y
35	222	<i>Ardisia silvestris</i> Pitard	Lá khô	VU	A1a,c,d+2d	Y
36	223	<i>Embelia parviflora</i> Wall. ex. A. DC	Thiên lý hương	VU	A1a,c,d+2d	Y
37	230	<i>Melientha suavis</i> Pierre	Rau sắng	VU	B1+2e	Y
38	232	<i>Platanus kerrii</i> Gagnep	Chò nước	VU	B1+2e	Y
39	233	<i>Fallopia multiflora</i> (Thunb.) Haraldson	Hà thủ ô đỏ	VU	A1a,c,d	Y
40	257	<i>Madhuca pasquieri</i> (Dubard) H.J. Lam	Sến mật	EN	A1a,c,d	Y
41	271	<i>Aquilaria crassna</i> Pierre ex Lecomte	Trầm hương	EN	A1c,d, B1+2b,c,e	Y
42	276	<i>Valeriana jatamansi</i> Jones	Sì to	EN	B1+2b,c	Y
II.2		<i>Liliopsida</i>	LỚP HÀNH			
43	293	<i>Guihaia grossefibrosa</i> ((Gagnep.) J. Dransf., S. K. Lee & Wei	Hèo sọt to	EN	B1+2e	Y
44	337	<i>Dendrobium chryssotoxum</i> Lindl.	Kim điệp thân phình	EN	B1+2e+3d	Y
45	343	<i>Dendrobium farmeri</i> Paxt	Ngọc điểm	VU	B1+2e+3d	Y
46	344	<i>Dendrobium fimbriatum</i> Hook	Kim điệp	VU	B1+2e+3d	Y
47	398	<i>Tacca subflabellata</i> P.P. Ling & C. t. Ting	Phá lữa	VU	A1a,c,d	Y
II		Pinophyta	NGÀNH THÔNG			
48	405	<i>Cycas balansae</i> Warb.	Tuế balansa	VU	A1a,c	Y
49	407	<i>Cycas chevalieri</i> Leandri	Tuế sơ valiê	LR	/nt	Y
50	424	<i>Cunninghamia konishii</i> Hayata	Sa mộc đầu	VU	A1a,d, C1	Y
III		Polypodiophyta	NGÀNH DƯỠNG XỈ			
51	428	<i>Drynaria fortunei</i> (Kuntze ex Mett.) J. Smith	Cốt thoái bộ	EN	A1c,d	Y
IV		Lycopodiophyta	NGÀNH THÔNG			
V		Rhodophyta	NGÀNH RONG ĐỎ			
52	432	<i>Hypnea cornuta</i> (Lamx.) j. Agardh	Rong đồng sao	EN	A1a,c,d, B1+3c,d	Y
53	433	<i>Hypnea japonica</i> Tanaka	Rong đồng móc câu	VU	A1a,c,d	Y
VI		Phaeophyta	NGÀNH RONG NÂU			
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

Table 2.1.38 Endangered Species in Nghê An Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Nghê An
I		Animal	Thú			
1	1	<i>Cynocephalus variegatus</i>	Chồn dơi	EN	A1c C1	Y
2	4	<i>Rhinolophus thomasi</i>	Dơi lá Tôma	VU	B2a	Y
3	7	<i>Myotis ricketti</i>	Dơi muỗi chân lớn	DD		Y
4	8	<i>Myotis siligorensis</i>	Dơi tai sọ cao	LR	nt	Y
5	9	<i>Nycticebus pygmaeus</i>	Cu li nhỏ	VU	A1c,d	Y
6	11	<i>Macaca arctoides</i>	Khỉ mặt đỏ	VU	A1c,d B1+2b,c	Y
7	15	<i>Macaca leonina</i>	Khỉ đuôi lợn	VU	A1c,d	Y
8	17	<i>Pygathrix nemaeus nemaeus</i>	Chà vá chân nâu	EN	A1a,c,d B2b	Y
9	21	<i>Trachypithecus delacouri</i>	Voọc mõng trắng	CR	A1c,d C1+2a	Y
10	23	<i>Trachypithecus hatinhensis</i>	Voọc gầy trắng	EN	A1c,d	Y
11	25	<i>Trachypithecus barbei</i>	Voọc xám	VU	A1c,d	Y
12	28	<i>Nomascus leucogenys leucogenys</i>	Vượn đen má trắng	EN	A1c,d C2a	Y
13	29	<i>Nomascus leucogenys siki</i>	Vượn đen má hung	EN	A1c,d C2a	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Nghe An
14	34	<i>Ursus thibetanus</i>	Gấu nhạ	EN	A1c,d C1+2a	Y
15	39	<i>Arctictis binturong</i>	Cây mực	EN	A1c,d C1	Y
16	46	<i>Viverra zibethica</i>	Cây giông Tây Nguyên	VU	A1c,d	Y
17	53	<i>Pardofelis nebulosa</i>	Báo gấm	EN	A1c,d C1+2a	Y
18	54	<i>Elephas maximus</i>	Voi	CR	A1cB1+2b,c,e C1+2a	Y
19	58	<i>Tragulus javanicus</i>	Cheo nam dương	VU	A1a,d C1	Y
20	61	<i>Cervus nippon</i>	Hươu sao	EW		Y
21	64	<i>Megamuntiacus vuquangensis</i>	Mang lớn	VU	A1c,d C1	Y
22	68	<i>Bos gaurus</i>	Bò tót	EN	A1c,d B1+2a C1+2a	Y
23	72	<i>Capricornis sumatraensis</i>	Sơn dương	EN	A1c,d B1+2a,b C2a	Y
24	73	<i>Pseudoryx nghetinhensis</i>	Sáo lả	EN	A1c,d B1+2a C1+2a	Y
25	75	<i>Manis pentadactyla</i>	Tê tê vàng	EN	A1c,d C1+2a	Y
26	76	<i>Belomys pearsoni</i>	Sóc bay lông tai	CR	A1+2c,d C1+2a	Y
27	85	<i>Nesolagus timinsi</i>	Thỏ vằn	EN	B1a+2aD	Y
II		Birds	Chim			
28	108	<i>Cairina scutulata</i>	Ngan cánh trắng	CR	A1a,c,d	Y
29	117	<i>Ichthyophaga humilis</i>	Điều cá bé	VU	B2a C1	Y
30	118	<i>Ichthyophaga ichthyaetus</i>	Điều cá lớn	VU	B2a C1	Y
31	126	<i>Lophura nycthemera</i>	Gà lôi trắng	LR	cd	Y
32	131	<i>Rheinartia ocellata</i>	Trĩ sao	VU	A1 b,c,d	Y
33	141	<i>Carpococcyx renauldi</i>	Phướn đất	VU	A1 a,b,c C2a	Y
34	146	<i>Aceros nipalensis</i>	Niệc cổ hung	CR	C2a+2bD	Y
35	154	<i>Garrulax merulinus</i>	Khướu ngực đỏm	LR	nt	Y
36	158	<i>Jabouilleia danjoui</i>	Khướu mỏ dài	LR	nt	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
37	166	<i>Leiolepis reevesii</i>	Nhông cát- Rivo	VU	A1d	Y
38	167	<i>Physignathus cocincinus</i>	Rồng đất	VU	A1c,d	Y
39	173	<i>Orthriophis moellendorfi</i>	Rắn sọc khoanh	VU	B1+2a,b,c	Y
40	178	<i>Ptyas korros</i>	Rắn ráo thường	EN	A1c,d	Y
41	179	<i>Ptyas mucosus</i>	Rắn ráo trâu	EN	A1c,d	Y
42	180	<i>Bungarus fasciatus</i>	Rắn cạp nong	EN	A1c,d	Y
43	181	<i>Naja naja</i>	Rắn hổ mang	EN	A1c,d	Y
44	189	<i>Platysternon megacephalum</i>	Rùa đầu to	EN	A1d+2d	Y
45	191	<i>Cuora galbinifrons</i>	Rùa hộp trán vàng	EN	A1d+2d	Y
46	193	<i>Cuora trifasciata</i>	Rùa hộp ba vạch	CR	A1d+2d	Y
47	197	<i>Indotestudo elongata</i>	Rùa núi vàng	EN	A1d+2d	Y
48	198	<i>Manouria impressa</i>	Rùa núi viền	VU	A1c,d+2d	Y
49	200	<i>Palea steindachneri</i>	Ba ba gai	VU	A1c,d+2cd	Y
50	201	<i>Pelochelys cantorii</i>	Giải khổng lồ	EN	A1d+2d	Y
III.2		Amphibian	Lưỡng cư			
51	206	<i>Tylototriton vietnamensis</i>	Sa giông Việt Nam	EN	B1+2b,d	Y
52	210	<i>Bufo galeatus</i>	Cóc rừng	VU	B1+2a,b,c,d	Y
53	214	<i>Paa spinosa</i>	Ếch gai	EN	A1d	Y
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
54	220	<i>Clupanodon thrissa</i>	Cá mèi cờ hoa	EN	A1a,d B1+2a,b,c	Y
55	221	<i>Tenualosa reevesii</i>	Cá chấy bắc	EN	A1 d B2a,b,c	Y
56	228	<i>Acrossocheilus annamensis</i>	Cá tróc	VU	D2	Y
57	233	<i>Elopichthys bambusa</i>	Cá măng	VU	A1c,d B2a,b	Y
58	240	<i>Semilabeo obscurus</i>	Cá anh vũ	VU	A1c,d B2a,b	Y
59	242	<i>Sinilabeo lemasoni</i>	Cá rầm xanh	VU	A1c,d B2a,b	Y
60	243	<i>Sinilabeo tonkinensis</i>	Cá hóa	VU	A1c,d B2a,b	Y
61	244	<i>Tor(folifer) brevifilis</i>	Cá ngra bắc	VU	A1a,c,d B1a,b,c	Y
62	246	<i>Hemibagrus guttatus</i>	Cá lăng	VU	A1c,d B2a,b	Y
63	248	<i>Bagarius rutilus</i>	Cá chiên	VU	A1c,d B2a,b	Y
IV.2		Sea fish	Cá biển			

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Nghè An
64	267	<i>Chanos chanos</i>	Cá măng sữa	VU	A2d	Y
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crustacean	Giáp xác			
65	309	<i>Potamon fruhstorferi</i>	Cua suối vô nhãn	VU	B1+2a,b,e	Y
V.1.2		Soft species	Thân mềm			
66	317	<i>Lamprotula leai</i>	Trai cóc hình tai	VU	B2a,b,e+3d	Y
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
V.2.2		Echinoderm	Da gai			
V.2.3		Crustacean	Giáp xác			
V.2.4		Soft species	Thân mềm			
V.3		Insects	Côn trùng			
67	387	<i>Lethocerus indicus</i>	Cà cưỡng	VU	A1 c,d,e C2b,c,e	Y
68	403	<i>Papilio noblei noblei</i>	Bướm phượng đốm kem	VU	A1a,c B1+2b	Y

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

2.1.9 Natural Hazards

2.401 Due to its geographic and topographic positions Vietnam has been suffered from severely changeable climate features such as flood, flash floods, typhoons, landslides, tornados, hail rains, tropical depression etc. The natural hazards usually occur round the year in specific time and in particular regions. For instance, those provinces in north section are usually hit by typhoons, flash floods, floods, landslides etc. While those provinces in south section have to confront to tide rise, whirlwind, riverbank and coastline erosion and hail rail etc. Recently, it is difficult for forecasting agencies to predict the natural disasters leading to tremendous loss of lives and properties in Vietnam in general and in north section in particular. Thus, natural hazard should be taken into consideration and studied properly before the project implementation. The detailed information about natural hazards in target provinces shown in following table.

Table 2.1.39 Characteristics of Natural Hazards at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	Report No./SNN-KH dated Oct. 10, 2011 in response to JST request for information on environmental and social considerations.	With typical feature of multiform terrain and 5 rivers running through the City, Hanoi is easily impacted and affected with the natural disasters; especially, with the impacts of the global climate change, it is forecasted that the natural disasters will occur more and frequently and the evolution of these disaster will be more seriously damage
2	Ha Nam	Annual Environmental Status Report in 2010, Chapter 8, pp.56-57	Limited information on natural hazards found in this report. Ha Nam faces forest fire, typhoon, flood and drought.
3	Nam Dinh	5ECSR period 2005- 2009 Summary report on flood and storm control, search and rescue in 2010 and coming tasks of flood and storm control, search and rescue in 2011.	Due to the impacts of global climate change, and El-Nino phenomenon, in 2010, our country had to face complicated changes in natural disasters with many abnormal phenomena. Nam Dinh Province is not an exception. In 2010, there were 2 storms (No 1 and No 3) affecting Nam Dinh Province.
4	Ninh Binh	5ECSR period 2005-2009, Chapter VIII, pp.123.	Ninh Binh is seated in a tropical monsoon zone, affected by coastal climate
5	Thanh Hoa	5ECSR 2006- 2010 period, chapter 8, pp. 141-142	In Thanh Hoa, storms and tropical depressions

			usually happen from Jun and end in October. On average every year there are 1 to 2 storms affecting Thanh Hoa. In peak months from August to October, every two to three years there is one storm, whereas at other times in the year, one storm affects in 4 to 8 years.
6	Nghe An	5ECSR, chapter X, pp.132-134	Nghe An Province is suffering from many natural disasters. Natural disasters happening in Nghe An are mainly storms, floods.

Source: DONRE, compiled by JICA Study Team

1) Natural Hazard in Hanoi City

2.402 Hanoi City is one of the large provinces/ cities. The city has area of 3,340 km², 6.5 million people of population and the multiform terrain which comprises many rivers, reservoirs, lakes, ponds and dams. There are 5 rivers running through Hanoi (Da river, Red river, Duong river, Cau river and Ca Lo one) as well as the inland rivers (such as: Day, Tich, Bui, and Thanh Ha). Besides, the system of flood prevention facilities have been developed, this system comprises 20 major dikes of which the total length was 470m. There are also 96 reservoirs by-type, among 5 ones of which the average volume is over 10 million m³/reservoir; while the average volume of the left ones is 2~5 million m³.

2.403 Hence, Hanoi is easily impacted and affected with the natural disasters; especially, with the impacts of the global climate change, it is forecasted that the natural disasters will occur more and frequently and the evolution of these disaster will be more seriously damage.

2.404 During the recent years, Hanoi has proactively formulated the specific measures for preventing, responding and overcoming the consequences of natural disasters which were forecasted to occur within Hanoi. Besides, the city has mobilized all the municipal resources, taken full advantages of the support of Central government, international organizations as well as called up the participation of the entire society, residential communities to improve the preventing and responsive capacity for minimizing the damages caused of the natural disasters which could occur within Hanoi.

2) Natural Hazards in Ha Nam Province

(1) Forest Fire

2.405 There were 6 forest fires in 2004, total damaged squares were 5.5 ha and 2 forest fires in 2009 with total damaged squares were 0.8 ha. The reason for forest fire is because people fire wood to get coal and the dried season.

(2) Storm, Flood and Drought

2.406 There have been many unusual changes in recent years, du to the climate change.

2.407 In 2006: Ha Nam Province was not affected by flood and storm but the unsteady rainfall distribution leads to the partly droughts.

2.408 In 2007: Ha Nam Province was affected by 2 storms, of which the storm No.5 caused big flood on Day river from 5 to 10 October; flood on Red river appeared from 29 July to 8 August caused some dangerous problems on shaped dikes, however, those problems were treated in time.

2.409 In 2008: Ha Nam was affected by 3 storms, of which 2 storms caused partly flood. Droughts appeared in the beginning winter and spring season and the rivers' water level was very low caused many difficulties for drought protection activities. Total rainfall in 2008 is higher than the one in previous years, especially; the big rainfall from 30 October to 6 November caused big damages for agriculture, people's livelihood, irrigation and many infrastructure works.

2.410 In 2009: droughts continued to appear in the beginning winter and spring season, total of rainfall is lower than that in previous years. And the flood situation was not so complicated. Ha Nam was affected by 4 storms, causing medium rainfall and partly heavy rainfall.

3) Natural Hazard in Nam Dinh Province

2.411 Due to the impacts of global climate change, and El-Nino phenomenon, in 2010, our country had to face complicated changes in natural disasters with many abnormal phenomena. There were 6 storms and 5 tropical depressions on the East Sea, among which, there were 2 storms (No 1, and No 3) and 4 tropical depressions affecting our country. In addition, heavy rains also caused serious inundation in many localities, especially in the Central area, resulting in great damages in terms of individual and state property.

2.412 In 2010, there were 02 storms (No 1 and No 3) affecting Nam Dinh Province. No 1 storm landed on Hai Phai – Thai Binh from 12th to 18th, July; in Nam Dinh, wind strength was at the 5th level, wind gust level 8; in Van Ly (Hai Hau), wind strength was at 7th level, wind gust level 9 with rains ranging from average rain to heavy rain, and even extremely heavy rain. Provincial average rainfall in the period of 14th to 6h30' on 18th, July, 2010 was approximately 160 mm, flooding about 39,000 ha newly planted rice (in rush - hour period). There were 1,164.3 ha rice dead, which need re-planting; 1,269 ha rice having to be trimmed or supplemented. No 3 storm landed on Thanh Hoa – Nghe An from 21st to 24th, August, in Van Ly (Hai Hau), wind strength is at 7th level, wind gust at 9th level with rains ranging from average rain to extremely heavy rains in some places.

2.413 Nam Dinh provincial rainfall averaged 1,322 mm in 2010, 396.3 mm lower than the average of many – years; average rainfall in Van Ly in 2010 was 1,603 mm, 113 mm lower than the average of many – years.

2.414 In 2010, there was only one small floods happening in the province, which is smaller than alarm level I. Water levels of rivers over months were all lower than the average of many years, salinity intruded from 30 to 40 km into the main land, causing difficulties to production water supply.

2.415 Due to impact of storms and tropical depression as well as extraordinary changes of seas on occasion of flood tide, many sections of dykes, dams and important dams on sea dykes were locally damaged.

4) Natural Hazards in Ninh Binh Province

2.416 Ninh Binh is seated in a tropical monsoon zone, affected by coastal climate. Average temperature is 23°C, lowest in January (13-15°C) and highest in July (28.5°C). Average rainfall registers at 1800mm annually, but not distributed evenly, 70% in summer (May to Sep) while dry season is prolonged from Nov to Apr.

2.417 Landscape in Ninh Binh is divided obviously into three zones: hilly and mountainous zone to the west and northwest, while plain and coastal area in the east and south. Ninh Binh stands in the transition area between the Red River Delta and the sedimentary rocks to the west, and also adjoined to the Eastern Sea.

2.418 Ninh Binh receives several storms every year, most of storms that hit the Northern Region hit the province with strong magnitude. Floods happen every year, too, threatening safety of dyke and dams. In districts of Gia Vien and Nho Quan, floods are annual, and even 6 communes of Nho Quan and five of Gia Vien have to live in flooding conditions for 1-3 months per year.

5) Natural Hazard in Thanh Hoa Province

2.419 In Thanh Hoa, storms and tropical depressions usually happen from June and end in October. On average every year there are 1 to 2 storms affecting Thanh Hoa. In peak months from August to October, every two to three years there is one storm, whereas at other times in the year, one storm affects in 4 to 8 years. Early storms in May, June are usually weak storms and tropical depressions with low wind and moderate rainfall, sometimes early storms bring more benefits than destruction by reducing dry weather and clean the environment. Whereas the rest of storms hitting Thanh Hoa all have heavy rain from 200-500 mm over a large area. Therefore, the amount of rainfall because of storm and tropical depression makes up 40–50% the total rainfall annual and mostly happens from August to October.

2.420 Thanh Hoa has strongest storm winds over 40 m/s on the high sea and 35 m/s in land. At Thanh Hoa hydrology and meteorology center, a storm with 39 m/s winds was recorded on 19 Sep 1963 and 40 m/s on Sep 15, 1973 with Southeast direction. The further inland, because of obstacles, wind speed reduces substantially, usually only reaches 20-25m/s in mountainous areas.

2.421 According to meteorology statistics within 40 years (1958–2002), every year only 1-2 storms and tropical depression lands in Thanh Hoa. Whereas the number of storms and tropical depressions affecting Thanh Hoa (lands north and south of Thanh Hoa) causing a considerable amount of rain and strong wind, counting both types, every year there are 4-5 storms and tropical depressions affecting Thanh Hoa. In 40 years, there has never been storm and tropical depression landing in Thanh Hoa before May and after October, only in the duration from Dec to April next year, there are no storms and tropical depressions influencing Thanh Hoa. September has the highest possibility of storms and tropical depression directly influencing Thanh Hoa (37% of directly landing and 22.5% of major influence).

2.422 Storm also causes heavy rain over large areas, which is a cause of sudden flooding. Every year Thanh Hoa has about 20–25 days of storm with an average rainfall each time from 300–500 mm, with a maximum of 800 mm.

2.423 Rain, flood and flash flood: According to statistics from 1960 until 2009, the whole province has encountered about 400 heavy rains and 36 flash floods. Especially, in the recent 10 years (from 1999 to 2009) there have been 5 flash floods causing great losses. Of which there are 3 floods in the districts of Thach Thanh, Vinh Loc, Tho Xuan (2007), in 2005, there were 2 floods in Thuong Xuan and Quan Hoa causing great human and property losses.

2.424 In 2008, there are 10 storms and 6 tropical depressions in the East Sea, of

which 4 storms (storm no 4, 6, 7, 10 and 2 tropical depressions in Aug 11 and Oct 13) directly influenced our country but not directly to Thanh Hoa. The total rainfall of areas in the province reaches and exceeds the average of many years and is a common of 1,200 mm~1,700 mm, some areas that had heavy rains were Cua Dat (2,281 mm), Lang Chanh (2,042 mm), Bat Mot (1,987 mm). On rivers, there were 1-5 floods at medium and low level. For the heavy rain from Oct 30 to Nov 3 only, on rivers there were flood to Emergency Level I, for Cau Chay river it was Emergency Level II, and on Buoi river it was Emergency Level III.

2.425 In 2009 there were 11 storms and 3 tropical depression in the East Sea, of which 5 storms (no 4, 7, 9, 10, 11) and 1 tropical depression on 9 Sep influenced Viet Nam. Thanh Hoa region was directly influenced by storm no. 7 with level 6 to 7 winds and gust level over 8. As for floods, because of low upstream raining, floods on river are negligible except for 1 flood on Muc and Chu rivers because of sudden local rain in the Southwest region of the city. The peak flood level on Muc river was Emergency Level 1 and on Chu river was Emergency Level 2, the flood duration was short and did not affect dykes as well as the living and production of the people.

2.426 Rain on Ma river basin: The average annual rainfall is from 1,100–1,400 mm and is unevenly distributed with a lot of fluctuation in terms of space and time, there are big differences between areas in terms of rainfall and rainy days, the area with lowest rain is Phu Le–Muong Lat, other areas like Ba Thuoc, Cam Thuy have heaviest rain. Usually, from May is rain season, monthly rainfalls in almost every sub-region all reach 100mm higher and gradually increases, August, September and October have heaviest rainfall with dangerous weather phenomena such as tornadoes, flood and flash floods causing human and property loses for the people. In Aug 18, 2006, flash flood and landslide happened in Trung Thanh and Thanh Son communes of Quan Hoa district. The heaviest rain after 6 hours was 80–200 mm and after 24 hours was 300–400 mm. According to statistics from 1951–2010, in Ma river basin there have been 35 flash floods in most districts that the river runs through.

2.427 Rain on Buoi river basin: The amount of rainfall is from 1,400–1,700 mm, rain is not frequent, the basin has main limestone mountains and the flow characteristic is peculiar in compassion to other reasons.

2.428 Different from Ma river basin, Chu river basin experiences flood season from June to November, of which the heaviest months are September and October, one month later than Ma river basin. The average annual rainfall is 200mm, heaviest months are August and September at 400–500 mm, and the amount of rainfall during dry season is 20–50 mm.

6) Natural Hazard in Nghe An Province

2.429 Nghe An is suffering from many natural disasters. Natural disasters happening in Nghe An are mainly storms, floods (according to data by the authority of flood and storm protection and prevention as well as Northern Central hydrometeorological stations).

2.430 Nghe An often suffered from hurricanes at the average of 2 to 4 storms, followed by floods in major damage to homes crops and property and especially the lives of people.

2.431 Compared to previous years from 2005 to now, the number of natural

disasters, floods in the province of Nghe An increase number of signs and special severity greater strength compared to the previous period.

2.432 In 2005, the number of hurricane landfall in Nghe An with a record from 1990 to now, six hurricanes and five landed in the flood. In the following year, the annual average of two hurricanes has landed in the province accounts for 20 to 30% of landfall in the country.

2.433 Human damage as a result of storms and floods in recent years increased significantly, especially deaths. From 2005 to six months in 2009, the number of deaths due to floods is 138, accounting for 39% over the entire period from 1990 to present. In 2007, Typhoon No. 5 pull in Que Phong floods claimed the lives of 38 people; the storm caused flood damage to most of the people from 1990 to present.

2.434 Number of damages to the people's property, houses and crops, livestock is also increasing. From 2005 to date, estimated the total damage caused by flood is over 400 billion / year. Many times are higher than those previous years. Specifically, in 2007, flood damage caused to the province's economy is huge with 900 billion.

2.435 In the first 6 months of 2009, weather and climate events have erratic five tornadoes occur on land and sea. On May 16, 2009, at Yen Thanh district, lightning phenomena happened, causing six farming people to die many others wounded. Flash floods in Tuong Duong also killed 5 people, causing 25 billion of damage.

2.436 Damage caused by natural disasters reflects the growing complexity and increasing destruction of natural disasters on human life. Along with the deeper consequences of the phenomenon of global climate change, natural disasters are increasing prevention, response and mitigation of consequences of natural disasters should be more emphasis to minimize unnecessary loss of life and of the people.

(1) Flood

2.437 Flood is typical hazard in north section, especially in central provinces such as Thanh Hoa and Nghe An, where flood usually hits around the year (beginning in June and ending in September). However, recently flood comes earlier and lasts later in October. While Hanoi City, Ha Nam and Nam Dinh provinces face submerged situation due to heavy rainfall and poor drainage systems.

Table 2.1.40 Characteristics of Flood at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	Report No./SNN-KH dated Oct. 10, 2011 in response to JST request for information on environmental and social considerations. 5ECSR, chapter 8, pp.123-127.	Since Hanoi's terrain is naturally low and hallow, the urban areas and the suburban areas are often inundated whenever it rains heavily.
2	Ha Nam	Report No. 85/BC-SNN dated Aug.12, 2011 on flood and typhoon hazards in Ha Nam Province. Record of floods (1997-2010)	There are few floods more serious than alarming level 2 and 3. The historic flood in the Day river last from October, 31st, 2008 to November, 14th, 2008. The peak of the flood was measured at 4.86 in Phu Ly.
3	Nam Dinh	Summary report on flood and storm control, search and rescue in 2010 and coming tasks of flood and storm control, search and rescue in 2011. Record of rain and flood on paddy field of Nam Dinh Province, May 2005	Only in 2006 and 2008, the flooding in Dao river and Day river rose to a warning level 3. In other years, it was at ordinary level and it just caused damages to flower and vegetable crops.
4	Ninh Binh	Detailed planning report on flood and dike	Ninh Binh is located in areas of high rainfall.

		control- Hoang Long River dated Aug. 2008, Chapter 6, 7, 8, pp. 52-71 Detailed planning report on flood and dike control- Rivers with inland dikes in Ninh Binh Province dated Nov. 2009, chapter 7, pp. 61-64.	The rainfall in the rainy season occupies 80% of total annual rainfall. In many year, the rainy season has major flooding rainfall in place and the cumulative amount of water from the northwest mountains is 1.2 times the basin, beyond the issue of flood inundation in Ninh Binh, it is influences by the main rivers flowing through the area of Day River, Hoang Long River and Tong river, storms and tides
5	Thanh Hoa	5ECSR 2006- 2010 period. See paragraph below. Hazard prone area map might be found in Powerpoint presentation including information on compiling map atlas for IDRMP (Integrated Disaster and Risk Management Project) report.	According to statistics from 1960 until 2009, the whole province has encountered about 400 heavy rains and 36 flash floods. Especially, in the recent 10 years (from 1999 to 2009) there have been 5 flash floods causing great losses.
6	Nghe An	Report on some hazards in Nghe An Province. Various maps on flood and submerged areas of Nghe An Province (Soft copy, AutoCAD).	Due to its topography and terrain, Nghe An Province is suffering from many natural disasters. Storms and floods are regarded as main natural hazard in Nghe An.

Source: DONRE and DARD, compiled by JICA Study Team

(a) Flood in Hanoi City

2.438 According to the Report made by Hanoi DARD and Hanoi DONRE, the urban areas and the suburban areas are often inundated whenever it rains heavily since Hanoi's terrain is naturally low and hallow.

2.439 Especially, the flood discharge is so difficult when the heavy rain coming together with flood on the rivers (Red, Da, Duong, Tich, Bui, and Day), so the consequences of this situation is so serious, either. On the other hand, Hanoi is the capital which has rapid development rate, actively economic-structure shift, land-use restructure (from agriculture into industry, urban area, tourism, service) that has changed the natural terrain, divided the existing drainage facilities, so the drainage capacity is limited and inundation develops more seriously as well as lasts for longer time.

2.440 Typically, a recent rain has made a new record for more than 100 years, which was lasting several days from the evening of October 30, 2008 in the north and the north central of Vietnam. This unseasonal heavy rain over all forecasts has caused a historic flooding in Hanoi, entailing a major influence on the environmental and economic life of the community.

Table 2.1.41 Summary of the Recorded Rainfall in Hanoi in 2008

(Unit: mm)

Name of Station	19:00 Oct 30 – 19:00 Oct 31	19:00 Oct 31 – 19:00 Nov 1	19:00 Nov 1- 19:00 Nov 2	Total
Lang	347	128.1	88.1	563.2
Ha Dong	514.2	186.4	112.3	812.9
Ha Noi	308.4	167.7	64.9	541
Thuong Cat	326.1	179.9	87.2	593.2
Kim Anh	207.6	126.1	54.5	388.2
Soc Son	238	111	63	412
Trau Quy	350.7	172.4	110.3	633.4
Dong Anh	380	126	60	566
Lien Mac	233.3	131.9	60.2	425.4
Thanh Tri	321.8	117.1	61	499.9

Source: Hanoi Sewage Company, 2008

2.441 After the rain on October 30, 2008, the whole city had 26-flooded points from 100m–300 m long, 1m deep. Losses in term of human were up to 20 people as of November 3. So far, Hanoi has exposed to heavy rain more frequently, resulting in local flooding in many areas, causing considerable impacts on the people’s life and the environment. According to the Hanoi Department of Construction, with rainfall less than 50 m, areas located within the service area of the drainage project (1st phase) virtually have no flooding. With heavy rainfall from 50–100 m, 25 points will appear flooding.

Table 2.1.42 List of 25 Points / Locations Exposed to Flooding in Hanoi

- Quoc Tu Giam (Van Mieu – Quoc Tu Giam junction)
- Ton Dan – Le Lai (Thuy Tien hotel – The committee)
- Le Trong Tan (Le Trong Tan – Nguyen Viet Xuan)
- Nguyen Luong Bang (from House No.115 to Dong Da Bike Company)
- Linh Nam Road (from Alley 183 to Vinh Hung – Linh Nam junction)
- Ly ThuongKiet – Phan Boi Chau intersection
- Nguyen Khuyen (in front of Ly Thuong Kiet School)
- Quan Thanh Street (in front of House No.192)
- Truong Dinh Road (Alley 521 to Set Bridge)
- GiaiPhong Road (Thinh Liet – Freight Transport)
- Kham Thien Street (from Toan Thang alley to Lenh Cu alley)
- Thai Thinh Street (in front of Acupuncture Institute)
- Doi Can Street (in front of House No.195, But Thap pagoda and House No.208, La Thanh Hotel)
- Ba Trieu – Nguyen Du intersection
- Nguyen Cong Tru – Ngo Thi Nham intersection
- Hang Chuoi – Pham Dinh Ho intersection
- Tran Hung Dao – Phan Chu Trinh intersection
- Dien Bien – Nguyen Tri Phuong intersection
- Huynh ThucKhang – Lang Ha intersection
- Ngoc Khanh (from House No.58-84)
- Thai Ha – Tay Son intersection
- Nguyen Trai Road
- Le Duan Road (Hanoi Station)
- Khuat Duy Tien Road
- Tr ng Chinh Road

Source: Hanoi DOC, 2008

2.442 According to the results of the inspection of the Ministry of Construction, Hanoi still has no elevation standard, from which to determine the direction of the natural drainage. In addition, the planning was patched and asynchronous in many new urban areas, resulting that drainage system is the lack of connection. The percentage of households connected to the urban drainage network remains low. The drain system was patchily added, with a total length shorter than the length of the streets, alleys. Many culverts having fewer slopes, sediment mud did not stop the odour.

2.443 To ensure drainage, it is necessary to define a standard for elevation with a slope of 5-7% on each urban terrain. The gravity drainage solutions should be prioritized, only the low-lying points that do not allow water to flow, new sewage pumping stations should be forced. Currently, in Hanoi, forced drainage solutions occupy a large proportion.

2.444 Traditional drainage systems are designed to carry rainwater away from the source as quickly as possible. Construction costs, operation and maintenance are often high but the capacity is limited and not easy to upgrade. This leads to the risk of flooding, soil erosion and pollution of downstream increased.

2.445 To combat flooding, Hanoi has implemented many projects, with large investment funds, however limited effectiveness; some places even become more serious situation.

(b) Flood in Ha Nam Province

2.446 According to Report No.85 by Ha Nam DARD, the most recent regulations on floods issued by the province. The provincial regulations comply with regulations of MARD.

2.447 Monitoring activities: Ha Nam Province possesses 2 hydro-meteorological stations, belonging to DARD, which are responsible for monitoring water level of 2 large rivers namely the Red river and the Day river flowing through the province as well as monitoring rainfall. Besides, data on floods is also monitored and collected by Ha Nam hydro-meteorological centre.

2.448 Through data summary, there are few floods more serious than alarming level 2 and 3. The historic flood in the Day River last from October 31, 2008 to November 14, 2008. The peak of the flood was measured at 4.86 m in Phu Ly.

(c) Flood in Nam Dinh Province

2.449 Only in 2006 and 2008, the flooding in Dao river and Day river rose to a warning level 3. In other years, it was at ordinary level and it just caused damages to flower and vegetable crops. Evidenced by the flood at late October and early November 2008, severe damages were made to 3,700 ha flower and vegetable in winter crop and 14,000ha rice was not ready to harvest.

2.450 According to 2010 statistics, on account of natural disasters, there were 245 people killed, 50 people lost, 363 people injured, 5,000 houses collapsed, washed away; 440,609 houses, nearly 2,000 schools and health stations flooded and damaged; more than 3,000 ha rice and second crop inundated and damaged; 48,553 tons of rice wet and drifted away; more than 700 thousand cattle and poultry killed and washed away; more than 2.3 million m³ of soil and rocks from irrigation works and more than 3.3 million m³ of rock and soil from transport works washed away and deposited; 26 ships and boats sunk, 26 other ships and boats heavily damaged; as well as other damages relating to aquaculture, communications, electricity systems. Total economic damage is estimated to be up to 15 thousand billion VND.

(d) Flood in Ninh Binh Province

2.451 Ninh Binh is located in areas of high rainfall. The rainfall in the rainy season occupies 80% of total annual rainfall. Ninh Binh has a diverse topography: hills and coastal plains. Even in the plain area, the terrain is different by upper and lower parts, making irrigation difficult.

2.452 In many year, the rainy season has major flooding rainfall in place and the cumulative amount of water from the northwest mountains is 1.2 times the basin, beyond the issue of flood inundation in Ninh Binh, it is influences by the main rivers flowing through the area of Day River, Hoang Long River and Tong river, storms and tides.

- (i) **External River Floods:** Located at downstream of the rivers and the topography is complex, Ninh Binh is frequently threatened and affected by the flood on the rivers as Hoang Long River, Day River, Red River flood diverted to Day River across Dao River of Nam Dinh. When a big flood occurs on Hoang Long River such as floods of September 1985, August 1996 and October 2007, to protect the left side of Hoang Long area, Ninh Binh City had to divert the flood into the right side of Hoang Long area, the flooding period after diversion usually lasts from 1 to 2 months causing great damage.
- (ii) **Flood on the Inland Rivers:** The system of inland dykes has not yet achieved the requirements for anti-flood. When a major flood occurs, there are many subsidence positions. In some case, the water rise to flow over some dyke sections, causing unsafe during floods.
- (iii) **Mountain Flood:** The dikes to prevent mountain floods and river dike systems were built to limit basic problems caused by the inland flooding.
- (iv) **Inundation:** Heavy rain and flood has caused losses of production and life over the last years. There are several reasons:
- The drainage flood provoked by inland rain of Ninh Binh Province depends on Hoa Binh reservoir on the upstream. During the drainage, if there is a case of tidal, the food would stay longer and it will be difficult for drainage, particularly the period August–beginning of September.
 - Economic development has intensified the drainage demands while the existing drainage works cannot meet current needs.
 - Previously, the irrigation system self-operated in some areas. Currently, dyke system is strengthened by motors, but lack of key works as Nam Can, the right side of Hoang Long, Canh Dieu and Kim Son.
 - Some key areas have pumping stations, but the equipment is degraded and irrigation system was filled such as the left side of Hoang Long area, Vac and Yen Mo.

Table 2.1.43 Affected Waterlogged Areas

No	Year	Time	Rainfall (mm)	Largest Water logged Area (ha)	Area of production Loss (ha)
1	1996	8/1996	407 (Hoa Lu)	33,380	15,063
2	1997	7/1997	460(Nho Quan)	17,815	1,417
3	2000	9/2000	678.5	13,311	45
4	2001	10/2001	404	13,508	2,633
5	2002	7/2002	253	10,197	731
6	2003	9/2003	357	19,104	1,591
7	2004	7/2004	395	18,795	2,971
8	2005	9/2005	533	21,973	4,109

Source: Ninh Binh DARD/2009

- (v) **Damage caused by Flooding and Natural Disaster:** According to a report summarizing the work of flood prevention in Ninh Binh Province in 2001-2005 damages caused by natural disasters of Ninh Binh in recent years as follows:
- **In 2003:** Due to the effects of storm and flood damage to people (one dead and 13 injured), the flooded area of rice fields was 27,621 ha and the

flooded area of vegetable and flowers was 2,341 ha. Heavy rain reduced 15% rice yield equivalent to three thousand tons of food, 10 classrooms were destroyed, 10 clinics and health centers were flooded and damaged, 134 were houses collapsed, 6,347 houses whose roofs were blown up. Other sectors such as electricity, postal, transportation, and manufacturing were also affected. The dikes-grade 4 and 5 were subsided. Storms and tropical depressions affected Ninh Binh Province not so much but in unpredicted so that it was difficult for the prevention and response.

- **In 2004:** The rain of July 2004 made 23,407 ha of rice and 1,350 ha of soybeans, 1,120 ha of vegetables flooded, some areas of vegetables were damaged, 555 ha of shrimp hatching were in loss, the total damage caused by flooding is 70,342.5 million VND.
- **In 2005:** Natural disasters were happening in a complicated, continuous and extraordinary manner. Ninh Binh was directly affected by the storms No.2,3,5,6,7 and 8, the most severe was the storm No.7. In addition, it was also affected by local flooding and floods on Hoang Long River. Summary of damage caused by natural disasters in 2005 as follows:
 - Casualty damage: 2 killed, 7 injured
 - Area of spilled rice: 22,822 ha
 - Area of rice inundated: 36,000 ha
 - Damage area of vegetable and flower crop was 4,011 ha
 - Flooded area of aquaculture was 970 ha
 - 183 houses were collapsed and 9,090 unroofed houses, 1,000m walls collapsed, 1,333 unroofed auxiliary works, two classrooms and 315 collapsed and unroofed classrooms.
 - 1 conference building was unroofed
 - 49,000 trees were fallen
 - 292 voltage electricity poles and telephone poles 1,295 collapsed
 - 2,847 m² unroofed of pump stations, 46 broken pumping stations
 - Ngoi Quyen embankment and the right side of Day dike in Yen Khanh district was eroded 350m long
 - Kim Son dyke: At K68 and at K72 +600, the slope was subsided.
 - A section of Truong Yen dyke (bordering Au Chanh) was soaked.
 - Anti-wave canvas of Binh Minh dyke II was tattered.
 - At section K19 of Vac dyke was subsided in 125 km long.
 - Parts of dyke- grade 4 of Moi River were collapsed (300m) and flooding in some locations such as Do Pagoda (100m), Dam bridge area (300m), a section (300m) in Khanh Ninh commune. Vo River dyke in Ninh An commune, Hoa Lu district was subsided in 200m. The dyke – grade 4 in Yen Mo district was subsided over a total length of 3km.
 - The embankment of Yen Quang Lake was eroded over 100 meters long
 - The inner embankment of Yen Thang was eroded

- The traffic and irrigation works under the project of living with floods in Nho Quan district, Gia Vien district were eroded and damaged.
- Road 477 was deep in the water and some sections are in 0.5 m water depth. In Tam Diep town, roads affected are as follows: NH 12B adjacent to NH1A flooded locally from 0.7–1.5 m, a number of positions on NH1A were flooded 0.35–0.4 m by heavy rains.

2.453 The total damage and cost recovery is 200 billion VND. So every year in Ninh Binh Province suffered hundreds of billions from natural disasters.

(e) Flood in Thanh Hoa Province

(i) **Current Status of Flood and Flash Flood**

2.454 According to statistics from 1960 until 2009, the whole province has encountered about 400 heavy rains and 36 flash floods. Especially, in the recent 10 years (from 1999 to 2009) there have been 5 flash floods causing great losses. Of which there are 3 floods in the districts of Thach Thanh, Vinh Loc, Tho Xuan (2007), in 2005, there were 2 floods in Thuong Xuan and Quan Hoa causing great human and property losses.

2.455 In 2008, there are 10 storms and 6 tropical depressions in the East Sea, of which 4 storms (storm No. 4, 6, 7, 10 and 2 tropical depressions in 11 Aug and 13 Oct) directly influenced our country but not directly to Thanh Hoa. The total rainfall of areas in the province reaches and exceeds the average of many years and is a common of 1,200 mm ~ 1,700 mm, some areas that had heavy rains were Cua Dat (2,281 mm), Lang Chanh (2,042 mm), Bat Mot (1,987mm). On rivers, there were 1-5 floods at medium and low level. For the heavy rain from 30 Oct to 3 Nov only, on rivers there were flood to Emergency Level I, for Cau Chay River it was Emergency Level II, and on Buoï River it was Emergency Level III.

2.456 Within 10 recent years, in the province there have been 7 flashfloods and landslides killing 11 people, wounded 5 people, swept away 39 houses, 76 small dams and heavily damaged transportation and irrigation structures... Within the 3 years of 2005, 2006, 2007, in the mountainous areas of Thanh Hoa there were 4 flash floods and landslides in Thuong Xuan, Ba Thuoc and Quan hoa districts killing 8, wounded 1, eroded and caused traffic jam on roads, swept away 17 houses, 76 small dams and hundreds of electric poles. of Large area of cultivation land were forever lost. According to statistics, there are 11 mountainous districts with 125 communes, 341 hamlets, 4,625 households and 20,695 residents within areas with flash flood and landslide risk.

(ii) **Countermeasures**

- Irrigational methods preventing erosion and flash floods

2.457 Irrigational methods are construction methods preventing erosion and floods by altering mountain formation, separate currents, retain water on hill slopes, implementing irrigation. These are current controlling and erosion preventing measures. These measures include: erect banks to

contain water, construct canals to prevent water at stream heads, construct dam to prevent erosion, flash floods, construct reservoirs to control floods and structures to divide, slow and discharge floods.

- Flash flood mitigation measure for transportation works

2.458 Transportation works in reality cannot reduce flash floods; on the other hand, flash floods usually destroy transportation works.

2.459 To prevent losses from flash floods for transportation works, aperture of discharge culverts should be increased, the sedimentation caused by floods will increase eventually and aperture will not be enough for water discharge, therefore, aperture must be increased or construct additional bridge at the position with sedimentation.

(iii) Flash Flood Preventive Measures in Construction

2.460 Construction planning of residential areas and urban areas must consider design specification for floods for each structure, flood possibility maps, management schemes, general basin development plan, and statistics of flash floods and historical floods in the location of the structure, estimate calculations and flood possibility in the future.

2.461 Vietnam as well as Thanh Hoa has already have outline standards for flood frequency using in national-nature important constructions, however standards for domestic construction is lacking, for specific cases, it is possible to refer to standards for domestic, agricultural and industrial construction. In principle, every structure is to be built such that it does not impede the flow and reduce the ability to discharge flood of the river, the flood plains and low lands. The flood division sketch as well as general guidelines from the experiences of other countries in the world as well as nationally.

2.462 Carry out land planning for the basin to prevent and reduce losses because of flood, use local preventive measures by increasing the elevation of the area under threat of flooding (natural accretion by directing river mud, mud from flash floods, artificial ground rising); creating flood proofing features for structures; improve the urban basin condition to reduce flash floods, construct structures and houses with supplementary water separation walls to prevent flood.

(iv) Flood Prevention Measures for Forestry

2.463 Afforestation and forest improvement to prevent flash floods: to avoid erosion and flood, firstly there must be measures to protect the flora and recover them in areas with prior destruction. Preventing erosion and floods by greenery is an effective and sustainable measure which is cheap and ensuring the living environment. The improvement and afforestation process in carried out on mountain slopes to:

- Adjust the amount and flow of water, reduce or eliminate erosion and the occurrence of flood flows.
- Zoning for afforestation in possible areas.
- Planting protective forest on barren hills.

(v) Agricultural technical measures to prevent erosion and flash floods

2.464 Using agricultural cultivation techniques, reducing the flow, retain water, retain nutrients to ensure stability and increase yield.

2.465 Besides, good management and education of natural disaster preventive measures must be done which includes:

- Improve the system and capacity, equipment and facility for supervision of flood prevention, reducing flash flood and rescue from provincial to district and commune level.
- Study and apply science and technology of flood and storm prevention, preventing flash flood, riverside and seaside erosion.
- Enhance resources for prevention and mitigation of flash flood.
- Enhance international cooperation through wide participation of organization in disaster mitigation in the region and on a global level.

(f) Flood in Nghe An Province

2.466 Nghe An Province is located in northeast of Truong Son mountain range, its topography and terrain are diversified, complicated and split by mountains and hills, rivers and streams, tilting from northwest to southeast. As a result, Nghe An is suffering from many natural disasters. Natural disasters happening in Nghe An are mainly storms, floods (according to data by the authority of flood and storm protection and prevention as well as Northern Central hydrometeorological stations).

2.467 Flood is a type of environmental disasters occurring in many areas (from upstream to areas along rivers and streams).

2.468 River flooding is a water level rise within a certain time, then gradually decreases. During the rainy season, the intermittent rain in a row on the river basin, the river makes a batch sequence to rise, creating floods in the rivers and streams.

2.469 A special flood phenomenon has serious impacts on social and economic life is a flash flood. Flash floods are natural phenomena, influenced by many factors such as rain to strengthen capacity on special terrain, where slope basin on 20% - 30%, especially in areas where coverage sparse vegetation cover due to damaged power plant, the stability of the basin topsoil poor, facilitating focus formation flow is drawn into the river favorable for water to accumulate more quickly and create great potential.

2.470 Floods cause major damage to human life or cause lasting adverse consequences for agriculture, irrigation works, destabilizing society in a social division of remote areas; causing psychological trauma; difficult forecasting and warning.

2.471 According to the records from 1954 to 2010, tendency and statistical record of water level is as detailed below:

- (i) 1954, 1978 and 1988 were recorded as historical floods (water level reached the emergency alarming).
- (ii) Flood exceeded alarming level III in years of 1964, 1971, 1973, 1987, 1989 and 2002.
- (iii) 15 years was beyond the alerting level II.
- (iv) 3 floods hit the province in three years, in 1963, 1967 and 1970, respectively.
- (v) 4 floods visited the province in 1964.
- (vi) 7 floods in 2005.

2.472 In 1954: 1954 big flood broke 8 points of Ta Lam dyke with 1,280 length and caused great loss for districts from Anh Son to Vinh City.

2.473 In 1978: Storm No. 7 (September 15, 1978) and storm No.9 (September 26, 1978) resulted in the biggest rainfall of 700-900mm in Nghe An, this serious flood broke the Tam Lam dyke at Phuong Ky, Cam Thai with length of 3,772 m, inundated 31 communes (in which 13 communes in Do Luong, 9 communes in Thanh Chuong, 9 communes in Vinh City and Nghi Loc), claimed 37 lives, 1,800 dead cows, collapsed 28,300 houses, submerged 64,000ha of rice and crop, lost 60 billion VND (market-based calculation).

(2) Landslide

2.474 Due to its topography and plain terrain, landslide rarely hits the target provinces in north section. However, riverbank and seabank erosions often occur in Nam Dinh, Thanh Hoa and Nghe An provinces instead, where coastal line spread along these provinces.

Table 2.1.44 Characteristics of Landslide at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	Flood and landslide map of Hanoi City. Report No./SNN-KH dated Oct. 10, 2011 in response to JST request for information on environmental and social considerations, , Heading 1. Natural environment, pp.1.	The floods rising from the upper-stream and flowing usually down Red river, Da river and Da river threaten to the safety of the dikes which protect Hanoi as well as make the riverbank erosion that affects to the riverside residential zones.
2	Ha Nam	No related document provided yet by concerned department of the province.	N/A
3	Nam Dinh	The Environmental Status Report period 2005- 2009, chapter VIII: natural hazard and environmental disaster, pp. 112, article 8.1.3.	Coastal subsidence is commonly found in Nam Dinh coastal area and now section in Hai Hau district with a length of 40km is being subsided.
4	Ninh Binh	No related document provided yet by concerned department of the province.	N/A
5	Thanh Hoa	Environmental current status report 2006- 2010 period, chapter 8. Hazard prone area map might be found in Powerpoint presentation including information on compiling map atlas for IDRMP (Integrated Disaster and Risk Management Project) report.	In Thanh Hoa the erosion of river bank and sea side happens annually at a speed of 0.5 – 1m/year.
6	Nghe An	Report on some hazards in Nghe An Province, heading 11, pp. 10-11 (EN version). Various maps on flood and submerged areas of Nghe An Province (Soft copy, AutoCAD).	The loss of coastal forest leads to landslide and erosion. Out of 45 coastal communes, there are 19 communes suffering from landslide and erosion. At an average annual landslide of 42m, Nghe An loses 100ha coastal land per year.

Note: "N/A"- Not available.

Source: 5ECSR/2005-2009, DONREs, compiled by JICA Study Team

(a) Landslide situation in Hanoi City (Report Prepared by Hanoi DARD)

2.475 The floods rising from the upper-stream and flowing usually down Red river, Da river and Da river threaten to the safety of the dikes which protect Hanoi as well as make the riverbank erosion that affects to the riverside residential zones. In addition, Hanoi is also affected with the forestry floods which rise from Thanh Hoa and inundate the right-sides of Tich river, Bui river, Thanh Ha river that threatens to the safety of the left-sides of these rivers.

2.476 On the other hand, with the climate change, the water level is decreased in the dry season that makes a great water-level gap between the dry season and the flood season. Besides, the regulation of Hoa Binh reservoir leads to the serious riverbank erosion which threatens to the safety of the embankments/ dikes as well as the life and the properties of households who live at riversides.

2.477 In the recent years, Central government, ministries, Hanoi People's Committee have invested with a great fund to reinforce the riverbanks along the right-side of Da river, the right and left sides of Red river, the right and left sides of Duong river (the section running through Hanoi) for the erosion prevention. In addition, along the dikes, 119 embankments, of which the total length is 139.56km, have been constructed.

2.478 The investment for embankment construction has gradually restrained the erosion situation of some locations; ensured the safety for the dikes, properties and people of households who are living along riversides; minimized the damages; taken part in the sustainability of the local people's life, production and the areal socio-economic development.

2.479 In the morning of 30th, November, in Quoc Oai town, after well was drilled to 50 m deep, the soil surrounding the house of Mr Pham Van Nga which was being constructed unexpectedly subsided, leading to the subsidence of two other houses. In the afternoon of the same day, tens of households were evacuated. After 3 days, the hole continued to expand with many surrounding houses suffering from large cracks. Provincial 419 passing through the city was evacuated. According to initial assessment, this area was located in limestone area, which was easy to be weathered, forming Karst. At present, competent authorities continue to supervise and monitor the subsidence process, and the development of impacts.

2.480 There have no assessment of the degree of groundwater pollution as well as other environmental impacts.

(b) Landslide situation in Nam Dinh Province

2.481 Coastal subsidence is commonly found in Nam Dinh coastal area and now section in Hai Hau district with a length of 40 km is being subsided. The most subsidence is in the area from Hai Ly commune to Hai Trieu commune. It is 10-20m of subsidence every year.

(c) Landslide situation in Thanh Hoa Province (Environmental Current Staus Report Period 2006-2010)

2.482 Flash flood, landslides:

2.483 Within 10 recent years, in the province there have been 7 flashfloods and landslides killing 11 people, wounded 5 people, swept away 39 houses, 76 small dams and heavily damaged transportation and irrigation structures. Within the 3 years of 2005, 2006, 2007, in the mountainous areas of Thanh Hoa there were 4 flash floods and landslides in Thuong Xuan, Ba Thuoc and Quan hoa districts killing 8, wounded 1, eroded and caused traffic jam on tens of kilometers of roads, swept away 17 houses, 76 small dams and hundreds of electric poles. Large cultivated area was heavily damaged. According to statistics, out of 27 towns/districts in the province, there are 11 mountainous districts with 125 communes, 341 hamlets, 4,625 households and 20,695 residents within areas with flash flood and landslide risk.

2.484 River bank and sea side erosion:

2.485 The erosion of river bank and sea side happens annually at a speed of 0.5 - 1m/year. Thanh Hoa has 102 km of coast and 1,008 km of dyke, of which there are 292 km of level I to level III dyke, over 700 km of level IV dyke and sea dyke. On major rivers with dyke (Ma River, Chu River, Len River, Lach Truong River), there are 178 spots with erosion, mostly on Ma river and Chu river with a 56,086 m length, there are 52 spots with signs of erosion but without protective structure with a 35,500 m length of which there are 20 dyke foot erosion spots threatening dyke safety. Many parts by the river floodplains have high erosion speed at an average of 5-10 annually affecting agricultural production of the localities. Sea and estuarial dykes of Thanh Hoa are in the districts of Nga Son, Hau Loc, Hoang Hoa, Quang Xuong, Tinh Gia, Sam Son town. After storm No.7 in 2005, some dykes were terribly destroyed and no longer provide stability during storm season, especially Hau Loc, Quang Xuong, Tinh Gia and Sam Son town sea dyke, which in recent years have seen investment to strength according to Decision 58/2006/QD-TTg by the Prime Minister. Structure to protect the coast in the province is 53,195 m long, erosion spots without protection are 35,520 m long. Of which there are some fast erosion spots such as in Sam Son town. Handling riverside and seaside erosion in the province every year caused hundreds of billions locally and at central levels to timely resolve before storm season.

(d) Landslide situation in Nghe An Province (Environmental Current Status Report Period 2005–2009)

2.486 Area of coastal protection forest and mangrove forest in Nghe An has decreased from 7,268.38 ha in 1990 to 6,791.50 ha in 2008.

2.487 The loss of coastal forest leads to landslide and erosion. Out of 45 coastal communes, there are 19 communes suffering from landslide and erosion. At an average annual landslide of 42 m, Nghe An loses 100 ha coastal land per year. Many landslides have intruded into residential areas like in Son Hai, Quynh Long; at some sections like Quynh Bang, Quynh Ngoc, landslide and erosion speed averaged 150–200 m/year. Coastal line along Dien Kim commune (Dien Chau district) landslide is up to 6 km long. The section from Cua Lo to Cua Hoi (Nghi Loc district), before dykes were constructed, had been strongly eroded, block house constructed by France in

1950, which used to 100 m away from coast line, is now right beside sea edge. Half of sand mound, about 15m from Cua Hoi to Xuan Thanh was washed away.

2.488 The trend for landslide along Nghe An coastline is moving coast line towards mainland, creating curvatures with the nose jutting out to the sea, which used to be vacant land formed in the Quaternary. This is natural forest exploited years ago. There are only a number of plants remaining like hassk, *Melastoma affine*. In recent years, about 5,348.1 ha casuarina, acacia, *Erythrophleum fordii*, Santal wood, Tea tree (out of 6,443.3 ha coastal hill land), however, still failing to recover all area washed away and eroded.

2.489 It is necessary for Nghe An DARD to instruct divisions and local authorities to strictly comply with Article 86, section 1, chapter IX of Law on Environmental Protection regarding prevention and dealing with natural hazards and environmental pollution.

(3) Typhoon

2.490 Typhoon is a common natural phenomenon which occurs at specific time of the year from June to November in all target provinces of north section except Ha Nam thanks to its location. The rest of city/provinces including Hanoi City, Nam Dinh, Ninh Binh provinces are usually hit by 2-3 storms per year. While Thanh Hoa and Nghe An provinces located in central provinces which have to suffer from more severe loss caused by a number of typhoons/storms.

Table 2.1.45 Characteristics of Typhoon at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	Report No./SNN-KH dated Oct. 10, 2011 in response to JST request for information on environmental and social considerations.	Hanoi is yearly affected directly with 2 to 3 typhoons and tropical pressures.
2	Ha Nam	Annual Environmental Status Report in 2010, chapter 8, heading 8.3, pp.56-57. Record of floods (1997-2010)	In 2007: Ha Nam Province was affected by 2 storms, of which the storm No.5 caused big flood on Day river from 5 to 10 October.
3	Nam Dinh	5ECSR. Summary report on flood and storm control, search and rescue in 2010 and coming tasks of flood and storm control, search and rescue in 2011. Record of rain and flood on paddy field of Nam Dinh Province, May 2005.	Since 2005, there have been 45 typhoons hitting Nam Dinh Province. However, 25 typhoons were considered directly affecting Nam Dinh Province.
4	Ninh Binh	Detailed planning report on flood and dike control- Hoang Long River dated Aug. 2008, Chapter 6, 7, 8, pp. 52-71. Detailed planning report on flood and dike control- with inland dikes in Ninh Binh Province dated Nov. 2009, chapter 7, pp. 61-64.	In 2005: Natural disasters were happening in a complicated, continuous and extraordinary manner. Ninh Binh was directly affected by the storms No.2, 3, 5, 6, 7 and 8, the most severe was The storm No.7.
5	Thanh Hoa	5ECSR 2006- 2010 period. (chapter 8). Hazard prone area map might be found in Powerpoint presentation including information on compiling map atlas for IDRMP (Integrated Disaster and Risk Management Project) report.	In Thanh Hoa, storms and tropical depressions usually happen from June and end in October. On average every year there are 1 to 2 storms affecting Thanh Hoa.
6	Nghe An	5ECSR heading 11, pp. 11-10(EN). Report on some hazards in Nghe An Province. Various maps on flood and submerged areas of Nghe An Province (Soft copy, AutoCAD).	Every year two or three storms hit or directly affect on Nghe An Province, making up 19% of all storms hitting the country.

Source: DONRE, compiled by JICA Study Team

(a) Typhoon in Hanoi City (Report No/SNN-KH)

2.491 Hanoi is yearly affected directly with 2 to 3 typhoons and tropical pressures. To prevent actively from the typhoons/ storms, the city directs to conduct the specific measures as follows:

- (i) Before the storm season: To review and specify the degraded tenements, high-buildings, the residential zones which are outside the dike or nearby the riversides, on-being-constructed facilities, degraded houses and warehouses; to prepare and conduct positively the measures for preventing works from collapse as well as to evacuate people and valued properties out of unsafe areas when it is typhoon.
- (ii) To cut down trees, branches; to prop electric pillars, lightings, power lines along streets; to formulate and conduct measures which ensures the safety for electric grid, public lights during the typhoon period.
- (iii) Within the typhoon time: Monitor seriously the direction and development of the typhoons as well as the affected rate of these ones to the city; to inform timely the rate, direction and forecasted time when the typhoons land; to proactively prevent in accordance with the formulated plan; to conduct well the information and report regime, to be ready to mobilize all forces and means for rescuing, supporting, preventing and responding promptly for the affected areas.
- (iv) After the typhoon time: basing on the formulated departments, sectors, levels must quickly overcome the consequences of the typhoons, such as: to repair the power grid, to clean up the fallen trees along the streets, to improve the environmental sanitation situation, to supply promptly fresh-water and power; to control the wide development of the arisen epidemic diseases, to help the seriously damaged households (especially the households are under preferential policies, solitary or very poor).

(b) Typhoon in Ha Nam Province (Annual environmental status report in 2010)

2.492 There have been many unusual changes in recent years, due to the climate change.

2.493 In 2006: Ha Nam Province was not affected by flood and storm but the unsteady rainfall distribution leads to the partly droughts.

2.494 In 2007: Ha Nam Province was affected by 2 storms, of which the storm No.5 caused big flood on Day river from 5 to 10 October; flood on Red river appeared from 29 July to 8 August caused some dangerous problems on shaped dikes, however, those problems were treated in time.

2.495 In 2008: Ha Nam was affected by 3 storms, of which 2 storms caused partly flood.

(c) Typhoon in Nam Dinh Province (Environmental Current Status Report)

2.496 Since 2005, there have been 45 typhoons hitting Nam Dinh Province. However, 25 typhoons were considered affecting Nam Dinh Province. More suffers have been found in recent typhoons. Particularly, Typhoon No.7 (Darmrey storm) on 27 September 2005 hit the coastal area of Nam Dinh Province. This has been the strongest typhoon over the last years causing serious damage to three coastal districts (Giao Thuy, Hai Hau and Nghia Hung). The total damage was

1,889.25 billion VND and three aforementioned districts suffered 827.16 billion VND. Total destroyed length of dyke was 19,054 m. After the typhoon, it was not only physical damages but also environmental pollution caused by accumulated wastes, dead animals, and dead poultry and so on.

2.497 Seawater intrusion to coastal areas of land, according to the Department of Agriculture, there were 8,765 ha of saline, including 265 ha of rice, 950 ha of flower and vegetable crop and 3,000 ha of shrimp farming.

2.498 After Typhoon no.7 (2005), Nam Dinh Province has been hit by other tropical depressions but not very severe.

Table 2.1.46 Number of Typhoons Hit Nam Dinh Province

No	2005	2006	2007	2008	2009
1	8	8	8	9	12
2	2	3	4	5	7

Source: Nam Dinh DARD/2009

(d) Typhoon in Thanh Hoa Province (Environmental Status Report of Thanh Hoa DONRE)

2.499 In Thanh Hoa, storms and tropical depressions usually happen from June to the end in October. On average every year there are 1 to 2 storms affecting Thanh Hoa. In peak months from August to October, every two to three years there is one storm, whereas at other times in the year, one storm affects in 4 to 8 years. Early storms in May, June are usually weak storms and tropical depressions with low wind and moderate rainfall; sometimes early storms bring more benefits than destruction by reducing dry weather and clean the environment. Whereas the rest of storms hitting Thanh Hoa all have heavy rain from 200-500mm over a large area. Therefore, the amount of rainfall because of storm and tropical depression makes up 40-50% the total rainfall annual and mostly happens from August to October.

2.500 Thanh Hoa has strongest storm winds over 40m/s on the high seas and 35m/s in land. At Thanh Hoa hydrology and meteorology center, a storm with 39m/s winds was recorded on 19 Sep 1963 and 40m/s on 15 Sep 1973 with Southeast direction. The further inland, because of obstacles, wind speed reduces substantially, usually only reaches 20-25m/s in mountainous areas.

2.501 According to meteorology statistics within 40 years (1958-2002), every year only 1-2 storms and tropical depression lands in Thanh Hoa. Whereas the number of storms and tropical depressions affecting Thanh Hoa (lands north and south of Thanh Hoa) causing a considerable amount of rain and strong wind, counting both types, every year there are 4-5 storms and tropical depressions affecting Thanh Hoa. In 40 years, there has never been storm and tropical depression landing in Thanh Hoa before May and after October, only in the duration from Dec to April next year, there are no storms and tropical depressions influencing Thanh Hoa. September has the highest possibility of storms and tropical depression directly influencing Thanh Hoa (37% of directly landing and 22.5% of major influence).

2.502 Storm also causes heavy rain over large areas, which is a cause of

sudden flooding. Every year Thanh Hoa has about 20–25 days of storm with an average rainfall each time from 300-500mm, with a maximum of 800mm.

(e) Typhoon in Nghe An Province (5ECSR)

2.503 Storm is a state of disturbance of the atmosphere and is a type of extreme weather.

2.504 In Vietnam, the term "storm" is often understood as a tropical storm, weather which is especially dangerous appears only on the tropical waters, often with strong winds and heavy rain. However, the broader term, including thunderstorms and other rare phenomena in Vietnam such as snowstorms, sandstorms, dust storms. Storms have caused the damages such as:

- (i) Serious damage for people: death, wounding
- (ii) Serious damage for national and residential assets: destroying houses, crops, transportation buildings, factories.
- (iii) Serious pollution after storms due to the large amount of stagnated waste, dead animals and cattles; causing potential risk of an outbreak of eye and digestive; salinization of coastal agricultural lands.

2.505 Causing inflation and a series of far-reaching impact on social life after the storm.

2.506 Every year two or three storms hit or directly affect on Nghe An Province, making up 19% of all storms hitting the country. Storms usually attack continuously from June to November with frequency of 6% in June, 13% in July, 18% in August, 43% in September and 20% in October.

2.507 Those 12 level storms which hit Nghe An Province and claimed serious loss and damage are storm No.7 dated October18, 1982, storm No.3 dated August 23, 1987, storm No. 7 dated October 3, 1989, storm No. 7 August 29, 2005, storm No.3 dated August 12, 2005, storm No.5 dated October 3, 2007. Especially, in October 1989, three storms directly hit the province within 10 days. The typhoon, rising tide cause the sea level rise in the coastal area and river estuaries, canals, at the same time the post-storm and depression rain caused flood, flash flood in the widespread area.

(4) Other Hazards

2.508 Apart from the above mentioned common natural hazards, drought, hail rain, tornado, explosive and fire, oil spills are recognized as other hazards confronting to the target provinces in the north section. In spite of low frequency of those hazards, target provinces need to actively prevent and prepare appropriate countermeasures to overcome the hazards. As described below is some relevant information on other hazards.

Table 2.1.47 Other Hazards at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	Report No./SNN-KH dated Oct. 10, 2011 in response to JST request for information on environmental and social considerations.	Draught and forest fire are regarded as the other hazards facing Hanoi City due to the abnormal phenomenon of weather.
2	Ha Nam	Annual Environmental Status Report in 2010, chapter 8, heading 8.3, pp.56-57.	Apart from common hazard, Ha Nam Province also confronts forest fire and draught in its province.
3	Nam Dinh	The Environmental Status Report period 2005-2009, Chapter 8. Summary report on flood and storm search and rescue in 2010 and coming tasks of flood and storm control, search and rescue in 2011.	Explosive and fire, oil spill and epidemic diseases are hazards confronting Nam Dinh Province recently.
4	Ninh Binh	Five-year environmental status report period 2006-2010, Chapter VIII, Heading 8.2, pp. 124-125.	In recent years, due to irregular changes in weather and prolonged sunshine conditions, as well as human factors such as illegal loggings and forest-burning (for agricultural land), 23 forest fires were reported during 2005 – 2009, claiming 11.66 ha.
5	Thanh Hoa	Environmental current status report 2006- 2010 period. Hazard prone area map might be found in Powerpoint presentation including information on compiling map atlas for IDRMP (Integrated Disaster and Risk Management Project) report.	Other natural hazards have been recorded in Thanh Hoa Province including tornado, hail, drought, dissertation, salinization and extremely cold weather etc).
6	Nghe An	Report on some hazards in Nghe An Province. pp.17.	Other natural hazards have been recorded in Nghe An Province including tornado, hail, drought, coastal erosion, land crack ans subsidence etc).

Source: DONRES/DARDs, compiled by JICA Study Team

(a) Other Hazard in Hanoi City

2.509 Impacts of local droughts because of the little rain: the water sources will be limited; the water volume in rivers, ponds, reservoirs, lakes, canals is dried and not in conformity with the designed level. Tich River, Day River and Nhue is dried and become the “dead” rivers. The water resources supplying for watering, irrigation, and environmental improvement of Hanoi depend much on Hong river, Da river and the reservoirs.

2.510 Impacts of the forestry fires: Hanoi’s total area of forests is 20,000ha which is distributed mainly in Ba Vi (10,000 ha), Soc Son (4,500 ha), My Duc (2,500 ha), Chuong My, Quoc Oai and Thach That. This area comprises special use forests, protective forests, economic forests and national parks.

2.511 Impacts of earthquakes and fire risks: Although, these events rarely occur, they should not be excluded. In addition, Hanoi is located on a loose soil base which has been formed with sediment and warp of the major rivers. With the rapid urbanization and industrialization, many urban areas, industrial zones, high buildings (over 70 to 80 floors) have been developed. Thus, the consequences will be unexpected when the earthquakes and fire risks occur if there are no proactive prevention measures combined with the construction.

(b) Other Hazard in Ha Nam Province

- **Forest Fire**

2.512 There were 6 forest fires in 2004, total damaged squares were 5.5 ha and 2 forest fires in 2009 with total damaged squares were 0.8 ha. The reason for forest fire is because people fire wood to get coal and the dried season.

- **Droughts**

2.513 Droughts appeared in the beginning winter and spring season and the rivers' water level was very low caused many difficulties for drought protection activities. Total rainfall in 2008 is higher than the one in previous years, especially; the big rainfall from 30 October to 6 November caused big damages for agriculture, people's livelihood, irrigation and many infrastructure works.

2.514 In 2009: droughts continued to appear in the beginning Winter and Spring season, total of rainfall is lower than that in previous years.

(c) Other Hazard in Nam Dinh Province

- **Explosive and Fire**

2.515 Since 2005, environmental incidents occurred in the province but few, especially no serious incidents. However, some production units do not strictly abide the firefighting measures so that the number of explosive cases tends to increase.

Table 2.1.48 List of Damages by Environmental Incidents

Year	Explosive and Fire Incidents	
	Number of Cases	Number of Deaths
2006	4	0
2007	1	1
2008	0	0
2009	12	0
Total	17	1

Source: Hanoi DARD/2010

- **Oil Spills**

2.516 In recent years, in the area of Nam Dinh Province, there were no major and serious oil spills causing impacts on the aquatic environment. However, due to a number of shipbuilding and repair establishments concentrated in main river routes and along the coastal line, it appears spill marks in main river routes. The spread of oil stains mainly due to the cleaning of vessels, ballast water from the means of water transportation. Most of the shipbuilding facilities have made reports of environmental impact assessment, but compliance with the contents of the report on environmental impact assessment is not complete.

(d) Other Hazard in Ninh Binh Province

- **Forest Fire**

2.517 In recent years, due to irregular changes in weather and prolonged sunshine conditions, as well as human factors such as illegal loggings and forest-burning (for agricultural land), 23 forest fires were reported during 2005 – 2009, claiming 11.66 ha.

2.518 However, thanks to proper fire-prevention and fighting squad, most of the incidents were timely identified and handled effectively. Losses then were minimized.

Table 2.1.49 Burnt Forest Areas, 2005–2009

Item	2005	2006	2007	2008	2009
Fire (cases)	12	9	2	0	0
Damaged areas (ha)	5.6	2.26	3.8	0	0

Source: Ninh Binh Forestry Protection Department

(e) Other Hazard in Thanh Hoa Province

2.519 Drought and desertification are frequent natural disasters in Thanh Hoa and rank 3 in terms of losses behind storms and flooding. In recent years, droughts continuously happen in areas of the province. Droughts cause 20-30% reduction in crop yield in certain years, seriously affect husbandry and people's living. Fighting drought is difficult due to lack of water and depleted upstream reservoirs prolong droughts lead to the risk of desertification in some areas, especially coastal sandy areas and slopes in the midlands and mountainous areas.

2.520 Salinization usually happens in coastal districts at different severity. District with high salinization risks are Nga Son, Ha Trung, Hau Loc, along Lach Sung estuary (Ma River), Quang Xuong, Tinh Gia districts at the estuary of Lach Ghep (Yen River) and Tinh Gia district at the estuary of Lach Bach (Bang River).

- **Tornadoes and Hails**

2.521 These are natural conditions usually happen in Thanh Hoa at the beginning of rain season which are sudden therefore causing heavy losses to the people in the province. Almost every year tornadoes and hails happen mountainous and midland districts of Thanh Hoa. In recent years only, in the whole province, there have been 19 tornadoes and hails killing 8 people, destroyed 417 houses and hundreds of ha of secondary crops were destroyed.

- **Droughts**

2.522 Droughts is the serious prolonged absence of rainfall, reducing humidity and water content in soil, depleting river and streams, reducing water levels of ponds and lakes and underground water, negatively affecting the growth of plants.

2.523 In Thanh Hoa Province in recent years, there have been many droughts, specifically in 2005 and at the beginning of 2009, hot weather prolonged, the water level on rivers receded strongly compared to designed levels of pump stations and culverts from 0.5 to 1.2 m. At the end of June 2009, through inspection on Hoat, Bao Van and Can river, salination happens on all these rivers with a salinity concentration taken at culvert and pump station from 1% to 8%, the duration of fresh water taking was 3 to 4 hours, the area of drought were 7,200 ha, which includes Nga Son 1,100 ha, Ha Trung 900ha, Hau Loc 1,100 Ha, Hoang Hoa 800ha, Tinh Gia 800ha, Yen Dinh 700ha. Each year the province has to invest dozens of billions to combat this.

- **Extremely Cold Weather**

2.524 This is the weather condition that prolongs causing extreme cold (average atmosphere temperature <15°C, and most extreme cold (<13°C) affecting crops, cattle and people.

2.525 The extremely cold weather lasting 38 days at the beginning of 2008 in Thanh Hoa directly affected agricultural production and the living of many farmer households. Losses: 53,178.7 ha of dead newly planted rice, 339.91 ha of dead rice seedlings, 6,632.9 ha of dead secondary crops, 9,883 dead cows and buffalos, 1,465 dead pigs, 1,960 dead goats, 53,934 dead poultry, 1,066,000 industrial seedlings destroyed.

(f) Other Hazard in Nghe An Province

- **Drought**

2.526 Drought is a phenomenon of severe rainfall deficiencies extend, reduce moisture in the air and water content in the soil, the depletion of river flows, lower lake water levels, water levels in the layer containing ground water to adversely affect plant growth, environmental degradation to poverty, disease causing, etc.

2.527 Droughts have a tremendous impact on the environment, economic, political, social and human health. Drought is a cause of poverty, disease and even war due to water conflicts.

2.528 Drought impacts the environment as destroying plants, animals, wildlife populations, reducing air quality, water or forest fires, soil erosion. These effects can last long and will not be recovered.

2.529 Drought impacts socio-economic, such as reducing crop yields, reducing cultivated area, reducing crop yields, mainly food crop production. Moreover, it is increasing agricultural production costs, reducing income of agricultural labor; rising prices and food prices; reducing the total value of livestock products. The hydropower plants copes difficulties during operation.

- **Tornadoes**

2.530 Hose or tornado: a phenomenon a swirl air flow extends down from a thundercloud to the ground.

2.531 Consequences caused by the hose are very serious to the localities where it passes through. More and more water cannons occurs most powerful water cannon for the loss of people as well as the infrastructure is growing.

2.532 Because of the move with lightning speed, with cyclones, water cannons seem to destroy everything in its path. The game may book flights up both cars, houses permanent, destroy the bridges and books by both humans, animals on the road.

- **Coastal Landslide, Land Cracks, Land Subsidence**

2.533 Coastal erosion is causing the erosion processes in coastal areas and coastal estuaries, related to the operation of river and coastal waves and currents. This process greatly affects the development and production life of coastal residents.

2.534 Ground cracking, landslide hazard phenomenon is due to the gravitational fast force. It usually modifies slopes with gradients over 30°.

2.535 Pursuant to Law on Enviromental Protection in 2005: environmental

hazards are incidents or risks happening during human activities or extraordinary natural changes, resulting serious environmental degradation.

2.536 Environmental hazards can be caused by factors as follows:

- Fires, forest fires, technical incidents in factories, trading activities, economic, scientific, technical, cultural, social, security, national defense projects potential to cause harm to environment.

2.2 Living Environment

2.2.1 Air Quality

2.537 The provincial regulation on air quality monitoring does not exist in all provinces/cities of the country. The QCVN 05:2009/BTNMT is applied instead to identify the air pollution in their provinces/cities. For comprehensive view, the monitoring system is summarized as shown in Table 2.2.1. It depends on the requirement of each province; a number of parameters, locations and frequencies are also differentiated accordingly.

Table 2.2.1 Air Quality Monitoring System at Each Province

No.	Prov/City	Location	Frequency	Method	Equipment	Description
1	Hanoi	Industrial zones/clusters, high frequency transportation, crossroads, Densely residential areas, craft villages spreading in the city.	Twice per year	Samples are surveyed, measured and collected at target sites, then analyzed at laboratory of Au Viet Environmental Technology Company	Specialized equipments	7 main parameters (Dust, °C, humidity, wind velocity CO, SO ₂ , NO _x) are analyzed in conformity with QCVN 05: 2009/BTNMT to identify the pollution of air quality.
2	Ha Nam	Vulnerable locations: industrial zones, crossroads, densely residential areas in Districts Phu Ly, Duy Tien, Thanh Liem, Binh Luc	Four times per year	Samples are collected at target sites periodically, and then analyzed at Laboratory of the Environmental monitoring center under DONRE.	Specialized equipments	6 main parameters (Dust, °C, humidity, CO, SO ₂ , NO ₂) analyzed based on QCVN 05: 2009/BTNMT to identify the pollution.
3	Nam Dinh	Industrial zones/clusters, roads, crossroads, densely residential areas, craft villages, disposal sites	Twice per year	7-16 samples are collected periodically and analyzed at the laboratory of the DONRE.	Specialized equipments	Eight main parameters are collected at each location and analyzed pursuant to QCVN 05: 2009/BTNMT
4	Ninh Binh	Road No.10, T-junction to Ninh Phuc port, T-junction at Vung Tram area, Cau Lim crossroad, residential area in Nam Son commune, T-junction at Chieu market, Ninh Van craft village, center of Yen Ninh town, center of Yen Thinh town.	Four times per year	Samples are collected at the target sites and analyzed at the laboratory.	Specialized equipment imported from different countries.	Only four parameters were analyzed; dust, CO, NO ₂ and SO ₂ in accordance with QCVN 05: 2009/BTNMT
5	Thanh Hoa	Vulnerable locations: traffic sites, densely residential areas, industrial zones/clusters and craft villages	Four times per year	Surveying, measuring and collecting samples to be analyzed at Thanh Hoa Health prevention center and mining and geology agency, respectively	Specialized equipments	18 parameters are analyzed in line with QCVN 05: 2009/BTNMT
6	Nghe An	18 locations in which Hoang Mai cement company, industrial zones/clusters (Dien Hong, Dien Chau, Nam Cam), Vinh City areas are typical polluters.	Four times per year	Collecting samples at the target sites and to be analyzed at the Laboratory at Nghe An Environmental monitoring center under Nghe An DONRE.	Specialized equipments	Five parameters are analyzed: dust, noise, CO, NO ₂ and SO ₂ in conformity with QCVN 05: 2009/BTNMT

Source: DONRE, compiled by JICA Study Team

2.538 Due to the rapid urbanization and industrialization, air pollution is regarded as one of the pressing problems of the environment in Vietnam now. Air pollution concentrates mostly on densely populated areas, roadsides, industrial zones, craft villages etc. Since the huge parameters were analyzed, only some main parameters

are displayed in Table 2.2.2 as typical cases.

Table 2.2.2 Typical Result of Air Quality at Each Province

No.	Province/city	Dust (mg/m ³)	Temp. °C	Humidity (%)	CO (mg/m ³)	NO ₂ (mg/m ³)	SO ₂ (mg/m ³)	Source/ year
	QCVN 05:2009/BTNMT	0.30	-	-	30.0	0.2	0.35	
1	Hanoi	0.32-0.92	26.5-27.3	70-73	0.80-4.90	0.010-0.084	0.049-0.450	5ECSR/2006-2010
2	Ha Nam	0.20-1.83	16.2-27.0	35-78	0.092-0.081	0.015-0.064	0.120-0.196	5CESR/2005-2009
3	Nam Dinh	0.21-1.02	31.0-36.4	46.6-85.0	2.80-8.20	0.01-0.09	0.012-0.070	5CESR/2005-2009
4	Ninh Binh	0.47-1.85	-	-	1.07-3.65	0.01-0.36	0.025-0.16	5CESR/2006-2010
5	Thanh Hoa	0.29-2.10	18.3-30.6	74-91	0.10-24.0	0.04-0.34	0.02-0.55	5CESR/2006-2010
6	Nghe An	0.11-0.34	-	-	2.0-11.0	0.04-0.19	0.10-0.31	5CESR/2005-2009

Note: "-": Not specified, "5ECSR": Five-year current environmental status report
Source: DONREs, compiled by JICA Study Team

2.2.2 Surface Water Quality

2.539 Similarly, the provincial regulation on surface water quality does not exist, either. As shown in Table 2.2.3, QCVN 08:2008/BTNMT issued by national level are used instead to identify the pollution of surface water. It depends on each province/city, locations, frequency, method and a number of parameters are required differently.

Table 2.2.3 Surface Water Quality Monitoring System at Each Province

No.	Prov/City	Locations	Frequency	Method	Equipment	Description
1	Hanoi	Rivers, streams, lakes, ponds, industrial zones/clusters spreading over the newly extended city.	Four times per year	Samples are collected periodically by VIWASE and other sub-contractors and analyzed at the laboratories.	N/A	12 main parameters are analyzed based on QCVN 08:2008/BTNMT to identify the pollution in the city.
2	Ha Nam	26 locations: mostly in Day river, Nhue river, Duy Tien river, Hoa Mac river, Chau Gian river, Sat river, dams, Chua Bau lake, bridges, culverts etc	Four times per year	Samples are collected periodically and analyzed at the Laboratory of Ha Nam environmental monitoring and analysis center	Specialized equipments	11 main parameters are analyzed based on QCVN 08:2008/BTNMT to identify the pollution the province.
3	Nam Dinh	14-21 locations: mostly in Red river, Dao river, Dang river, Hung Vuong river, Day river, Sat river, Vinh Giang river, Vi Xuyen lake, Truyen Thong lake, Thong Nhat lake and other lakes/ponds in the province.	Twice per year	Samples are collected periodically and analyzed at the Laboratory of Nam Dinh environmental monitoring and analysis center	20 specialized equipments	14 main parameters are analyzed and based on QCVN 08:2008 to identify the pollution in the province.
4	Ninh Binh	9 locations: mostly in Day river, Van river at Lim bridge, Yen river and Vac river, May xay lake, Khe Rong stream, autumn lake,	Four times per year	N/A	N/A	5 main parameters: pH, TSS, DO, NH ₃ and Coliform are analyzed and based on QCVN 08:2008 to identify the pollution in the province.
5	Thanh Hoa	40 locations: mostly in Ma, Lo, Chu, Cau Chay, Bui, Len, Lach Truong, Yen, Thi Long, Nhom, Muc, Hoang, Ly, Hoat, Bang, Dao rivers and lake in the province.	Four times per year	Surveying, measuring and collecting samples in targeted sites stipulated in the Decision No. 44/QĐ-STNMT on environmental monitoring plan and being analyzed at the laboratory of Hanoi industrially chemical institute.	Specialized equipments	27 main parameters are analyzed and based on QCVN 08:2008 to identify the pollution in the province.
6	Nghe An	25 locations: Mostly in Hoang Mai, Thai at Giat bridge, Cau Bung, Cam, Dao rivers, Vech Bac, Nha Le canals, lakes, ponds sewages in Vinh City as well as in other places of the province.	Four times per year	N/A	Specialized equipments	23 main parameters are analyzed and based on QCVN 08:2008 to identify the pollution in the province.

Note: "N/A": No information available in the reference document
Source: DONRE, compiled by JICA Study Team

Table 2.2.4 Typical Result of Surface Water Quality at Each Province

No	Province/City	pH	DO (mg/l)	TSS (mg/l)	BOD ₅ (mg/l)	COD (mg/l)	NH ₄ ⁺ (mg/l)	NO ₂ (mg/l)	NO ₃ (mg/l)	Coli (MPN/100ml)	Source/year
	QCVN 08:2008/BTNMT	5.5-9	≥4	50	15	30	0.5	0.04	10	7,500	
1	Hanoi	6.5-7.6	1.7-5.1	240-475	4.0-35	11-81	0.05-16.0	0.024-0.059	0.02-8.10	9,000-90,000	ESR/2008 & 5ECSR/06-10
2	Ha Nam	6.81-7.71	0.39-11.0	106-192	5.0-30	15-50	0.2-10.5	0.01-0.9	0.5-2.1	3,900-43,000	SR/2010 & 5ECSR/05-09
3	Nam Dinh	6.8-7.0	5.6-6.0	12-50	11-24	21-23	-	-	0.97-2.58	4,200-7,800	SR/2010 & 5ECSR/05-09
4	Ninh Binh	6.95-7.25	3.58-4.64	19.1-82.1	N/A	N/A	N/A	N/A	N/A	3,150-6,280	5ECSR/06-10
5	Thanh Hoa	-	-	0.2-70	0.1-7.0	1.0-18	0.01-0.5	0.01-0.11	N/A	N/A	5ECSR/06-10
6	Nghe An	N/A	N/A	30-220	7.0-25	N/A	N/A	N/A	N/A	N/A	5ECSR/05-09

Note: "N/A": No information available in the reference document "-"not specified "5ECSR": Five- year environmental current status report, "ESR": Environmental Status Report, "SR": Summary report
Source: DONRE, compiled by JICA Study Team

2.2.3 Groundwater Quality

2.540 Groundwater plays an important role in industrial activities as well as in daily life of the factories and residents, respectively. Particularly, the groundwater supplies a huge amount of raw water to water treatment plants meeting the increasing demands of industrial zones and households of the country. The detailed information on groundwater quality is described in Table 2.2.5 and Table 2.2.6.

Table 2.2.5 Groundwater Quality Monitoring System at Each Province

No.	Prov/City	Locations	Frequency	Method	Equipment	Description
1	Hanoi	South Red River including Thanh Xuan, Dong Da, Hai Ba Trung, Thanh Tri, Tu Liem and Long Bien Dist, North Red River, and Gia Lam area.	Twice per year	Samples are collected in rainy and dry seasons and analyzed at the Laboratory of Center for Hanoi natural resources and environmental monitoring and analysis.	Special equipments	5 main parameters are analyzed in line with QCVN 09:2008/BTNMT to identify the pollution in the city.
2	Ha Nam	8 different locations; mostly in Dong Van industrial zone, Hoang Tay and Hoa Hau communes, Hoa Mac town, Vinh Tru, Yen Nam, Non and Bo De commune.	Four times per year	Samples are collected periodically and analyzed at the Laboratory of Ha Nam environmental monitoring and analysis center.	Special equipments	11 main parameters are analyzed in accordance with QCVN 09:2008/BTNMT to identify the pollution in the province.
3	Nam Dinh	8 different locations; mostly in drilling wells of households in Districts (My Loc, Vu Ban, Y Yen, Nam Dinh City)	Twice per year	Samples are collected at the targeted sites and analyzed at the laboratory of Nam Dinh environmental monitoring and analysis center	Special equipments	11 main parameters are analyzed in line with QCVN 09:2008/BTNMT to identify the pollution in the province.
4	Ninh Binh	5 locations in drilling wells in different places within the province; Ninh Son commune (Ninh Binh City), Tam Diep town, Yen Khanh, Hoa Lu and Yen Mo.	Four times per year	Samples are collected periodically and analyzed at the Laboratory of Nam Dinh environmental monitoring and analysis center.	Specialized equipments	8 main parameters are analyzed in accordance with QCVN 09:2008/BTNMT to identify the pollution in the province.
5	Thanh Hoa	20 different locations; mostly in industrial zones/clusters, craft villages, near mineral exploration sites, and other potentially polluted areas.	Twice per year	Surveying, measuring and collecting samples in targeted sites stipulated in the Decision No. 44/QD-STNMT on environmental monitoring plan and to be analyzed at the laboratory of Hanoi industrially chemical institute.	Specialized equipments	25 parameters are analyzed and based on QCVN 09:2008/BTNMT to identify the pollution of ground water in the province.
6	Nghe An	11 locations; mostly in surrounding areas of Dien Hong industrial clusters, Nam Cam industrial zone, ground water and drilling wells of households.	Four times per year	11 samples are collected periodically and analyzed	Specialized equipments	20 parameters are analyzed based on QCVN 09:2008/BTNMT to identify the pollution of ground water in the province.

Source: DONRE, compiled by JICA Study Team

Table 2.2.6 Typical Result of Groundwater Quality at Each Province

No	Province/ City	pH	Fe (mg/l)	Cl- (mg/l)	As (mg/l)	Mn (mg/l)	NO ₂ - (as N, mg/l)	Pb (mg/l)	CaCO ₃ (mg/l)	Coliform (MPN/100ml)	Source /year
QCVN 09:2008/BTNMT		5.5 - 8.5	5	250	0.05	0.5	1	0.01	500	3	
1	Hanoi	N/A	N/A	N/A	0.004 - 0.042	N/A	0.038 - 0.16	N/A	N/A	N/A	5ECSR /2006-2010
2	Ha Nam	6.09 - 6.75	0.98 - 28.6	24.08- 293.2	0.002 - 0.175	0.07 - 1.238	0.002 - 0.10	0.016- 0.186	N/A	N/A	SR /2010
3	Nam Dinh	6.9 - 7.3	0.8 - 6.02	50- 524.66	0.009 - 0.056	0.001 - 0.94	0.01 - 0.015	N/A	28-78	3-30	SR/2010 & 5ECSR/05-09
4	Ninh Binh	6.85 - 7.02	3.78 - 6.62	N/A	0.001 - 0.03	0.094 - 0.15	0.015 - 0.020	0.001- 0.003	286- 317	1-2	5ECSR /2006-2010
5	Thanh Hoa	N/A	0.5 - 13.9	N/A	N/A	0.01 - 1.51	N/A	N/A	100- 1.300	N/A	5ECSR /2006-2010
6	Nghe An	5.5 - 6.5	0.07- 39.92	N/A	0.002 - 0.010	0.002 - 1.670	N/A	N/A	N/A	750	5ECSR /2005-2009

Note: "N/A": No information available in the reference document, "5ECSR": Five-Environmental current status report,

MPN: most probable number

Source: DONRE, compiled by JICA Study Team

2.2.4 Soil

2.541 Soil monitoring system at each province is shown in Table 2.2.7.

Table 2.2.7 Soil Monitoring System at Each Province

No	Prov/City	Locations	Frequency	Method	Equip.	Description
1	Hanoi	7 locations; mostly in the ricefield and kilns in Gia Lam, Dong Anh Thanh Tri, Tu Liem, Van Lam, Thach That and Thanh Oai Districts.	Twice per year	Samples are collected at the target sites and analyzed at the laboratory of Vietnam Environment Administration	Specialized equipment	6 main parameters are analyzed in accordance with 03/15:2008/BTNMT to identify soil contamination of the city.
2	Ha Nam	5 locations; mostly in the field in Thanh Liem and Duy Tien Districts	Twice per year	Samples are collected at the target sites and analyzed at the Laboratory of Ha Nam Monitoring and Analyzing Center for Natural Resources and Environment.	Specialized equipment	5 main parameters are analyzed in line with 03/15:2008/BTNMT to identify soil contamination in the province.
3	Nam Dinh	5 locations; mostly in the field in Liem Hai, Nam Duong, Giao Thien, Yen Dinh and Goi Towns.	Twice per year	Samples are collected at the targeted sites and analyzed at the Laboratory	Specialized equipment	10-12 parameters are analyzed in conformity with QCVN 03/15:2008/BTNMT to identify soil contamination in the province.
4	Ninh Binh	Soil in Thach Binh, Quynh Luu, Gia Lap, Truong Yen, Ninh An, Ninh Tien, Ninh Phuc, Mai Son, Yen Son communes, soil in Quen Kho landfill, craft village in Yen Khanh, and soil in shrimp planting areas in Kim Trung commune.	Four times per year	Samples are collected at the targeted sites and analyzed at the Laboratory at Environmental monitoring center under Ninh Binh DONRE.	Specialized equipment	6 main parameters: pH, Cu, Pb, Cd, Zn, As analyzed in line with QCVN 03/15:2008/BTNMT to identify soil contamination in the province.
5	Thanh Hoa	10-12 locations; mostly in Nong Cong, Tho Xuan, Thieu Hoa, Dong Son, Tinh Gia, Nga Son, Ha Trung and Trieu Son Districts.	Twice times per year	Surveying, measuring and collecting samples in targeted sites stipulated in the Decision No. 44/QD-STNMT on environmental monitoring plan and to be analyzed at the laboratory of Hanoi industrially chemical institute.	Specialized equipment	9 main parameters are analyzed in line with QCVN 03/15:2008/BTNMT to identify soil contamination in the province.
6	Nghe An	NA1(Chau Kim), NA2 (Chau Binh), NA3 (Chieu Luu),	Twice per year	Samples are collected and analyzed at Laboratory of	Specialized	8 main parameters are analyzed in line with

	NAD01 (Nam Dan) and NAD02 (Hung Nguyen)		Nghe An Center for Monitoring and Technical Environment.	equipment	QCVN 03/15:2008/BTNMT to identify soil contamination in the province.
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Source: DONRE, compiled by JICA Study Team

Table 2.2.8 Typical Result of Soil Quality at Each province

No	Prov/City	pHKCL	Humid (%)	Lindan (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Zn (mg/kg)	As (mg/kg)	Source/year
	QCVN 03/15:2008/BTNMT	-	-	-	50	70	2	200	12	
1	Hanoi	N/A	N/A	N/A	45-114.8	26.0-64.1	0.5-1.5	83.5-176.2	0.4-28.2	5ECSR/2006-2010
2	Ha Nam	4.6-7.41	N/A	N/A	N/A	N/A	N/A	N/A	0.0007-8.0	5ECSR/2005-2009
3	Nam Dinh	5.86-8.0	32.5-41	0.003-0.005	48	15	N/A	50	N/A	SR/2010, 5ECSR/0509
4	Ninh Binh	6.71-7.61	-	-	16.13-51.75	13.83-63.12	0.13-1.21	12.6-21.6	5.31-12.36	5ECSR/2006-2010
5	Thanh Hoa	4.8-7.03	-	-	3.0-4.6	0.6-13.5	0.1-0.4	2.0-8.0	0.23-0.51	5ECSR/2006-2010
6	Nghe An	7.7-8.6	-	0.02	N/A	N/A	N/A	N/A	N/A	5ECSR/2005-2009

Note: "N/A": No information available in the reference document, "-"not specified, "5ECSR": Five-Year Environmental Current Status

Report, "SR": Summary Report

Source: DONRE, compiled by JICA Study Team

2.2.5 Noise

2.542 Noise monitoring system at each province is shown in Tables 2.2.9 and 2.2.10.

Table 2.2.9 Noise Monitoring System at Each Province

No.	Prov/City	Location	Frequency	Method	Equipment	Description
1	Hanoi	Industrial zones/clusters, high frequency transportation, crossroads, Densely residential areas.	Twice per year	Noise is surveyed, measured and collected at target sites, then analyzed at laboratory of Au Viet Environmental Technology Company	Specialized equipments	Monitored together with air monitoring in line with QCVN No. 26: 2010/ BTNMT to identify the noise permitted level.
2	Ha Nam	Vulnerable locations: industrial zones, crossroads, densely residential areas in Districts Phu Ly, Duy Tien, Thanh Liem, Binh Luc	Four times per year	Samples are measured at target sites periodically, and then analyzed at Laboratory of the Environmental monitoring center under DONRE.	Specialized equipments	Measured together with air monitoring associated with QCVN No. 26: 2010/ BTNMT to identify the permitted level.
3	Nam Dinh	Industrial zones/clusters, roads, crossroads, densely residential areas.	Twice per year	Noise is measured periodically and analyzed at the laboratory of the DONRE.	Specialized equipments (Noise measuring machine LA 125)	Measured together with air monitoring associated with QCVN No. 26: 2010/ BTNMT to identify the permitted level.
4	Ninh Binh	Road No.10, T-junction to Ninh Phuc port, T-junction at Vung Tram area, Cau Lim crossroad, residential area in Nam Son commune, T-junction at Chieu market.	Four times per year	Noise is measured at the target sites and analyzed at the laboratory.	Specialized equipment	Measured together with air monitoring associated with QCVN No. 26: 2010/ BTNMT to identify the permitted level.
5	Thanh Hoa	Vulnerable locations: traffic sites, densely residential areas, industrial zones/ clusters.	Four times per year	Surveying, measuring and collecting noise to be analyzed at Thanh Hoa Health prevention center and mining and geology agency, respectively	Specialized equipments	Monitored together with air monitoring associated with QCVN No. 26: 2010/ BTNMT to identify the permitted level.
6	Nghe An	18 locations in which	Four times per	Measuring the noise at the	Specialized	Monitored together

No.	Prov/City	Location	Frequency	Method	Equipment	Description
		Hoang Mai cement company, industrial zones/clusters (Dien Hong, Dien Chau, Nam Cam), Vinh City areas are typical polluters.	year	target sites and to be analyzed at the Laboratory at Nghe An Environmental monitoring center under Nghe An DONRE.	equipments	with air monitoring associated with QCVN No. 26: 2010/ BTNMT to identify the permitted level.

Source: DONRE, compiled by JICA Study Team

Table 2.2.10 Typical Result of Noise Monitoring

No.	Province/City	dB(A)	Source/year
	QCVN No. 26: 2010/ BTNMT (QCVN 5949-1998)	60-75	
1	Hanoi	62-92	ECSR/2008
2	Ha Nam	56-90	5ECSR/2005-2009
3	Nam Dinh	53-84	ECSR/2009
4	Ninh Binh	51-79	SR/2011
5	Thanh Hoa	75-93	SR/2010
6	Nghe An	Below 75	ECSR/2009

Note: "ECSR" Environmental Current Status Report, "5ECSR": Five-Environmental Current Status Report, "SR": Summary report

Source: DONRE, compiled by JICA Study Team

2.543 The figures in the Table 2.2.10 show that most of all parameters exceed the standard (QCVN) of 26:2010/BTNMT at 51-93 dB(A). This high level of noise is originated mostly from transportation means such as trucks, cars, and motorbikes concentrated in residential areas and at the heavy traffic of cities of the provinces/cities.

1) Noise in Hanoi City

(1) Noise in Industrial Zones/Clusters

2.544 According to results of measurement, monitoring in industrial zones, clusters, positions, which have already been put into operation and step by step stabilized like: An Khanh industrial zone (Hoai Duc), Thach Hoa, Phu Cat (Quoc Oai), Binh Da (Thanh Oai) of Ha Tay; and old Hanoi, it can be concluded that noise level in most of these industrial zones and clusters is lower than permitted level regulated for production area based on TCVN 3958-1999 (noise level lower than 85dB(A)) and TCVN 5949-1998.

2.545 However, in Phung Xa industrial zone (Thach That), the production of some enterprises and company at some time caused noise level higher than permitted level. The average noise level in these production bases at many times was higher than permitted level (higher than 85 dB(A)). This is due to the fact that, in this industrial position, there are many companies and enterprises specialized in producing and manufacturing mechanical products. This is the kind of production easy to cause loud noise.

(2) Noise in Transportation Activities

2.546 Binh Da and Te Tieu are two air monitoring localities to examine air environment along Road 21B. With traffic volume lower than other axis, surrounding air along 2 road sides is just lightly polluted in terms of toxic gas; basic indicators are lower than permitted level. However, just like other axis, noise level and dust contents

also exceed permitted level with highest dust contents of 0.37 mg/m^3 and noise level of 90 dB(A).

2.547 Along Road 1: monitoring activities shall be implemented in 2 locations namely Thuong Tin and Cau Gie. The results show that most of indicators are lower than permitted level; however, due to means of transport travelling, noise level is relatively high, at some time up to 91 dB(A). According to results, air environment at Hoa Lac T-junction has higher noise level and dust contents than An Khanh T-junction and permitted level, up to 92 dB(A). The main reason is due to the fact that this is the T-junction adjacent to express way and national highway 21, as a result, there are many heavy means of transport travelling through in condition of the road being expanded.

2.548 There are 27 out of 34 locations having noise level exceeding permitted level. There are 2 intersections: Long Binh bus stop, foot of Pham Van Dong overpass and Ngo Gia Tu-Duc Giang intersections having noise level, which is 1.18 times as much as permitted level. The main reason is high traffic volume in all day.

(3) Noise in concentrated residential areas

2.549 Noise level (Laeq) in all urban areas satisfies QCVN 5949-1998: 75 dB(A), ranging from 61.5 to 67.4 dB(A).

2) Noise in Ha Nam Province

2.550 According to TCVN 5949-1998, the noise in residential zones is ≤ 60 dB(A), the noise in the mixed area of residential and production is ≤ 75 dB(A).

2.551 The noise monitored at Phu Ly City, district-towns, rural areas are 1.03 to 1.71 times higher than the permitted standard (TCVN 5949-1998). In recent years, the noise rate of these areas has increased and be higher than the permitted standards (the regulated rate for residential zone: 60 dB(A)). The main origin of the noise is from the transport means.

2.552 In the industrial zones, besides the noise caused by the material transportation means, the operation of factories also takes part in the noise pollution. Hence, the noise rate of these areas has been 1.03 to 1.31 times higher than the limit of TCVN 5949-1998. For example, the noise monitored in Dong Van was 98 dB(A) (2008), 90 dB(A) (2009).

3) Noise in Nam Dinh Province

2.553 Noise: Monitoring value varied from 53 dB(A) to 84 dB(A). Noise level gradually increased in 2009 from 70 dB(A) in 2007. The highest noise level was recorded at the end of the year, reaching 84 dB(A) in December 2008.

- (a) **For Traffic Roads in the City:** noise level from traffic activities in main lines is approximately equal to or exceeds permitted level for residential areas (TCVN 5949-1998). During rush hours, at some main traffic lines, noise level can reach max value at 83.5 dB(A). Noise level varied from 63 to 78 dB(A) and often exceeded 75 dB(A) (residential areas located in trade, services and production areas).
- (b) **Noise Level in Industrial Areas and Clusters:** noise level in these areas is approximately equal to or exceeds permitted level (QCVN 5949-1998) (applied to residential areas located in areas of trade, services and production). Based on

comparison between Hoa Xa industrial area and industrial clusters, noise level in industrial clusters is lower, however, its effect is higher due to the fact that the location of industrial clusters are nearer residential areas. In Hoa Xa industrial zone, workers have to suffer from noise directly arising from machines combined by noise from transport modes.

4) Noise in Ninh Binh Province

2.554 Similar to other provinces, noise source is originated mostly from transportation means; individual (motorbikes, cars) as well as public (buses, minibuses) etc. Due to the bad habits from the users, horn is used freely here in Vietnam, especially in big cities such as Hanoi, HCM, Hai Phong etc. The noise level is around 51-79 dB(A), lower than Hanoi City and Ha Nam Province, however, higher than the standard (QCVN No. 26: 2010/ BTNMT): 75 dB(A). Following tables shown the record in different target places within the province from 2006 to 2011.

Table 2.2.11 Noise Level at Lim Bridge Crossroad- Ninh Binh City (from 06h-22h)

No.	Parameter	Unit	Result			QCVN No. 26: 2010/ BTNMT
			7/2006	2008	4/2011	
1	Noise level	dB(A)	68-82	65-80	72	75

Source: Ninh Binh DONRE/2011

Table 2.2.12 Noise Level at T-junction of Chieu Market- Tam Diep Town (from 06h-22h)

No.	Parameter	Unit	Result				QCVN No. 26: 2010/ BTNMT
			7/2006	2007	2008	4/2011	
1	Noise level	dB(A)	62-70	46-49	52-58	79	75

Source: Ninh Binh DONRE/2011

Table 2.2.13 Noise Level at Towns (6h – 22h)

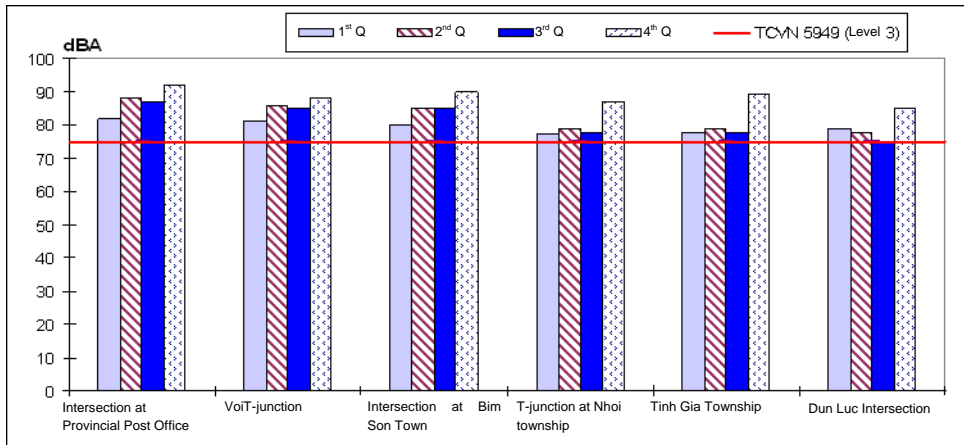
Place	Parameter	Unit	Results				QCVN No. 26: 2010/ BTNMT
			7/2006	2007	2008	4/2011	
Thien Ton town	Noise	dB(A)	60-69	62-67	60-66	-	75
Yen Ninh town			58-70	65-71	64-70	72	
Yen Thinh town			51-59	65-73	61-67	74	

Source: Ninh Binh DONRE/2011

5) Noise in Thanh Hoa Province

2.555 Noise pollution variously changes in different times and places, these changes mostly depend on transportation vehicles at a specific time. Motorbikes and cars traffic on roads is increasing therefore noise also tends to increase.

2.556 Noise at some key intersections in 2010 was relatively high, and mostly higher than the permitted noise level regarding commercial service areas, according to TCVN 5949-1998 (level 3). Some key intersections with high noise level are: Provincial Post office cross, Voi cross, Bim Son town cross, Tinh Gia town, which are indicated in the following graph:

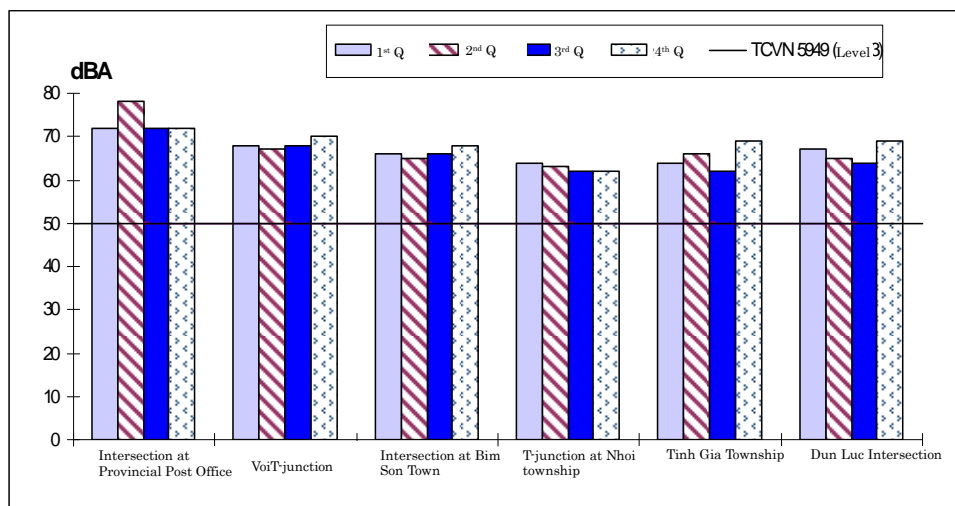


Note: Q means quarter of the year.
 Source: Thanh Hoa DONRE/2010

Figure 2.2.1 Noise Level (Lmax) in 2010 at Some Key Intersections at 6-8h

2.557 In the end of the year (4th quarter) vehicle traffic on roads highly increased, noise level at all places reached its highest level compared to other periods of the year. At the Provincial Post Office cross (6-8h), motorbikes traffic oscillated from 3,642–4,260 motorbikes/h, and cars traffic fluctuated between 1220–1620 cars/h.

2.558 At night, traffic of transportation means partly reduced, however noise level was still higher than the permitted noise level regarding the commercial service areas, according to TCVN 5949-1998 (50 dB(A)). At the Provincial Post office cross at 22-24h, motorbikes traffic fluctuated from 986-1250 motorbikes/h, and cars traffic wavered from 540 to 1,230 cars/h.

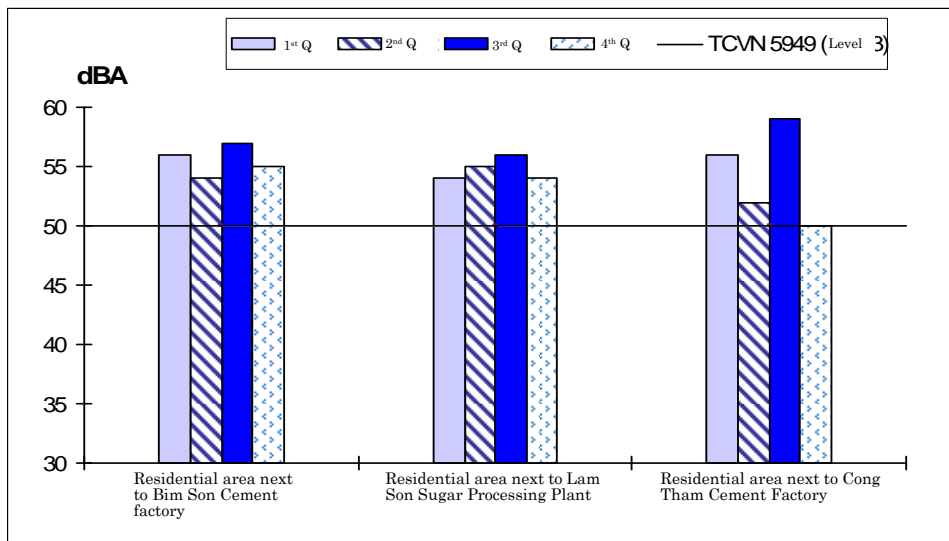


Note: Q means quarter of the year.
 Source: Thanh Hoa DONRE/2010

Figure 2.2.2 Noise Level (Lmax) in 2010 at Some Key Intersections at 22-24h

2.559 Noise from the residential area near Industrial zone: was relatively high at night. All the results from monitoring points outnumbered the limitation, according to

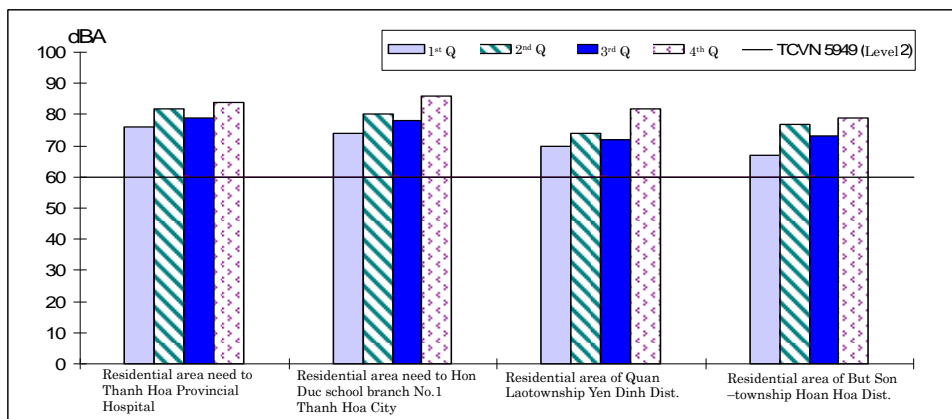
TCVN 5949-1998 (level 3 eq 50 dB(A)). The main reason caused the high level of noise from residence near the industrial zones was that industrial activities continued at night and so did many other following services.



Note: Q means quarter of the year.
 Source: Thanh Hoa DONRE/2010

Figure 2.2.3 Noise Level (Lmax) in 2010 at Residential Area Near Industrial Zone at 22-24h

2.560 Level of noise pollution at residence focusing on the period from 6-8h all outnumbered the permitted level according to TCVN 5949-1998 (level 2).



Note: Q means quarter of the year.
 Source: Thanh Hoa DONRE/2010

Figure 2.2.4 Noise Level (Lmax) in 2010 at Residential Concentration on 6-8h

2.561 The results from four-time monitoring in 2010 illustrates that the noise level in residence was comparatively high; among those, the residence near Provincial Polyclinic hospital, and near Hong Duc I secondary school were the most polluted areas because of highly-populated concentration there, also many commercial service activities, and the high rate of transportation means.

6) Noise in Nghe An Province

2.562 Air environment of Nghe An Province has not been contaminated by noise yet. At all points of observation have shown that the average intensity of noise drops

below the standard However, in all these areas, it appears large oscillation causing tense noise intensity that exceeds the permitted standards. The cause is mainly engaged in traffic activities so that such pollution occurs locally at a certain time.

2.2.6 Vibration

2.563 In spite of fact that the vibration is stipulated in the regulation No. 27: 2010/BTNMT, most of tentative provinces/cities have not conducted monitoring activities for vibration yet. As a result, the relevant data are unavailable in the reference documents (Five year environmental current status report).

2.2.7 Solid Waste

2.564 Waste problem has been recognized as the alarming level in the country in general and the target provinces in particular. Thousands of tones of waste are generated daily in the country, while proper waste management has been delayed for years, especially just few sanitary landfills have been constructed in city/provinces due to various difficulties in investment capital or human capacity. Particularly, of the 94 landfill across the country, there are only 17 sanitary landfills (As surveyed by WB). The remaining landfills are still open or unsanitary ones leading to pollution of surrounding areas and health problem.

Table 2.2.14 Final Disposal Sites at Each Province

No	Prov./City	Location	Capacity	Life	Type	Status
1	Hanoi	Nam Son waste treatment complex	83.5 ha	30 years	Sanitary disposal site	To be closed by Dec.2011
		Kieu Ky landfill	14 ha	10 years	N/A	2014
		Nui Thong landfill	N/A	N/A	N/A	N/A
		Xuan Son landfill	30.000 m ²	Since 2004	Open disposal site	Operating
		Lam Du landfill	13.8 ha	N/A	Construction surplus	Closed
2	Ha Nam	Thanh Liem central waste treatment	18 ha	N/A	Sanitary	Operating
3	Nam Dinh	Man-Loc Hoa landfill	20 ha	N/A	Sanitary	Operating
4	Ninh Binh	Thung Quen Kho landfill	6,5 ha	N/A	N/A	Operating
		Thung Chau landfill	5 ha	N/A	N/A	Operating
		Bo Dinh landfill	0.5 ha	N/A	N/A	Operating
5	Thanh Hoa	Phu Son landfill	4.2 ha	N/A	Open	Overloaded
		Truong Son landfill	2.77 ha	N/A	Open	Overloaded
		Dong Son landfill	3.8 ha	N/A	Open	Overloaded
		Nga Van landfill	1.5 ha	N/A	Open	Operating
		Sao Vang landfill	10 ha	N/A	Open	Operating
		Minh Tho landfill	5.6 ha	N/A	Open	Operating
6	Nghe An	Nghi Yen landfill	50 ha	35 years	Open	Operating
		Ngoc Son landfill	7.2 ha	30 years	Open	Operating

Note: "N/A": No information available

Source: DONRE, compiled by JICA Study Team

2.3 Social Environment

2.3.1 Land Use and Demography

2.565 Only land-use information has been found mostly in the five-year environmental status reports of four target provinces of north section including Hanoi City, Nam Dinh, Thanh Hoa and Nghe An provinces, while these kinds of reports have not been provided by Ha Nam and Ninh Binh provinces. In general, land-use is divided into agricultural land, non-agricultural land and unused land. However, due to industrialization process land-use of each type is utilized differently, especially in the emerging city/provinces; there has been significant decline in area of agricultural land, meantime, area of non-agricultural land has been on the rise dramatically. Below is for further detail.

Table 2.3.1 Land-Use and Demography at Each Province

No	Province/City	Available documents	Description
1	Ha Noi	2008 Environmental Current Status Report of Hanoi City, chapter 3, Heading IV Soil environment and agricultural environment Article IV, pp. 259-285.	Hanoi land including both urban areas and 5 suburban districts (exclusive of lakes, rivers, residential land) covers an area of 68,795.5 ha (74.7% of natural land). This area is divided into 5 categories including 19 land units.
2	Ha Nam	N/A	N/A
3	Nam Dinh	5ECSR period 2005-2009, chapter 1, Heading 1.1 Natural condition and 1.3 land use current status, pp.8-11.	The land area of Nam Dinh Province in 2009 was 165,299 ha, allocated over Nam Dinh city, 16,529ha/district on average. Nghia Hung district has the largest area (25,444 ha) accounting for 15.4% of the province.
4	Ninh Binh	N/A	N/A
5	Thanh Hoa	5ECSR 2006- 2010 period, Chapter 1, heading 1.3 land use status, pp. 8-14.	According to land statistics of 2009, the total natural area of the province is 1,113,341.71ha in which Agricultural land: 824,122.18 ha, making up 74.0%; Non-agricultural land: 157,731.14 ha, accounting for 14%; Unused land: 131,488.39 ha, standing at 12%.
6	Nghe An	5ECSR, chapter 1, Chapter 1, heading 1.3: land use status, pp. 9- 11.	Nghe An Province has a total natural area of 1,649,068.227 ha. The province is located at the northern-east of Truong Son range and on North – South traffic line (of railway, road, airway and marine-way).

Note: N/A Not available in the reference documents

Source: DONRE, compiled by JICA Study Team

2.566 There are more than 22 million households in whole country with average 3.89 person per household (3.8 in urban area and 3.92 in rural area) though household size is decreasing (it was 4.44 persons in 2002, 4.36 persons in 2004, 4.24 persons in 2006 and 4.12 in 2008).

2.567 Average household size in almost provinces in the project area is higher than the country average size accounting for 4.0 to 4.5, except 3 provinces such as Ha Nam, Nam Dinh and Ninh Binh provinces.

2.568 The detail of demography of city/provinces in Table 2.3.2.

Table 2.3.2 Demographic Information at Each Province

No.	Province	District	Population (person)			Natural increase rate (%)	Total HH	Average HH size
			Total	Urban	Rural			
Whole Country			87,840,000	27,888,200	59,951,800	9.7		3.89
Red River Delta			19,999,300	6,179,000	13,820,300	9.2		3.65
North Central and Central Coastal Areas			19,046,500	4,999,600	14,046,900	9.1		3.94
1	Hanoi	Total	5,948,026	2,893,500	3,806,100	13.5	1,612,784	3.9
		Thuong Tin	219,248	6,800	212,448	13.3	56,881	-
		Phu Xuyen	182,008	14,800	167,208	10.9	53,687	-
		Ung Hoa	182,008	13,000	169,008	10.3	50,873	-
2	Ha Nam	Total	1,486,204	82,400	704,500	7.0	445,966	3.6
		Duy Tien	125,983	9,825	116,158	8.5	39,331	-
		Thanh Lien	128,111	9,332	118,779	9.3	38,709	-
		Binh Luc	145,718	5,250	140,468	8.4	43,036	-
3	Nam Dinh	Total	1,828,111	329,500	1,504,000	7.4	555,605	3.4
		Nam Dinh city	243,186	198,437	44,749	5.6	78,864	-
		My Loc	69,143	4,792	64,351	12.0	20,357	-
		Vu Ban	129,669	6,619	123,050	10.0	38,120	-
		Y Yen	227,160	9,945	217,215	15.0	66,019	-
4	Ninh Binh	Total	898,999	181,900	725,000	4.7	257,088	3.5
		Ninh Binh City	110,541	93,030	17,511	-	33,484	-
		Tam Diep town	55,021	34,783	20,238	-	17,006	-
		Hoa Lu	66,187	3,076	63,111	-	20,139	-
		Yen Khanh	133,420	12,601	120,819	-	37,878	-
		Yen Mo	110,304	3,436	106,868	-	32,337	-
5	Thanh Hoa	Total	2,912,588	380,500	3,032,100	11.3	759,478	4.0
		Bim Son Town	53,442	46,800	6,642	11.1	16,160	-
		Ha Trung	108,049	5,850	102,199	6.8	30,945	-
		Hoang Hoa	246,626	9,620	237,006	8.0	62,797	-
		Hau Loc	165,742	3,480	162,262	6.7	42,216	-
		Nong Cong	182,898	3,590	179,308	6.5	45,871	-
		Dong Son	102,783	8,850	93,933	6.5	28,666	-
		Quang Xuong	256,931	2,820	254,111	12.1	68,524	-
		Tinh Gai	214,665	4,620	210,045	10.7	56,400	-
		Thieu Hoa	176,747	7,600	169,400	10.6	46,794	-
		Thanh Hoa city	210,551	150,300	60,500	11.2	63,846	-
6	Nghe An	Total	2,306,050	392,200	2,550,700	11.6	607,296	3.9
		Vinh City	303,714	216,325	87,389	0.9	94,309	-
		Quynh Luu	346,030	14,818	331,212	1.3	84,263	-
		Dien Chau	266,447	5,392	261,055	1.2	68,693	-
		Nghi Loc	184,148	4,780	179,368	1.3	46,356	-
		Hung Nguyen	110,451	7,876	102,575	0.9	27,988	-

Source: JICA Study Team based on Statistical Handbook of Vietnam, 2011, Statistical Year Book Provinces and District, 2011, Viet Nam Household Living Standards Survey, 2010 and some data provided by Statistics office at District level, 2011

1) Land-Use Status in Hanoi City

(1) Existing Land Use Situation

2.569 According to the data provided by unofficial source (Hanoi DONRE, Hanoi CPC):

2.570 Land use principles for the forthcoming period are: economical, reasonable, efficient use, coupled with environmental protection to ensure sustainable and stable development.

2.571 Arrange a reasonable share of land among different sectors like: agriculture, forestry, industry, tourism, culture, health, education, sports; between different areas: urban areas, rural areas; among different types of infrastructure: transport, irrigation, electricity, telecommunications, etc. and national defense.

2.572 Ensure the suitability for socio-economic conditions, science and technology, present and future conditions; closely integrate local development into national development in order to bring about the optimal result.

- Old Hanoi:
 - Small, crowded. Most of the population is living in the metropolitan areas.
 - Land for agricultural production: is gradually decreasing, farmers tend to move to urban areas and industrial zones to look for jobs.
- New Hanoi:
 - Land area is extended; infrastructure fails to satisfy development.
 - Percentage of urban areas is small compared with total natural land area.

(a) Agricultural Land

2.573 After expansion, agricultural land in new Hanoi covers an area of more than 192,000 ha (accounting for about 57.4% of total natural land), of which land for agricultural production is more than 160,000 ha wide.

2.574 Forest and forestry land cover an area of 25,123.7 ha, making up 7.5% of total natural land, of which land having forests is 20,028.3 ha wide, constituting 79.7% of forestry land, including: natural land: 5,436.3 ha (27.1%); planted forest and fruit trees: 14,592 ha (72.9%); land without forests: 5,095.4 ha (20.3% of forestry land).

2.575 Agricultural land of Hanoi City is rich and fertile; mainly concentrated in riparian areas and flooded areas.

2.576 Rice productivity of many districts in old Ha Tay such as: Chuong My, Thanh Oai, Phu Xuyen, Phuc Tho in 2008 reaches 60 ton per ha.

2.577 Total natural land of Hanoi is 92,097.45 ha, of which agricultural land covers an area of 43,612.43 ha (47.4% of total natural land area). At present, suburban land makes up 91% of total natural land while urban land only 9%.

Table 2.3.3 Land Structure Based on Main Use Purposes

No	Land Types	Area (ha)	Compared with Total Natural Land (%)
	Total Natural Land	92,097.45	100.0
1	Agricultural Land	43,612.43	47.4
2	Forestry Land	6,127.60	6.6
3	Specialized Land	20,534.39	22.3
4	Housing Land	11,688.65	12.7
5	Unused Land, River, Spring, Rock Mountain	10,134.39	11.0

Source: Hanoi DONRE/2008

2.578 Out of total natural land, lakes and rivers account for 6.0%, rock mountains account for 0.1%, etc. There have been many changes in land use in Hanoi due to the implementation of many big projects, typically: Soc Son export processing zone, industrial zones of small and medium scale in Thanh Tri, Northern Thang Long in Dong Anh, new urban areas in Linh Dam, Dinh Cong – Thanh Tri, other works supporting environment, irrigation, road projects such as: Lang – Hoa Lac, Nguyen Chi Thanh, Hoang Quoc Viet, etc.

2.579 Current use of agricultural land and housing land is in Table 2.3.4.

Table 2.3.4 Structure of Agricultural Land and Housing Land

No	Land Types	Area (ha)	Compared with Total Area of Agricultural Land and Housing Land (%)
	Total Area of Agricultural Land	43,612.43	100.0
1	Land for growing annual trees (rice + second crops + annual industrial trees)	39,065.87	89.6
2	Land for mixed garden	510.89	1.2
3	Land for growing perennial trees	764.16	1.8
4	Land for growing grass for farming	101.23	0.2
5	Land having water for aquaculture	317	7.2
	Total Area of Housing Land	11,688.65	100.0
1	Rural land	8,816.77	75.43
2	Urban land	2,871.88	24.57

Source: Hanoi DONRE/2008

2.580 Structure of forestry land having forests is in Table 2.3.5.

Table 2.3.5 Structure of Forestry Land in Soc Son District

No	Types	Area (ha)
	Total Land Having Forests	6,127.6
1	Production Forest Land	1,703.95
2	Protection Forest Land	2,936.64
3	Special use forest Land	1,404.41

Source: Hanoi DONRE/2008

2.581 According to inventory report, forestry land covers an area of 6,127.6 ha (6.6% of total natural land) and is mainly concentrated in Soc Son district with planted forest making up 99.7% forestry land.

2.582 Specialized land accounts for 22.3% of total natural land, equivalent to 20,534.39 ha, of which some main types are as follows:

(i) Construction land: 5,559.03 ha (27.1%)

- (ii) Traffic land: 5,618.82 ha (27.4%)
- (iii) National security and defense land: 2,060.88 ha (10.0%)
- (iv) Cemetery land: 752.41 ha (3.7%)
- (v) Cultural and historic heritage land: 262.22 ha (1.3%)

2.583 Unused land, rivers, springs and rock mountains: This type of land accounts for 11% of total natural land, equivalent to 10,134.39 ha. Structure of this land type is presented in Table 2.3.6.

Table 2.3.6 Structure of Unused land, Rivers, Springs, Rock Mountains

No	Land Types	Area (ha)	Compared with Unused Land (%)
	Total	10,134.39	100
1	Flat Land	1,700.76	10.4
2	Mountainous Land	938.59	16.8
3	Water Surface	5,913.73	9.3
4	River, Spring	63.61	58.4
5	Rock Mountain without Trees	467.04	0.6
6	Unused Land	1,050.66	4.6

Source: Hanoi DONRE/2008

2.584 Hanoi land including both urban areas and 5 suburban districts (exclusive of lakes, rivers, residential land) covers an area of 68,795.5 ha (74.7% of natural land). This area is divided into 5 categories including 19 land units.

Table 2.3.7 Hanoi Land Categories

No	Land Categories	Land Classification Units	Area	Percentage
1	Sandy soil (sand mound and sand bank)	1	359.0	0.5
2	Alluvial soil	13	42,328.4	61.5
3	Exhausted grey soil	2	17,663.0	25.7
4	Red yellow soil	2	8,386.8	12.2
5	Valley soil	1	58.3	0.1
	Sum	19	68,795.5	100.0

Source: Hanoi DONRE/2008

2.585 Alluvial soil has all micro-quantity substances such as: Cu, Bo, Mo, which satisfies requirements for growing plants (except for some areas in Thanh Tri district, which lack Mo). Exhausted grey soils are lacking in Bo and Mo. Yellow and red soil on clay shale is seriously lacking in Bo.

2.586 Hanoi soil is facing with heavy metal contamination, however, contents of heavy metal in agricultural land is still low compared with permitted level. As for some areas of Thanh Tri district, contents of Cd (cadmium) in soil is approximately equal to allowed level.

2.587 Based on land use demand of Hanoi City, there 2 land categories, which play the most important part in the capital's socio-economic development, namely agricultural, forestry land and construction land. Through actual use and according to some index of physical components, mechanical and chemical components, agricultural land is classified into 3 types: good soil, average soil, bad soil. Construction land is divided into 3 levels: convenient, less convenient, and inconvenient.

2.588 Assessing Hanoi land fund based on demands for agriculture and construction, Hanoi area is divided into 9 groups:

- (i) Land good for construction and agricultural – forestry development: in the Southern Dong Anh district, forming small regions, concentrated in the western Tu Liem district.
 - (ii) Land good for construction and average for agricultural and forestry development: distributed in narrow strips in Soc Son district, Tu Liem district and a small area in the south-western Dong Anh district.
 - (iii) Land convenient for construction and bad for agricultural and forestry development: distributed in 3 districts namely Soc Son, Dong Anh, Tu Liem, accounting for 2/5 area of all city. This is the city, which has high potential for construction development.
 - (iv) Land, which is not so convenient for construction but convenient for agricultural and forestry development: concentrated in 4 districts namely Gia Lam district, Thanh Tri district, Dong Anh district, Tu Liem district. At present, this is a large area specialized in rice and second crop cultivation.
 - (v) Land, which is not so convenient for construction, and average for agricultural and forestry development: small area, mainly concentrated in 2 districts namely Thanh Tri and Tu Liem.
 - (vi) Land, which is not so convenient for construction, bad for forestry and agricultural development,: covers a small area in the northeastern Gia Lam district and part of Tu Liem district, which is contiguous to urban areas.
 - (vii) Land not convenient for construction and good for forestry and agricultural development: distributed in 2 districts: Gia Lam and Thanh Tri. In addition, there is a small area in Tu Liem and Dong Anh district.
 - (viii) Land not convenient for construction, bad for forestry and agricultural development: concentrated in Soc Son district, Hanoi urban areas and a small part of Dong Anh and Thanh Tri district.
 - (ix) In Hanoi metropolitan area, a majority of land is considered to be not suitable for construction due to phenomena of ground water, water surface subsidence, land slide, crack, weak ground structure, etc... Some areas in the metropolitan area are low-lying and flooded on account of marsh.
 - (x) Non-agricultural land: 75,674.98 ha (34.5% of natural land)
 - (xi) Unused land: 7,168.28 ha (3.3% of natural land).
- (b) Non-Agricultural Land

2.589 Total area: 75,674.98 ha (34.5% natural land), of which:

- (i) Housing land: 16,910.03 ha (22.3% of non-agricultural land); including 15,679.7 ha in rural area and 1,230.33 ha in urban area.
- (ii) Specialized land: 38,298.65 ha (50.6% of non-agricultural land); including:
 - Office and professional works land: 727.27 ha
 - National security and defense land: 6,434.13 ha
 - Land for non-agricultural production and trade: 4,391.63 ha (inclusive of industrial zone: 2,242.83 ha; land for trade and production bases:

1,170.51 ha; land for mineral exploitation; land for construction materials production and pottery)

- Land used for public purposes: 26,745.62 ha

(iii) Land for religious purposes: 581.67 ha (0.8% of non-agricultural land).

(iv) Cemetery land: 1,928.62 ha (2.5% of non-agricultural land).

(v) River, spring and specialized water surface land: 17,743.83 ha (23.4% of non-agricultural land).

(vi) Other non-agricultural land: 212.18 ha (0.3% of non-agricultural land).

(c) Unused Land

2.590 Total area: 7,168.28 ha (3.3% of natural land), of which:

(i) Unused flat land: 3,233.5 ha

(ii) Unused mountainous land: 1,248.93 ha

(iii) Rock mountain land without forest: 2,685.85 ha

2.591 Land structure according to land users:

2.592 Out of 219,629.73 ha natural land of the whole province, based on land users, natural land is divided into different types as follows:

2.593 Land user: 177,080.13 ha, 80.6% of total natural area:

(i) Household, individual: 123,740.52 ha, 56.3%

(ii) Domestic organization: 52,893.84 ha, 24.1%, where:

(iii) People's committee of communal level: 18,570.47 ha, 8.5%

(iv) Economic organization: 11,729.65 ha, 5.3%

(v) Other organizations: 22,539.72 ha, 10.3%

(vi) Foreign organization, foreign individuals: 189.32 ha, 0.09%, where:

(vii) Joint-venture: 129.7 ha, 0.06%

(viii) 100% foreign invested companies: 59.62 ha, 0.03%

(ix) Investors, who are Vietnamese living overseas: 4.42 ha, 0.002%

(x) Community: 306.03 ha, 0.14%

(xi) People who are allocated with land for management: 42,549.61, 19.4%

(xii) Managed by community: 22.45 ha, 0.01%

(xiii) Managed by People's committee of communal level: 37,600.86 ha, 17.1%

(xiv) Managed by other organizations: 4,926.3 ha, 2.2%

(2) Land Use Planning

(a) Development Orientation for Industries

2.594 Industry has been concentrated on and experienced a high growth rate. There has been a rapid change in quality and efficiency as well as competitiveness of industrial products. Percentage of industry has been rapidly increased in provincial GDP structure, facilitating deeper integration into Hanoi regional economy, national economy, regional economy and world economy.

2.595 Industry is projected to develop at average annual speed of 24-25%

(according to industrial production value) for the period 2006-2010 and for the period 2011-2015 at 18-19%, at 16-17% for the period 2016-2020. Orientations for the development and distribution of industrial production, industrial zones, industrial clusters, industrial locations, as well as traditional villages:

2.596 Develop provincial industrial zones and clusters and integrate it into the system of industrial zones in the Northern Focal Economic Region and Hanoi economy in order to promote comparative advantages of the whole region. Complete infrastructure system lying outside the fence of industrial zones and clusters, which should be accompanied by environmental protection.

2.597 Until 2010, concentrate on constructing infrastructure and attracting investment in industrial zones, clusters and locations, traditional villages in the province according to decision 225/2005/QĐ-UB dated March, 2005 by the city people's committee regarding the approval for the list of industrial locations, clusters, traditional villages with total area of 6,500 ha, including 9 industrial zones (where there is one high tech industrial zone) with total area of 4,450 ha and 23 industrial clusters with total area of 823 ha and 176 traditional villages with total area of 1,200.8 ha. After the year 2010, study on the formulation of some industrial clusters with important traffic arteries and new urban areas.

2.598 Orientations for the development of rural industries: (1) Restore traditional villages, based on which, step by step develop industry of medium and small scale in rural areas in the direction of advanced industry; formulate many industrial locations in towns, townships with large inter-communal scale and communes used as satellite for big enterprises. (2) Encourage and subsidize the development of handicrafts in order to improve skills and increase income, create jobs for rural people. Strive to 2010, 100% villages in the province have jobs, of which 400 villages satisfy requirement to become industrial – handicraft village of the province. (3) Maintain the development of traditional villages and develop new jobs, use local labors and materials, meeting the local demands in the region, province as well as export demands, which will help create jobs and increase income for workers and eradicate hunger, decrease poverty. (4) Invest in new technology, improve skills in order to continuously increase quality of products, decrease prices of products, creating attractive forms, and raising competitiveness in the market. (5) Develop traditional villages, accompanied by environmental protection; arrange for factories which cause pollution for rural and mountainous area: in communes where there are no markets, markets shall be newly constructed. In communes where there are two markets, it is necessary to maintain and upgrade them to cater for the demand for goods transportation.

2.599 In the province, there are 235 markets. It is projected that until 2020 there shall be 330 markets. In the period 2006-2010, markets in the province shall be upgraded and improved in the direction of solidification so that there are no temporary markets basically.

2.600 Development orientations for center for goods transaction: It is projected that until 2020, in Ha Tay (old), there shall be one goods transaction center of medium scale with area of 5,000 to 10,000 m², which shall serve goods transaction for about 20 partners in each transaction.

2.601 Development orientations for the network of trade centers, supermarkets,

department stores: In each district, there are trade centers of small scale and clusters of trade and services with main functions of regional retail and services. These trade centers include department stores, or small supermarkets. Centers of this kind are located in such districts as: Phu Minh (Phu Xuyen), Thuong Tin, Dai Nghia (My Duc), Van Dinh (Ung Hoa), Kim Bai (Thanh Oai), Truc Son (Chuong My), Quoc Oai, Lien Quan (Thach That), Tram Coi (Hoai Duc), Phung (Dan Phuong), Phuc Tho, Tay Dang – Ba Vi. Centers in districts shall be formed in the period 2010-2020 and in the forthcoming years with scale of each center being from 5,000 to 10,000 m².

2.602 In addition to above mentioned supermarkets, in the center of townships, industrial zone^s in the province shall be established in the form of satellite supermarket, of which scale shall be more than 500 m² (equivalent to supermarket of type 3).

2.603 Department store: this is traditional type of business. Department stores shall be arranged widespread in all provinces.

(b) Development Orientation for Trade, Services

2.604 Urban center of national level: Hoa Lac urban center in 2020 (type I), population: 7,800 people, density: 100 m²/ person. Construction area is projected to be 7,500 ha. Where:

- **Industry:** industrial zones specializing in high technology with scale of 1,200 ha; high technology zone: 1,650 ha.

2.1 The system of universities, scientific research institute: Hanoi national university: 1,000 ha. This project is being developed.

- **Residential Area:** Dong Xuan residential area (large scale) for the staff working in industrial zone of high technology, Hanoi national university, Binh Yen residential area (medium scale) for the staff working in high technology zone, students in the dormitory of Hanoi national university; main labors of high technology zone shall live in the zone itself.

2.2 The system of public works of type I-urban includes Hoa Lac complex center of training-technology-industry-administration-trade and Dong Mo center for culture-tourism-entertainment.

2.3 The system of urban public works includes a center for civil administration like: Hanoi national university, Hoa Lac high technology zone, industrial zone of high tech.

2.4 The system of green parks and sports centers includes: Dong Xuan, Tan Xa, Than Lan, Phu Cat, Dong Mo and the forest and environmental strip in western Hanoi (Vien Nam Mountain, Ba Vi).

2.605 Urban area of provincial level (type II):

- **Son Tay Town:** central urban area of provincial level (in the north). Population scale until 2020 is projected to be 170,000 people. Natural land area is 11,346.85 ha; land for urban construction is 1,800 ha. On average, urban construction land is 120 m²/person.
- **Ha Dong District (Type II):** population decentralization urban area, adjacent

to the Day river eco-tourism area. Population scale to 2020 is projected to be 180,000 people. Natural land area is 3500 ha, land for urban construction land: 2,160 ha. On average, urban construction land is 150 m²/person.

2.606 Urban area of provincial level (type III) and the equivalent:

- **Xuan Mai Urban Area (Type III):** population scale to 2020 is projected to be 200,000 people. Natural land area is 1,065 ha and the expanded area is 3,000 ha, construction land area is 300 ha. On average, construction land is 150 m²/person.
- **Troi-Phung Urban Area (Type III):** is a new urban area (inclusive of Dan Phuong and Hoai Duc). This is a new urban area with large scale and is the population decentralization area of the city. Population scale up to 2020 is projected to be 200,000 people. Natural land area is 4,000 ha (urban area: 401.42 ha), construction land area: 3,000 ha. On average, construction land is 150 m²/person.
- **Thuong Tin Urban Area (Type III):** is a new urban area (including Thuong Tin Township), is urban area of large scale serving the purpose of population decentralization. Population scale until 2020 is projected to be 200,000 people. Natural land area is 4,000 ha (old urban area: 382.29 ha), urban construction area is 3,000ha. On average, construction land is 150 m²/person.
- **Phu Xuyen Urban Area (Type III):** new urban area (inclusive of Phu Xuyen Township); central urban area in the southern Ha Tay Province. Population scale until 2020 is projected to be 80,000 people. Natural land area is 3,000 ha (including 685.69 existing land), urban construction land: 1,200ha. On average, construction land is 150 m²/person.

2.607 Urban areas of district level (type IV) and the equivalent:

- **Chuc Son Urban Area:** urban area in Chuong My Township, services center in Chuc Son – Mieu Mon airports. This is urban area of eco and spirit tourism. Population scale to 2020 is projected to be 50,000 people. Natural land area is 1,500 ha, urban construction land: 750ha. On average, construction land is person.
- **Kim Bai Urban Area:** urban area in Thanh Oai Township, a center for industry-services-the Day river eco-tourism services. Population scale up to 2020 is projected to be 50,000 people. Natural land area is 1,000 ha (including 532 ha of existing urban area), urban construction land is 750ha. On average, construction land is 150 m²/person.
- **Quoc Oai Urban Area:** urban area in Quoc Oai Township, an urban area of eco and spirit tourism. Population scale up to 2020 is projected to be 60,000 people. Natural land area is 1,500ha; urban construction land is 900 ha. On average, construction land is 150 m²/person.
- **An Khanh Urban Area:** is a new urban area serving the purpose of population decentralization of the capital. This is a center for sports, services and the Day river eco-tourism. Population up to 2020 is projected to be 70,000 people. Natural land area is 2,000 ha, urban construction land is 1,050ha. On average, construction land is 150 m²/person.
- **Mieu Mon Urban Area:** is an urban area aimed at providing services to Mieu

Mon airports and airline industry, tourism services and Ho Chi Minh road. This urban area has an important defense position. Population scale up to 2020 is 50,000 people. Natural land area is 600 ha (not including airport), urban construction area is 450 ha. On average, construction land is 150 m²/person.

- **Te Tieu Urban Area (Dai Nghia):** is an urban area in the center of My Duc Township. This is a center for eco-tourism services (Quan Son lake). This is also an important traffic hub of the nation (Ho Chi Minh road and highway Hoa Binh – Kim Boi – Cho Ben – Hung Yen – Nam Dinh – Thai Binh). Population scale up to 2020 is 50,000 people. Natural land area is 1,000 ha (including 496.62 ha of existing urban area), urban construction land is 750 ha. On average, construction land is 150 m²/person.
- **Tay Dang Urban Area:** is an urban area in Ba Vi Township. It is a trade centre located in the north-western gateway of the province. Population scale up to 2020 is projected to be 50,000 people. Natural land area is 1,205.38 ha; urban construction land is 750 ha. On average, construction land is 150 m²/person.

2.608 Existing urban areas shall be upgraded to type V:

- **Phu Minh Town (Phu Xuyen):** is an urban area of water port industry and services. Population scale up to 2020 is projected to be 10,000 people. Natural land area: 300 ha, urban construction land area: 200 ha. On average, construction land is 200 m²/person.
- **Van Dinh town (Ung Hoa district):** is an urban area of administration, services and industry of the district. Population scale up to 2020 is projected to be 6,500 people. Natural land area is 539.31ha; urban construction land is 130 ha. On average, construction land is 200 m²/person.
- **Lien Quan town (Thach That district):** is an urban area of administration, eco-tourism services of the district. Population scale up to 2020 is projected to be 12,000 people. Natural land area: 291 ha; urban construction land is 240 ha. On average, construction land is 200 m²/person.
- **Phuc Tho Town (Phuc Tho District):** is an urban area of administration, services, trade and culture of the district. Population scale up to 2020 is projected to be 12,000 people. Natural land area: 300 ha; urban construction land is 160 ha. On average, construction land is 200 m²/person.
- New urban areas of type V shall be formed and developed from now to 2020, including 17 urban areas with population scale up to 2020 being 210,000 people. Urban construction land is 4,200 ha. On average, construction land is 200 m²/person.
- **Townships:** are residential areas considered as the center for economy, socio-culture for a commune cluster. A township can be located in one or many communes but have no administration boundary. This is rural residential area in the form of urban area but have not enough conditions to be categorized as urban area. Among 300 commune centers, 35 townships shall be constructed.
- **Ba Vi District:** it is projected to construct 4 townships: Phu Dong, Phu Phuong, Minh Quang, Tien Phong. Population scale up to 2020 is projected to be 1,000people/township with area of 10ha.

- **Phuc Tho District:** it is projected to construct township named Thuong Coc. Population scale up to 2020 is projected to be 2,000 people/ township. Construction land: 20ha.
- **Dan Phuong District:** it is projected to construct 2 townships namely Yen So and Yen Nghia. Average scale up to 2020 is projected to be 2,000 people/ township with area of 20 ha.
- **Quoc Oai District:** it is projected to construct 1 township named Liep Tuyet. Average scale up to 2020 is projected to be 2,000people/township with area of 20ha.
- **Chuong My District:** it is projected to construct 4 townships namely Huu Van, Hong Phong, Nam Dien, Phu Nam An. Average scale to 2020 is projected to be 1,500people/township with area of 15ha.
- **Thanh Oai District:** it is projected to construct 4 townships namely Tan Uoc, Kim Thu, Binh Minh, My Hung. Average scale up to 2020 is projected to be 1,500 people/ township with area of 15ha.
- **Thuong Tin District:** it is projected to construct 3 townships namely To Hieu (Tia), Nguyen Trai, Chuong Duong. Average scale up to 2020 is 3,000 people/township with area of 30 ha.
- **Phu Xuyen District:** it is projected to construct townships namely Quang Lang, Khai Thai, Dai Xuyen, Phuong Duc, Tan Dan. Average scale up to 2020 is 1,000 people/township with construction area of 10 ha.
- **Ung Hoa District:** it is projected to construct 3 townships namely Dong Tan, Dai Cuong, Hoai Nam. Average scale up to 2020 is 1,000people/township with construction area of 10ha.

(c) Development Orientation for Urban Areas and Rural Residential Areas

- **General Orientations**

2.609 Agricultural land is planned in the direction of industrialization, modernization of production, goods production combined by processing industry and export oriented industry, helping to boost the shift of rural agricultural economy structure into a new structure industry – services and agriculture.

2.610 In addition to sparing a reasonable land fund for the construction of infrastructure, industrial zones, services, the remaining agricultural land must be effectively and efficiently used in order to implement food security strategy, satisfying demand for agricultural product, food of high quality for society; increase land use coefficient and land fertility, suitably arrange the structure of agricultural land in the direction of goods production. Spare a specialized land fund for developing farming into concentrate area.

2.611 Step by step develop suburban agriculture based on the development of potential and comparative advantages of the province, quickly adapt to the market, and actively integrate into regional and global economy. Rapidly shift the structure of agricultural production in the direction of industrialization and modernization, based on which, formulate strategic products in each locality.

2.612 Step by step apply high technology into agricultural production; in the immediate future, apply high tech into the production of plant seeds, cattle

breeding and some strategic products (safe vegetables, fruit; pig farming, poultry, aquaculture) combined by the development of product brand to make a breakthrough in national market and global market.

2.613 Increase income per cultivation land area; step by step increase income and improve people's life. Ensure food security, in the meantime, shift towards nutrition safety and increase living standards with a view to developing community, creating a qualified source of labor for the forthcoming development stages.

- **Agricultural–Aquacultural–Forestry**

2.614 The growth rate: on average more than 5% per year.

2.615 Growth rate of agriculture in the GDP structure: 20-21%.

2.616 With regard to a shift in agricultural structure: in the direction of increasing share of farming, aquaculture to 55% in 2010, cropping to 42-43%. In cropping, it is projected to shift towards an increase in plants of high value, high quality like special rice, safe vegetables, flower, ornamental trees, fruit trees, etc. in order to increase production value to 1 ha cultivation land.

- i. Production value of aquaculture-agriculture-forestry/ 1 ha agricultural land: 70 million VND.
- ii. Agricultural production value/ 1 ha agricultural production land: more than 83 million VND.
- iii. Crop value per ha annual cultivation land: 40 million VND
- iv. Average agricultural production value per agricultural laborer until 2010: 7.4 million per laborer.
- v. Total food output: 800-900,000 ton per year.

2.617 Rice production: Until 2020, annual rice land shall be reduced to 120.1 thousand ha, where: spring crop: 61.4 thousand ha (reduce by 18.9 thousand ha compared with that of 2005), Summer and Autumn crop: 58.8 thousand ha (decrease by 23.1 thousand ha compared with that of 2005).

2.618 Concentrate on intensive cultivation: continue improving rice variety to level 1, striving towards prototypal variety bringing about high productivity, suitable for soil and ecology of each region; improve the quality of irrigation and drainage; well develop insecticide and pesticide program based on IPM method; synchronously apply intensive cultivation methods.

2.619 Rice production in the forthcoming time is oriented towards rice production of high productivity, good quality, especially for regions with concentrated area, active irrigation and drainage system is basically completed.

2.620 Corn production to 2010: due to the fact that some of agricultural land is converted to non-agricultural land, and the winter crop concentrating on producing soybeans and vegetable, corn land shall continue to be reduced, until 2020, corn land area is projected to be

10,000 ha; in which winter crop accounts for 75-80% with a view to ensuring food security.

- Annual plants:

2.621 Main annual plants of the province are soybean and peanut.

2.622 Soybean: in 2010, land for growing soybean is 27 thousand ha, autumn and summer crop: 1,000 ha; spring crop: 1,200 ha, the rest is mainly in spring crop on rice land. Concentrate on investment in intensive cultivation; put new variety into mass production combined by suitable care process; until 2010, strive to increase productivity to 17 quintal/ha/crop in order to reach an output of 47 thousand ton.

2.623 Peanut: Until 2010, strive to reach a peanut land area of 5,000 ha, in which winter spring crop: 4,260ha, summer-autumn crop: 740 ha. Concentrate on putting new variety into mass production combined by intensive farming: cover nylon and balanced fertilizer; until 2010, strive to increase average productivity to 23 quintal/ha in order to reach output of 12 thousand ton.

- Vegetable

2.624 Arrange stable land for vegetable: 20ha in 2010, in which spring crop: 3,300 ha; autumn-spring crop: 4,300ha, the rest is winter crop. Formulate a specialized and clean vegetable production area serving Hanoi market, Ha Dong, Son Tay, Mieu Mon, Xuan Mai.

- Production of clean and safe vegetable:

2.625 Until 2010, in the province, there shall be more than 2,000 ha land for specialized vegetable cultivation area aimed at serving Ha Noi market. Focal safe and clean vegetable production areas concentrate on areas surrounding the Day river and the Red river (Phuc Tho, Dan Phuong, Hoai Duc, Quoc Oai, Chuong My, Thuong Tin, Ung Hoa); and areas surrounding important traffic arteries (Lang – Hoa Lac, provincial road 21B, Do Xa – Quan Son, National highway 1A) and some communes, localities with tradition and experiences as well as capacity to invest in vegetable production.

2.626 Flower and ornamental tree development: strive to reach an area of 2,000 ha in 2010. In addition, it is possible to expand land for growing flower and ornamental trees in winter crop on second crop and rice land. Mainly concentrate in Dan Phuong, Quoc Oai, Hoai Duc, Thuong Tin, Ha Dong, Son Tay, My Duc and areas surrounding important traffic arteries, towns and townships.

- Perennial trees development

2.627 Production of fruit trees: to the year 2010, total land for growing fruit trees is expected to reach 11,000ha; in which there is about 3,000 ha Dien pomelo, Canh orange, late longan. In which: newly grow 2,000 ha concentrated fruit tree area in the hilly areas, the Day river area, combined by the development of ecological areas with a view to having enough

conditions for intensive cultivation, increasing productivity, quality, economic efficiency and construction of product brand. Newly growing area mainly concentrates on special products which Ha Tay has an advantage: Dien pomelo, Canh orange and late longan. Concentrate on improving more than 2,000 ha fruit trees with low efficiency and replace by specialty fruit trees with high economic efficiency.

2.628 Tea development: stable area for growing tea: 2.5–2.6 thousand ha. In the process of urbanization surrounding national highway 21A, however tea area is reduced shall be expanded and compensated by the equivalent area in other places (Ba Vi, Chuong My).

2.629 Direction for arranging concentrated production area: formulate a concentrated pig farming and goods production area with farms of medium and large scale (20 to more than 100 sows/ per household; 100 – more than 500 meat pig/ household). Until 2020, strive to reach the percentage of concentrated pig farming and goods production area of more than 20% of total number of pigs with a view to increasing productivity and quality of product, mitigating environmental pollution and increasing ability to prevent and control diseases.

2.630 Arrange land to develop concentrated farming area: to formulate concentrated farming and goods production area with farms of large and medium scale (20 to more than 100 sows/ per household; 250-more than 500 meat pigs/household)' Until 2010, strive to reach the percentage of concentrated pig farming and goods production area of more than 20% of total number of pigs; regional concentrated poultry farming in hilly districts with 40–50% of poultry in concentrated farm.

2.631 Concentrate areas are located in high terrain with wide area and being far from residential area, enough water supply and satisfactory waste water and solid waste treatment, ensuring that there shall be no environmental pollution and disease control and prevention shall be facilitated.

2.632 During the period of 2005–2010, land area for developing farming is projected to be 2,300 ha (in each commune from 2–3 localities to develop concentrated farming, with average scale of 2–4 ha per localities).

- **Aquaculture Development**

2.633 With regard to growth rate: annual average growth rate of aquaculture is 11% per year; aquaculture accounts for about 6.5–7% of total agricultural value (including agriculture, forestry, and aquaculture).

2.634 In 2010, aquaculture land reaches 15,000 ha. Average productivity is more than 2 ton/ha. Fish cage farming has a scale of 600-700 cages with total output of 38-40 thousand ton (among which output of specialty aquaculture: 50-70 ton per year, sowing fish from 150 to 200 million fishes)

- **Arrange Production**

2.635 Take advantage of all kinds of water surfaces for aquaculture, convert part of low-lying rice field to aquaculture land, increasing specialized

aquaculture land to 9,400 ha in the form of semi intensive cultivation and intensive cultivation with industrial food.

- **Fish Cage Farming**

2.636 Hanoi forests are not large, as a result, it is determined that the main effect of forests is the protection of ecological environment, tourism landscape; the focal task is to protect gene fund.

2.637 Well implement forest management and protection, fire protection and prevention; mitigate to the maximum the number of forest fires and deforestation in the area.

2.638 Actively grow concentrated forests with branch trees and enhance the improvement of existing forests. Combine afforestation and forest improvement with the development of concentrated fruit trees area to serve eco-tourism. Until 2020, strive to reach the area of concentrated forest of 2,000 ha at minimum and improve 20% of existing forest (about 2,000 ha). Increase coverage rate to 11% in 2010.

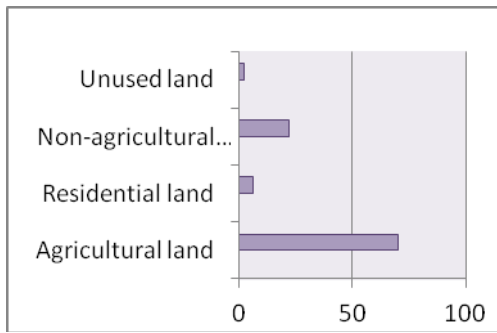
2) Land Use Status in Nam Dinh Province

(1) Current Land Use Situation

2.639 According to data provided Nam Dinh DONRE in five5ECSR: The area of Nam Dinh Province in 2009 was 165,299 ha, allocated over Nam Dinh City, 16,529 ha/district on average. Nghia Hung district has the largest area (25,444 ha) accounting for 15.4% of the province and Nam Dinh City has the smallest area (4,625 ha) accounting for 2.8% of the province.

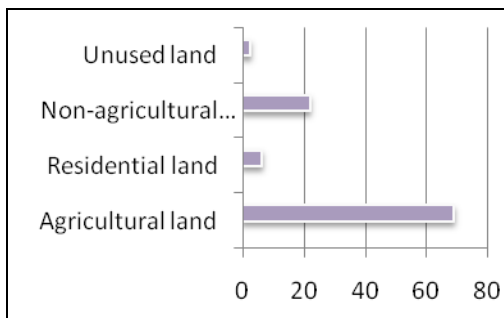
2.640 The natural land area of Nam Dinh Province tends to increase due to accretion in the coastal districts (Giao Thuy and Nghia Hung). In five years (from 2005 -2009), a natural land area of Nam Dinh Province increased by 266.89 ha.

2.641 In recent years, due to population growth along with the urbanization, economic development is giving more pressure on the land. The need of land for construction, housing and economic development, urban, industrialization, transportation, irrigation, transportation has been more and more increasing. Meanwhile, the agricultural land was decreasing (937.63 ha) from 2005-2009 so that the agricultural land area per capita decreased accordingly.



Source: Nam Dinh DONRE/2005

Figure 2.3.1 Land Use (2005)



Source: Nam Dinh DONRE/2009

Figure 2.3.2 Land Use (2009)

3) Land-use Status in Thanh Hoa Province

2.642 Thanh Hoa landuse situation could be summarized as follows based on 5ECSR provided Thanh Hoa DONRE (Thanh Hoa PPC):

(1) Current Land Use Situation

2.643 According to land statistics of 2009, the total natural area of the province is 1,113,341.71ha in which 824,122.18 ha of agricultural land (74%), 157,731.14 ha of non-agricultural land (14%) and 131,488.39 ha of unused land (12%).

(2) Agricultural Land

2.644 Thanh Hoa has an agricultural land area of 824,122.18 ha, making up 74% the natural area, an average of 2,222 m²/person

Table 2.3.8 Agricultural Land Use Situation as of 2009

No	Land type	Code	Area (ha)	Structure (%)
I	Agricultural land	nnp	824,122.18	100.0
	Agricultural production land	sxn	245,726.23	29.8
	Annual crop land	chn	215,440.88	26.1
	Rice land	lua	148,299.23	18.0
	Other annual crop land	hcn	63,697.51	7.7
	Husbandry grassland	coc	3,444.14	0.4
	Perennial tree land	cln	30,285.35	3.7
	II	Forestry land	lnp	566,040.45
	Production forest land	rsx	249,302.14	30.3
	Protective forest land	rph	232,816.56	28.3
	Special use forest land	rdd	83,921.75	10.2
III	Aquaculture land	nts	11,275.65	1.4
IV	Salt production land	lmu	404.59	0.0
V	Other agricultural land	nkh	675.26	0.1

Source: DONRE, compiled by JICA Study Team

(a) **Agricultural Production Land:** There are currently 245,726.23 ha, making up 29.8 the natural area, an average of 2,220 m²/person. These include the followings:

- **Annual Crop Land:** There are currently 218,779.59 ha, of which
 Rice cultivation land 148,299.23 ha, consisting of: wet rice land: 125,555.73 ha, other rice land: 1,8495.29 ha and hilly rice land: 4,248.21 ha. Wet rice land mainly distributes in key districts of the province (such as Yen Dinh, Thien Hoa, Trieu Son, Dong Son, Tho Xuan) The quality of land is mostly alluvial land with suitable characteristics for rice and secondary food crops, along with favorable land scale and infrastructure (transportation, irrigation), and educational level, here an high yield intensive cultivation zone has formed, also with the cultivation of mix-bred strains of rice. During recent years, thanks to the stable and long term hand over of land to farmers, the people have been the true owner of their land so they were settled to invest, cultivate intensively, increase the number of crops and apply scientific technologies in terms of breeds, fertilizer, pesticides, especially the structural changes of plants and crops, therefore yield and productivity in recent years have risen significantly. Hilly rice land of mountainous areas have been cultivated stably, the people here cultivate hilly rice land to be independent in terms of food supply.

2.645 Other annual crop land: These are lands specialized for secondary crops, vegetables, short term industrial crops such as sedge, sugarcane, cassava. Material zones for sugar and cassava powder factories have been formed with an area of 63,697.51 ha, making up 29.5% of cultivation land. This is a land type with high economic value, centrally distributed in the plains and midlands.

2.646 Husbandry grassland: There are currently 2,444.14 ha dividing into: improved natural grassland: 2,953.07 ha; planted grassland: 491.07 ha. Grassland for husbandry currently is mostly cattle herding grounds distributed in most districts but is more common in mountainous districts, on plains, these

land areas are small and dispersed, used for natural cattle herding and sometimes for other uses. With the principle to develop husbandry and especially increase and improve milk cow herds, grassland areas are in need of planning, of which the importance is planning for grassland areas in districts with milk cow husbandry project such as Tho Xuan, Yen Dinh, Trieu Son.

- **Perennial Tree Land:** There are currently 30,285.25 ha, of which:
 - 2.647 Industrial perennial tree: Centrally distributed in mountainous districts, the tree composition here consists of rubber tree, coffee, and tea. In comparison to the potential and characteristics of soil, there are abundant land for industrial trees in the province, especially rubber tree which is suitable to the climate and soil to form centralized material zones for processing factories.
 - 2.648 Fruit trees (3,058.5 ha): Fruit tree land is currently distributed in a dispersed manner in the districts, towns and cities, centralized areas are not substantial and unmatched to the land potential. However, there have been some centralized areas established such as pineapples for fruit and food processing factories.

(b) Forestry Land

2.649 Currently there are 566,040.45 ha, making up 50.8% the total natural area, these include:

(i) Production forest land: There are 249,302.14 ha, accounting for 44.0% of forest land, consisting of:

- Natural forest production land : 101,612.2 ha.
- Land with planted production forest : 92,325.42 ha.
- Zoned land for production forest recovery : 11,295.43 ha.
- Land for production forest planting : 43,069.09 ha.

2.650 Centrally distributed in mountainous district, forest resource is generally rich in terms of fauna and flora, the forest production reserve is rather rich. During recent years, with the implementation of programs and projects, production forest land has increased.

(ii) Land with protective forest: Currently there are 232,816.5 ha making up 41.1% the forestry area. Of which:

- Land with natural protective forest : 157,287.23ha.
- Land with planted protective forest : 23,394.63ha.
- Zoned land for protective forest recovery : 12,229.46ha.
- Land for protective forest planting : 39,905.24ha.

2.651 Protective forests are rather well kept, especially in hot spots, border areas and headwaters which contribute to environmental protection, climate improvement, and land protection from erosion.

(iii) Land with special use forest: There are currently 83,921.75 ha, making up 14.8% of forestry land. Of which:

- Land with natural special use forest : 77,543.63ha.

- Land with planted special use forest : 4,457.00ha.
- Zoned land for special use forest recovery : 1,511.62ha.
- Land for special use forest planting : 409.50ha.

2.652 These consist of the national parks of Ben En, Cuc Phuong, reservation zones of Xuan Lien, Pu Hu, Pu Luong, Tam Quy madhuca pasquieri forest and historical vestiges and renowned touristic site. Thanh Hoa special use forest has a rich genome pool of flora and fauna, and it is also a resource with great potential for eco-tourism attracting large numbers of tourists.

(c) Aquacultural Land

2.653 There are currently 11,275.65 ha, making up 0.9% the natural land area. Of which: Saline and brackish water aquaculture land is 3,409.39 ha; fresh water aquaculture land is 7,866.0 ha. The area of fresh, saline and brackish aquaculture land has received significant investment, forming industrial and semi-intensive cultivation zones. Besides areas specializing in aquaculture, recently emerged is the rice-fish model with initial economic effectiveness and higher land use efficiency.

(d) Salt production Land

2.654 There are currently 404.59ha distributing in 3 districts: Hau Loc, Quang Xuong and Tinh Gia. In recent years, salt production in general have been facing difficulties, income of salt producers has been low. In the upcoming years, industrial technology to produce salt must be applied to increase the productivity and quality of clean salt to meet the market demand and stabilized the existing salt area.

(3) Non-Agricultural Land

2.655 There are 147,900.12 ha, making up 13.3% the total natural area.

Table 2.3.9 Non-Agricultural Land Situation

No	Land Use Purpose	Code	Total	Percentage (%)	Area by land use purpose		
					Total	Of which	
						Rural residential area	Urban area
1	Non-agricultural land	PNN	157,731.16	100.0	157,731.16	66,979.91	6,907.85
1.1	Residential land	OTC	50,200.63	31.8	50,200.63	47,500.13	2,003.05
1.1.1	Rural residential land	ONT	48,197.66	30.6	48,197.66	47,500.13	
1.1.2	Urban residential land	ODT	2,002.97	1.3	2,002.97		2,003.05
1.2	Specialized land	CDG	67,323.79	42.7	67,323.79	17,210.6	3,968.29
1.2.1	Office and construction land	CTS	858.71	0.5	858.71	584.54	254.61
1.2.1.1	Governmental office and construction land	TSC	805.88	0.5	805.88	552.02	
1.2.1.2	Other office land	TSK	52.83	0.03	52.83	32.52	
1.2.2	National security land	CQP	4833.1	3.1	4,833.1	88.8	174.25
1.2.3	Public security land	CAN	3,720.86	24.4	3,720.86	81.05	126.65
1.2.4	Non-agricultural business, production land	CSK	5,435.22	3.5	5,435.22	303.08	852.41
1.2.4.1	Industrial zone land	SKK	1,341.03	0.9	1,341.03	29.01	
1.2.4.2	Business and production outfit land	SKC	1,445.72	0.9	1,445.72	239.6	
1.2.4.3	Mineral activity land	SKS	1,588.46	1.0	1,588.46	11.76	
1.2.4.4	Construction material and pottery land	SKX	1,060.01	0.7	1,060.01	22.71	
1.2.5	Public purpose land	CCC	52,475.9	33.3	52,475.9	16,153.13	2,560.37
1.2.5.1	Transportation land	DGT	28,119.32	17.9	28,119.32	10,576.28	

No	Land Use Purpose	Code	Total	Percentage (%)	Area by land use purpose		
					Total	Of which	
						Rural residential area	Urban area
1.2.5.2	Irrigation land	DTL	19,555.43	12.40	19,555.43	2,439.45	
1.2.5.3	Power supply land	DNL	549.84	0.35	549.84	256.75	
1.2.5.4	Telecommunication land	DBV	26.16	0.02	26.16	19.44	
1.2.5.5	Cultural land	DVH	587	0.37	587	433.01	
1.2.5.6	Health land	DYT	268.32	0.17	268.32	169.68	
1.2.5.7	Educational land	DGD	1,791.38	1.14	1,791.38	1,432.21	
1.2.5.8	Sports land	DTT	854.9	0.54	854.9	648.49	
1.2.5.9	Scientific research land	DKH	0.27	0.00	0.27		
1.2.5.10	Public service land	DXH	19.65	0.01	19.65		
1.2.5.11	Market land	DCH	164.63	0.10	164.63	117.51	
1.2.5.12	Historical vestige land	DDT	401.08	0.25	401.08	58.11	
2.2.5.13	Waste treatment and landfill	DRA	137.91	0.09	137.91	2.2	
1.3	Religious and spiritual land	TTN	147.96	0.09	147.96	108.65	11.55
1.3.1	Religious land	TON	58.09	0.04	58.09	44.31	
1.3.2	Spiritual land	TIN	89.87	0.06	89.87	64.34	
1.4	Cemetery land	NTD	5,338.92	3.38	5,338.92	341.7	122.67
1.5	River, streams and specialized water surfaces	SMN	34,612.87	21.94	34,612.87	1,813.47	793.44
1.5.1	Rivers, canals, streams	SON	24,550.15	15.56	24,550.15	1,729.25	
1.2.5	Land with specialized water surface	MNC	10,062.72	6.38	10,062.72	84.22	
1.6	Other non-agricultural land	PNK	106.98	0.07	106.98	5.35	8.85

Source: DONRE, compiled by JICA Study Team

(4) Residential Land

2.656 Currently there are 50,200.63 ha accounting for 4.5% the total natural area. Of which:

(a) Rural Residential Land

2.657 Currently there are 48,197.66 ha; mostly areas of rural residential land are established for a very long period of time binding with village culture. On average, a rural household is 250 m² (213 m² for coastal plains, 378 m²/household for midlands and mountainous areas), equals with the average level nationwide. Every year, the separation of households was arranged such that the new household will share land with the household they originated from, therefore, the occupation of agricultural land is controlled. In the coming years, rural residential land must be planned to go in accordance with the improvement of rural residential areas with the goal to create a new outlook for the rural area together with the improvement of infrastructure and living conditions for the people and environmental protection. Also, rural residential land is the supply for urban residential land (towns, commune cluster centers, pre-urban areas).

(b) Urban Residential Land

2.658 There are currently 2,002.97 ha. The average area per household for urban residential land is 127 m²/household and 34 m²/person. The urban system of Thanh Hoa in recent years has seen development in both quantity and scale, but still remains at administrative, commercial and service functions. Industrial and service urban areas are few. In recent years, most urban areas have formulated and adjusted their general plans and got approval from the authorities. The management of constructions and land according to plans have reduced

overlapped development. Function zones have been specifically defined. Modern architecture has been creating a modern outlook for Thanh Hoa City, Bim Son and Som Son. Especially, Thanh Hoa City has been going on with new urban areas with large and comprehensive investments.

(5) Specialized Land

(a) Office Land

- There are 858.71 ha, which includes:
- Governmental offices: 805.88 ha
- Other office land: 52.83 ha

(b) National and Public Security Land

- **National Security Land:** the whole province has 4,833.10 ha.
- **Public Security Land:** there are currently 3,720.86 ha.

2.659 National and public security land are managed and planned separately by the Ministry of National Defense and Ministry of Public Security, respectively.

(c) Non-agricultural Business and Production Land

- **Industrial Zone:** Currently there are 1,341.03 ha;

2.660 Centralized industrial zones of the province were approved by the prime minister and are being implemented (Le Mon, Nghi Son, Bim Son, Dinh Huong – Northwest of station, Lam Son – Sao Vang industrial zones) Some zones are fully occupied by investors and are going into stable production.

- **Business and Manufacturing Outfit land:** There are currently 1,445.72 ha, distributing in most districts and towns of the province. These include lands for small industrial and craft outfits, craft villages, small industrial clusters, and they are under the governance of districts and towns.
- **Mineral Activity Land:** There are 1,588.46 ha. This is the area for the exploitation of limestone deposits such as Bim Son, chromite, cement additives, phosphate, serpentine and stone for tiling.

2.661 Construction material production and pottery land includes 1,060.01ha, distributing in most districts, towns and city.

2.662 To meet the demand of economic shifting towards industrialization and modernization, in the upcoming time, the land resource for non-agricultural business and production must be allocated sufficiently.

(d) Public Purpose Land

- **Transportation Land:** There are currently 28,119.32 ha including national highways, provincial roads, district, inter-hamlet, inter-communal, infield roads accounting for 2.5% the natural area of the province. Generally, the transportation network of the province is rather complete in terms of density and distribution, however the structure and road width are at rather low levels. Urban roads still lacking branching roads and ring roads... Branching roads have been constructed to connect impetus economic zones to Hochiminh Road, there is no airport yet.

- **Irrigation Land:** There are currently 19,555.43 ha, including canals, dykes and key constructions (not including reservoirs) accounting for 8.07 the total annual cultivation land; this is a suitable ratio. Thanh Hoa is one of the provinces that carry out well irrigation in several years up to now. Lands for rice and secondary crops are mostly actively irrigated and drained with constructions. Upon the completion of Cua Dat hydropower and irrigation reservoir, the total irrigation capacity of the construction will be up to 220,000 ha.
- **Power Supply and Telecommunication Land:** The area is 576 ha, including wire constructions and power stations as well as old pipes distributed all over the province.
- **Cultural land:** The area is 587,00 ha including land for theatres, museums, squares, statues, memorials, parks, playgrounds, cultural post offices, cultural houses and other cultural establishments. To meet the demand of cultural institutionalization, during planning, land resource must be allocated to construct hamlet cultural houses and other public cultural welfare constructions.
- **Health Establishment Land:** The area is 268.32 ha, including healthcare establishments (hospitals at provincial, district and regional level, communal clinics). To gather public investment in healthcare, it is encouraged that state and private healthcare establishment be founded and land be reserved for this purpose.
- **Education and Training Land:** The area is 1,791.38 ha. During recent years, education sector has invested substantially in the construction of facilities: classrooms have been fortified, educational equipment bought, there have been new openings of semi-public and private schools and the capacity of education has been improved to meet the human resource training demand of the province. However, many schools are not meeting standards in terms of land, the system of pre-schools and nurseries are weak. Therefore, in order to attract public investment into education and human training, land resource must be allotted to expand and construct new schools from nurseries to preschools, general education schools, universities, colleges, vocational schools and community learning centers.
- **Sports land:**The area is 54.90ha (2.3 m²/person average, the standard is 3.8 m²). Comparing to the demand for sports and improving the physical and emotional life of the people, during recent years, the land resource for this purpose is limited. Sports centers in the districts and towns are small; the province does not have a national level sports center. Therefore, enough land should be allocated for this purpose.
- **Market Land:** The area is 164.63 ha. Mostly are rural market areas for farmers to exchange produces which greatly contributes to goods circulation, improve the budget income for the province, and are within the system of trade services.
- **Historical Vestige Land:** The area is 401.08 ha. These are areas for rated vestiges.

- **Waste Treatment and Landfills:** The area is 137.91 ha centrally distributed in major urban areas such as Thanh Hoa City, Bim Son. Most districts, towns and craft village clusters have not had this type of land allocated. The environmental issue led by industrial production and crafts as well as domestic garbage is a hot topic. Therefore, this land type must be planned and allocated appropriately to solve environmental issues.

(e) Religious and Spiritual Land

2.663 The area is 147.96 ha including religious land 54.46ha and spiritual land 91.50ha.

(f) Cemeteries

2.664 The area is 5,338.92 ha. Currently cemeteries are distributed in a dispersed manner according to local practices; the majority still cause environmental problems. This is also a problem to be solved in land planning.

(g) Rivers, Streams and Specialized Water

2.665 The area is 34,612.87 ha, of which 24,550.15 ha are rivers and streams, 10,062.72 ha are specialized water surfaces (irrigation reservoirs and other specialized surfaces).

(h) Other Specialized Non-Agricultural Land

2.666 The area is 106.98 ha.

(6) Unused Land

2.667 Currently there are 131,488.39 ha, accounting for 11.8% the natural area, which includes:

- Unused flat land

2.668 The area is 14,816.61 ha, distributed in most administrative unites but at small scale, especially for plain districts. This is the supplemental land resource of agriculture to make up for the conversion of agricultural land to other purposes.

- Unused hilly and mountainous land

2.669 The area is 93,789.47 ha. Climate and soil characteristics favor afforestation. This is the supplemental land resource for agriculture and forestry.

- Rocky Mountains Without Tree

2.670 The area is 22,882.31 ha, distributed both on plains, midlands and mountainous areas.

(7) General Assessment of Land Use Situation

2.671 The province's land has been handed over to owners to use, is currently used under the principle of making best use per unit of land. Agricultural land is seeing strong shifts in terms of plants and crops. Specialized land has been scrutinized to plan using the economical and effective principle.

4) Land Use Status in Nghe An Province

(1) The Change of Land Use Areas

2.672 Nghe An has a total natural area of 1,649,068.227 ha. The province is located at the northern-east of Truong Son range and on North-South traffic line (of railway, road, airway and marine-way). The locality has a complicated diversified terrain which is separated with a network of mountains, hills, rivers and streams. The highest mountain is Puxalaileng (2,711 m above the sea-water level) of Ky Son district; while the lowest locations are the lowland districts as Quynh Luu, Dien Chau, Yen Thanh, etc. The land-area is distributed unevenly; thus, the mountainous and hilly area covers 83% of the total provincial natural area.

2.673 Based on the data supplied by Land-use Right Registration Office (under directly DONRE):

- (i) In 2006: the agricultural area was 1,163,226.470 ha, the non-agricultural area was 113,489.470 ha, the un-used area was 372,104.700 ha and the coastal surface-water area-included land-area (as the monitoring result) was 346,310 ha.
- (ii) In 2007: the agricultural area was 1,170,716.32 ha, the non-agricultural area was 114,086.81 ha, the un-used area was 363,644.81 ha and the coastal surface-water area-included land-area (as the monitoring result) was 346,310 ha.
- (iii) In 2008: the agricultural area was 1,163,838.229 ha, the non-agricultural area was 115,239.848 ha, the un-used area was 370,825.063ha and the coastal surface-water area-included land-area (as the monitoring result) was 256,200 ha.
- (iv) In 2009: the agricultural area was 1,174,147.320 ha, the non-agricultural area was 118,171.627 ha, the un-used area was 356,749.280 ha and the coastal surface-water area-included land-area (as the monitoring result) was 250,600 ha.

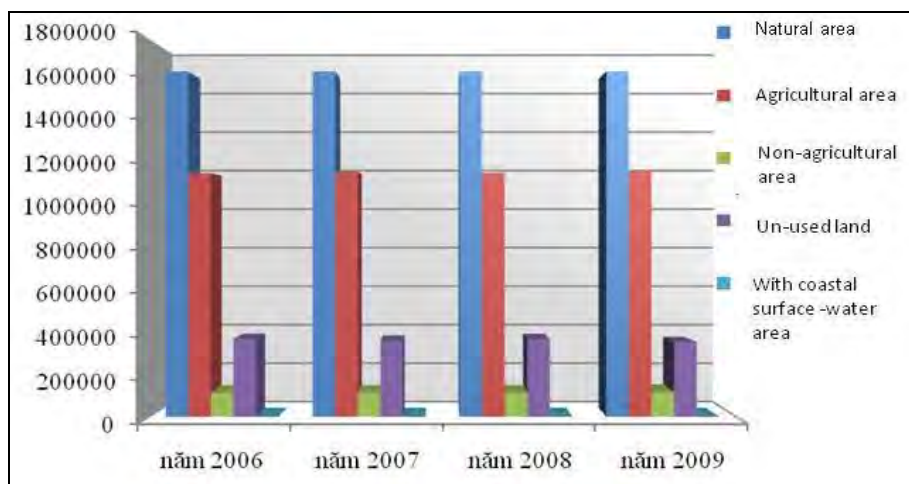
Table 2.3.10 The Land-Use Area Change by-Year

Year	Land-Use Area (ha)			
	Agricultured	Non-Agricultured	Un-Used	Coastal Surface-Water Area-Included
2006	1,163,226.470	113,489.470	372,104.700	346,310
2007	1,170,716.32	114,086.810	363,644.810	346,310
2008	1,163,838.229	115,239.848	370,825.063	256,200
2009	1,174,147.320	118,171.627	356,749.280	250,600

Source: Nghe An DONRE/2009

(2) The Change of Land-Use Type

2.674 The total used area covers about 58% of the total natural areas. The forested-land covers 41.6%, the unused bare land covers 42.0%, while the agricultural area covers only 5 to 10%. The agricultural area distribution is specified by-districts as follow: the highland district has a small rate of agricultural area (for example: Tuong Duong's agricultural area covers only 0.3% of the total district natural area, this one of Ky Son is 1.7%, 1.8% is of Con Cuong, the one of Quế Phong covers 1.4% of the total district natural area and the one of Quy Chau is 2.4%), while the midland districts has relatively large agricultural area (specifically, Quy Hop: 7.4%, Thanh Chuong: 15.7%, Anh Son: 12.9%, Tan Ky: 18.5% and Nghia Dan: 34.2%).



Source: Land-use Right Registration Office

Figure 2.3.3 Land-Use Change by Type in Period 2006–2009

2.675 In fact there have been many shortcomings in land-use issue; the land is encroached, abandoned and used uncontrolledly. Hence, to use the land sustainably, the locality needs to focus on some following issues:

- (i) To improve the local people's awareness and responsibilities in land-use and the maintained soil-fertility;
- (ii) To have a sensible land-use plan; to implement effectively the FLA (forest land allocation), thus, land and forest will be allocated to organizations, households, individuals to be used, managed in long-term in accordance with the plan;
- (iii) To promote the land-use management (in both the quality and area) in which the integrated management involving all sectors should be focused with the motto "land saving";
- (iv) To have the long-term land-use management projects which combined closely with socio-economic development programs;
- (v) To have the long-term programs studying generally on the soil-fertility protection and improvement; the transferred technologies should be combined with the local knowledges to ensure the sustainable land-use in accordance with each land-use type.

2.3.2 Land Acquisition and Compensation

2.676 Through the baseline survey, relevant laws and regulations were collected at city/province level.

Table 2.3.11 Relevant Laws and Regulations on Land Acquisition and Compensation

No	Province/City	Available documents Description
1	Ha Noi	<ul style="list-style-type: none"> • Decision No. 108/2009/QĐ-UBND dated 29/9/2009 - Promulgation of regulation on promulgating regulations on compensation, rehabilitation and resettlement in case of land recovery by the state in Ha Noi. • Decision No. 108/2009/QĐ-UBND dated 29/9/2009 -Promulgation of regulation on compensation, support and resettlement upon land recovery by the State in Hanoi area. • Decision No. 48/2011/QĐ-UBND dated 26/12/2011 - Amending and supplementing some articles of the regulation issued with Decision 02/2010/QĐ-UBND dated 18/01/2010 of HPC on

		<p>land recovery, land allocation, land leasing and change in land use purpose to implement investment projects and build rural houses in rural residential zones in Hanoi area.</p> <ul style="list-style-type: none"> • Decision No. 02/2010/QĐ-UBND dated 18/01/2010 – Promulgation of regulation on land recovery, land allocation, land lease and change in land use purpose to implement investment projects and build rural houses in rural residential zones in Hanoi area. • Decision No. 45/1999/QĐ-UB dated 4/6/1999 – Promulgation of “Temporary regulations on construction, conservation and improvement management of Hanoi’s ancient quarter”. • Decision No. 35/2011/QĐ-UBND dated 5/12/2011 – Promulgation of construction prices for new houses, temporary houses and architectural structures as a basis for valuation of compensation and support when the State recovers land in Hanoi area; • Decision No. 50/2011/QĐ-UBND dated 30/12/2011 – Promulgation regulation on prices of lands in Hanoi area. • Notification No. 6323/STV-BG dated 29/12/2011 of Hanoi Department of Finance – Promulgation of unit prices in compensation and support for trees, crops and livestock on land with water surface to serve land clearance works in Hanoi area in 2012.
2	Ha Nam	<ul style="list-style-type: none"> • Decision No: 30/2009/QĐ-UBND dated 26/10/2009 - Promulgating regulations on some details of compensation, supports and resettlement for land acquired by the State in Ha Nam Province. • Decision No. 33/2011/QĐ-UBND dated 30/12/2011 - Promulgating regulations on issuing unit price for compensating houses, architectural works and moving graves when land is acquired by the State. • Decision No. 18/2011/NQ-HĐND dated 15/12/2011 – Promulgation regulation on prices of lands in Ha Nam province.
3	Nam Dinh	<ul style="list-style-type: none"> • Decision No. 33/2010/QĐ-UBND dated 21/12/2010 - Promulgation regulation on implementing compensation and resettlement in Nam Dinh province. • Decision No. 24/2011/NQ-HĐND dated 8/12/2011 - Promulgation regulation on prices of land in Nam Dinh province. • Decision No. 25/2009/QĐ-UBND dated - Promulgation On amending and supplementing some Articles of/ into The March 7th 2008 Decision No.02/2008/QĐ-UBND of The Provincial People’s Committee (regarding to promulgating the catalogue of compensation and supporting price units for the affected houses, facilities, architectural structures when the government acquires land). • Decision No. 15/2008 dated - on promulgating the compensation, support price rate for affected houses, works and architectural structures when the government acquires land. • Decision No. 02/2008/QĐ-UBND - on promulgating the compensation, support price rate for affected houses, works and architectural structures when the government acquires land.
4	Ninh Binh	<ul style="list-style-type: none"> • Decision No. 27/2009/QĐ-UBND dated 16/10/2009 - Promulgating the Regulation on issuing policies for land compensation, support and resettlement when the state acquires land in Ninh Binh province. • Decision 1226/2011/QĐ-UBND dated 31/12/2010 – Promulgation regulation on prices of lands in Ninh Binh province. • Decision No. 06/2011/QĐ-UBND dated 21/7/2011 - Promulgating on the price units of houses, architectural structures, plants, livestock within Ninh Binh. • Decision No. 15/2010/QĐ-UBND dated 12/7/2010 - Promulgating on the price units of houses, architectural structures, plants, livestock within Ninh Binh.
5	Thanh Hoa	<ul style="list-style-type: none"> Decision No. 2072/2010/QĐ-UBND dated 11/6/2010 -Regulating on procedure of land acquisition, changed land-use purpose, land allocation, land leasing for implementing the investment project within Thanh Hoa. • Decision No. 4293/2011/QĐ-UBND dated 21/12/2011 - Promulgating on prices of lands in Thanh Hoa province in 2012. • Decision No. 3644/2011/QĐ-UBND dated 4/11/2011 - Promulgating on the price units of houses, architectural structures in Thanh Hoa province. • No. 3788/2009/QĐ-UBND dated 23/10/2009 - Promulgating on support and resettlement policy for land acquired by the state in Thanh Hoa province.
6	Nghe An	<ul style="list-style-type: none"> • Decision No. 04/2010/QĐ-UBND - Regulating on compensation, support and resettlement when the government acquires land within Nghe An. • Decision No 107/2010/QĐ-UBND dated 23/12/2010 - Regulating on the price units of newly built houses/ architectural structures for compensation, support and resettlement when the government acquires land within Nghe An. • Decision No. 30/2011/NQ-HĐND dated 9/12/2011 - Promulgating on prices of lands in Nghe An province in 2012.

Source: DONRE, compiled by JICA Study Team

2.3.3 Socio Economic Condition

2.677 Mainly from statistical sources, socio-economic information was collected. Collected information of (1). Housing and Property, (2). Education, and (3) Employment and Income are summarized as follows.

Table 2.3.12 Percentage of Households having House by Type of House and Province

No.	Province	Total (%)	Permanent House(%)	Semi-Permanent House(%)	Less-Temporary House(%)	Temporary House and other house(%)
1	Ha Noi	100	94.0	6.0	0.1	-
2	Ha Nam	100	97.0	2.8	0.2	-
3	Nam Dinh	100	95.1	4.4	0.4	0.1
4	Ninh Binh	100	95.8	3.6	0.5	0.1
5	Thanh Hoa	100	79.1	10.2	4.8	5.9
6	Nghe An	100	78.4	12.0	5.8	3.8

Source: Viet Nam Household Living Standards Survey, 2010

Table 2.3.13 Living Area per capital by Type of House and Province (Unit: m²)

No	Provinces	Total	Permanent House	Semi-Permanent House	Less-Temporary House	Temporary House and other house
1	Ha Noi	21.5	21.8	16.3	8.3	-
2	Ha Nam	17.0	17.2	12.9	10.0	-
3	Nam Dinh	17.4	17.7	11.5	19.5	7.5
4	Ninh Binh	17.1	17.2	11.4	33.0	20.0
5	Thanh Hoa	16.0	17.3	12.8	11.2	10.0
6	Nghe An	16.4	17.4	13.7	12.6	12.4

Source: Viet Nam Household Living Standards Survey, 2010

Table 2.3.14 Durable goods per 100 households by region

Items	Whole Country (No.)	Red River Delt (No.)	North Central Coast (No.)
Car	1.3	1.8	1.0
Motorbike	96.1	91.9	87.6
Telephone	128.4	138.9	113.3
Refrigerator	39.7	49.8	30.1
Video	54.2	53.6	46.8
Color TV	85.9	93.7	80.3
Computer	17.0	20.1	12.5
Air conditioner	9.4	17.7	4.0
Washing machine	17.6	23.7	10.6

Source: Viet Nam Household Living Standards Survey, 2010

Table 2.3.15 Illiterate Rate (over 15 year old)

No.	Province	Illiterate Rate (over 15 year old, %)
1	Hanoi	1.1
2	Ha Nam	0
3	Nam Dinh	1.9
4	Ninh Binh	0.6
5	Thanh Hoa	2.4
6	Nghe An	1.6

Source: Viet Nam Household Living Standards Survey, 2010

2.3.4 Cultural and Historical Heritages

1) General

2.678 Cultural and Historical Relics are regarded as spiritual life of Vietnamese people contributing to socio-economic development in general and stable society of the country in particular. Since the country experienced a range of wars, some relics were destroyed during the wars, while a number of relics are on the rise and in need of protection, especially revolutionary relics and cultural relics. These relics are supposed to spread from North to South, along the tentative HSR alignment. According to the collected list of heritages from the target provinces and baseline site survey, there are many national and provincial ranking relics along the HSR, especially Tam Coc-Bich Dong tourism site in Hoa Lu District, Ninh Binh Province, Tran dynasty' temple in Nam Dinh Province and Ham Rong revolutionary relics in Thanh Hoa Province etc. Below table is summary information about the cultural and historical heritages of five targeted provinces, except Nghe An due to unavailability of the data.

Table 2.3.16 Cultural and Historical Heritages at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	Partial information extracted for the relics list of five Districts including Thanh Xuan, Phu Xuyen, Thuong Tin, Thanh Tri and Ha Dong.	There are about 400 nationally and provincially designated relics in these five districts in which HSR might pass through.
2	Ha Nam	Letter No. 237/SVHTTDL-NVVH&GD dated Aug.15, 2011 on landscape and historical and cultural relics	There are 6 relics near and adjacent to high speed railway planned to cross (distance is calculated from eastern side of express way to toe relic boundary).
3	Nam Dinh	List of national ranking relics of Nam Dinh Province, 2006 (Hard copy, 10 pages) Marked relics map (Hard copy, 1 piece).	There are 75 nationally and provincially designated relics spreading in Nam Dinh Province. Especially, densely concentration relics appear in Y Yen District such as Tran dynasty's Temple, Thien Truong Temple, Pho Minh Tower Pagoda etc.
4	Ninh Binh	List of designated relics at national and provincial ranking in Ninh Binh Province (Hard copy, 12 pages).	There are 222 relics in which 78 national ranking relics and 144 provincial ranking relics spreading in the province. Especially, densely heritage concentration found in Hoa Lu District (former capital of the country) with 26 national designated relics.
5	Thanh Hoa	List of cultural and historical relics and landscape designated till Dec. 2010 (Hard copy, 32 pages) Letter No. 971/SVHTTDL-QLDSVH dated June 22, 2011 on ranking provincial level cultural and historical relics and landscape (Hard copy, 1 page). Marked relics map (Hard copy, 1 piece).	There are 145 national ranking relics and 564 provincial ranking relics in Thanh Hoa Province. Especially, Ho dynasty' citadel has been designated as world heritage since 2011. It is necessary to consider this densely heritage concentration when draw the alternative alignments to avoid sensitive properties.
6	Nghe An	N/A	N/A

Note: "N/A": Not available in the reference documents
 Source: DOCST, compiled by JICA Study Team

2.3.5 Public Health

2.679 Only partial information was provided by two provinces of north section, for further detail on public health, data collected visit is expected to target provinces for more comprehensive information. According the collected data from two provinces; Ha Nam and Ninh Binh are usually hit by the infectious diseases including hand, foot and mouth disease, sore eyes, diarrhea etc. due to the pollution of surrounding environment. What is more, these provinces also have to confront to the rise of HIV/AIDS diseases in the community as shown in table below.

Table 2.3.17 Public Health at Each Province

No	Province/City	Available Documents	Description
1	Ha Noi	N/A	N/A
2	Ha Nam	Provincial regulations related to infectious diseases including HIV/AIDS and Statistic data of infectious diseases including HIV/AIDS	There has been a decline in HIV cases from 158 cases to 41 cases during 2006-2011, while number of dead by AID is on the rise from 197 to 417 cases in the same period.
3	Nam Dinh	N/A	N/A
4	Ninh Binh	Report on infected diseases period 2006- 2010 by Ninh Binh DOH.	Apart from the infectious diseases, Ninh Binh is also a typical province in HIV/AIDS; There has been increasing trend from 1,247 cases in 2006 to 2,475 cases in 2010.
5	Thanh Hoa	N/A	N/A
6	Nghe An	N/A	N/A

Note: "N/A": Not available in the reference documents
 Source: DOHs, compiled by JICA Study Team

2.3.6 Vulnerable Groups

1) Ethnic Minority and Women

2.680 Ethnic minority usually lives in mountainous areas, especially in the north, there are different ethnic minorities living in Lai Chau, Hoa Binh, Son La, Dien Bien provinces etc. For north section, only few ethnic minority found in Thanh Hoa and Nghe An provinces. However, according to DOCSTs persons, they live far away from tentative HSR alignment. For more detailed information, target provinces are requested to provide relevant data on ethnic minority.

2.681 The demographic information of ethnic minority and women is summarized below. The distribution of ethnic minority is summarized in the environmental sensitivity map (See Technical Report No.4).

Table 2.3.18 Gender and Ethnic Minority at Each Province

No.	Province	District	Population (Person)			Ethnic Group (%)	
			Male	Female	Total	Kinh	Ethnic Minority
Whole Country			43,444,800	44,395,200	87,840,000	-	-
Red River Delta			9,872,300	10,127,000	19,999,300	-	-
North Central and Central Coastal Areas			9,425,500	9,621,000	19,046,500	-	-
1	Hanoi	Total	3,314,400	2,633,626	5,948,026	98.7	1.3

No.	Province	District	Population (Person)			Ethnic Group (%)	
			Male	Female	Total	Kinh	Ethnic Minority
		Thuong Tin	108,205	111,043	219,248	99.8	0.2
		Phu Xuyen	89,105	93,673	182,008	99.6	0.4
		Ung Hoa	88,335	93,673	182,008	99.9	0.1
2	Ha Nam	Total	384,300	1,101,904	1,486,204	99.8	0.2
		Duy Tien	61,713	64,270	125,983	99.8	0.2
		Thanh Lien	62,512	65,599	128,111	99.8	0.2
		Binh Luc	71,176	74,542	145,718	99.9	0.1
3	Nam Dinh	Total	897,200	930,911	1,828,111	99.8	0.2
		Nam Dinh city	115,561	127,625	243,186	99.7	0.3
		My Loc	33,576	35,567	69,143	99.8	0.2
		Vu Ban	62,519	67,150	129,669	99.8	0.2
		Y Yen	111,215	115,945	227,160	99.8	0.2
4	Ninh Binh	Total	451,500	447,499	898,999	97.4	2.6
		Ninh Binh City	55,267	55,274	110,541	99.8	0.2
		Tam Diep town	28,547	26,474	55,021	98.9	1.1
		Hoa Ly	32,073	34,114	66,187	99.8	0.2
		Yen Khanh	65,875	67,545	133,420	99.9	0.1
		Yen Mo	54,087	56,217	110,304	99.9	0.1
5	Thanh Hoa	Total	1,686,300	1,226,288	2,912,588	70.6	29.4
		Bim Son Town	27,047	26,395	53,442	99.1	0.9
		Ha Trung	52,701	55,348	108,049	98.7	1.3
		Hoang Hoa	121,201	125,425	246,626	-	-
		Hau Loc	81,385	84,357	165,742	-	-
		Nong Cong	92,413	90,485	182,898	99.5	0.5
		Dong Son	50,756	52,027	102,783	99.8	0.3
		Quang Xuong	126,054	130,877	256,931	99.7	0.3
		Tinh Gai	106,583	108,082	214,665	99.5	0.5
		Thieu Hoa	176,747	87,504	89,243	99.9	0.1
Thanh Hoa city	210,551	102,048	108,503	99.9	0.1		
6	Nghe An	Total	1,460,600	845,450	2,306,050	84.7	15.3
		Vinh City	147,796	155,918	303,714	99.2	0.9
		Quynh Luu	172,626	173,404	346,030	99.4	0.6
		Dien Chau	130,587	135,860	266,447	99.9	0.07
		Nghi Loc	91,440	92,708	184,148	99.9	0.1
		Hung Nguyen	54,903	55,548	110,451	99.9	0.06

Source: Statistics Data at District level, Province Level 2011

2.682 Distribution of ethnic groups at each province in the project area is shown in the following tables.

Table 2.3.19 Ethnic Distribution at Hanoi City

(unit: persons)

Ethnicity \ Town/District	Thuong Tin	Phu Xuyen	Ung Hoa
Kinh	218,889	181,208	181,764
Tay	114	63	40
Thai	47	11	13
Muong	113	61	159
Kho Me	0	0	1
Chinese	5	4	12
Nung	51	24	5
Hmong	7	5	0
Dao	7	6	7
Gia rai	0	0	2
E De	4	0	0
Ba Na	1	0	0
San Chay	5	2	5
Cham	0	0	0
Co Ho	9	0	0
Xo Dang	0	0	0
San Dieu	3	1	0
Hre	0	0	0
Ra Glai	0	0	0
Mnong	0	1	0
Tho (4)	0	1	0
Xitieng	0	0	0
Kho Mu	0	0	0
Bru Van Kieu	0	0	0
Co Tu	0	0	0
Giay	0	1	0
Ta Oi	0	0	0

Source: Statistics Data at District level, Province Level 2011

Table 2.3.20 Ethnic Distribution at Ha Nam Province

(unit: persons)

Ethnicity \ Town/District	Duy Tien	Thanh Liem	Binh Luc
Kinh	125,772	127,894	145,529
Tay	26	44	42
Thai	68	58	69
Muong	44	42	25
Kho Me	0	0	2
Chinese	7	8	2
Nung	9	11	11
Hmong	33	32	25
Dao	7	10	3
Gia rai	0	0	1
E De	0	0	1
Ba Na	0	0	0
San Chay	5	4	3
Cham	0	0	0
Co Ho	0	0	0
Xo Dang	0	0	0
San Dieu	1	0	0
Hre	0	0	0

Town/District \ Ethnicity	Duy Tien	Thanh Liem	Binh Luc
Ra Glai	0	0	0
Mnong	0	0	1
Tho (4)	4	5	0
Xitieng	0	0	0
Kho Mu	2	2	2
Bru Van Kieu	0	0	0
Co Tu	0	0	0
Giay	0	0	0
Ta Oi	0	0	0

Source: Statistics Data at District level, Province Level 2011

Table 2.3.21 Ethnic Distribution at Nam Dinh Province

(unit: persons)

Town/District \ Ethnicity	Nam Dinh	My Loc	Vu Ban	Y Yen
Kinh	242,408	68,991	129,396	226,620
Tay	144	11	23	44
Thai	217	81	140	274
Muong	111	22	47	78
Kho Me	5	0	0	3
Chinese	134	1	0	1
Nung	47	6	8	23
Hmong	67	23	33	81
Dao	19	5	1	11
Gia Rai	0	0	0	0
E De	1	1	0	0
Ba Na	0	0	0	0
San Chay	2	0	0	0
Cham	0	0	0	0
Co Ho	0	0	0	0
Xo Dang	0	0	0	0
San Dieu	0	0	0	0
Hre	0	0	0	0
Ra Glai	0	0	0	0
Mnong	0	0	0	0
Tho (4)	6	0	1	1
Xitieng	0	0	0	0
Kho Mu	0	0	2	2
Bru Van Kieu	0	0	0	0
Co Tu	0	0	0	0
Giay	12	0	0	3
Ta Oi	0	0	0	0

Source: Statistics Data at District level, Province Level 2011

Table 2.3.22 Ethnic Distribution at Ninh Binh Province

(unit: persons)

Town/District \ Ethnicity	Ninh Binh	Tam Diep	Hoa Lu	Yen Khanh	Yen Mo
Kinh	110,278	54,439	66,029	133,230	110,149
Tay	23	34	45	59	37
Thai	31	11	0	0	0
Muong	164	502	75	97	94
Kho Me	0	0	0	0	0

Chinese	1	4	0	3	1
Nung	1	4	9	1	3
Hmong	5	1	4	3	1
Dao	4	7	0	5	5
Gia Rai	1	0	0	0	0
E De	0	3	0	0	0
Ba Na	0	0	0	0	0
San Chay	5	4	0	1	0
Cham	0	0	1	0	0
Co Ho	0	0	0	0	0
Xo Dang	0	1	0	0	0
San Dieu	0	1	3	0	0
Hre	0	0	0	0	0
Ra Glai	0	0	0	0	0
Mnong	0	0	0	0	1
Tho (4)	3	2	1	1	0
Xitieng	0	0	0	0	0
Kho Mu	0	0	0	0	0
Bru Van Kieu	0	0	0	0	5
Co Tu	0	0	0	0	0
Giay	2	0	0	0	0
Ta Oi	3	1	0	0	0

Source: Statistics Data at District level, Province Level 2011

Table 2.3.23 Ethnic Distribution at Thanh Hoa Province

(unit: persons)

Town/ District Ethnicity	Thanh Hoa	Bim Son	Ha Trung	Thieu Hoa	Thang Hoa	Hau Loc	Nong Cong	Dong Son	Quang Xuong	Tinh Gia
Kinh	205,382	52,984	106,614	176,777	-	-	181,985	102,529	256,181	213,663
Tay	62	95	9	17	-	-	47	15	30	2
Thai	777	73	36	55	-	-	348	90	316	16
Muong	1,328	185	1,384	113	-	-	372	114	358	878
Kho Me	1	1	1	3	-	-	4	2	2	84
Chinese	29	1	0	2	-	-	4	5	3	2
Nung	10	24	1	6	-	-	18	10	12	1
Hmong	23	7	2	0	-	-	64	8	3	4
Dao	22	7	0	3	-	-	22	6	6	2
Gia Rai	0	3	0	0	-	-	0	0	0	3
E De	0	1	0	0	-	-	0	0	0	0
Ba Na	0	0	0	0	-	-	0	0	0	1
San Chay	2	1	0	0	-	-	2	2	0	1
Cham	5	0	0	0	-	-	0	0	5	0
Co Ho	0	0	0	0	-	-	0	0	0	0
Xo Dang	0	9	0	2	-	-	0	0	0	0
San Dieu	2	0	0	0	-	-	8	0	0	0
Hre	0	4	0	0	-	-	0	0	0	0
Ra Glai	3	0	0	0	-	-	0	0	0	1
Mnong	4	9	0	0	-	-	0	0	4	0
Tho (4)	46	5	2	2	-	-	19	2	11	5
Xitieng	0	0	0	0	-	-	0	0	0	0
Kho Mu	0	0	0	0	-	-	1	0	0	0
Bru Van Kieu	0	14	0	0	-	-	0	0	0	0
Co Tu	0	7	0	0	-	-	0	0	0	0

Town/ District Ethnicity	Thanh Hoa	Bim Son	Ha Trung	Thieu Hoa	Thang Hoa	Hau Loc	Nong Cong	Dong Son	Quang Xuong	Tinh Gia
Giay	0	3	0	0	-	-	0	0	0	0
Ta Oi	0	5	0	0	-	-	0	0	0	0

Source: Statistics Data at District level, Province Level 2011

Table 2.3.24 Ethnic Distribution at Nghe An Province

(unit: persons)

Town/District Ethnicity	Vinh	Quynh Luu	Dien Chau	Nghi Loc	Hung Nguyen
Kinh	301,120	344,083	266,257	183,955	110,388
Tay	110	33	23	25	6
Thai	1,849	1,816	109	125	38
Muong	162	37	15	12	7
Kho Me	6	1	0	0	1
Chinese	24	1	2	0	0
Nung	19	12	1	6	1
Hmong	85	4	4	1	0
Dao	11	4	2	1	0
Gia Rai	0	0	0	0	1
E De	1	0	0	0	0
Ba Na	0	0	0	0	0
San Chay	2	1	0	0	0
Cham	2	1	1	0	0
Co Ho	0	0	0	0	0
Xo Dang	2	0	0	0	0
San Dieu	3	0	0	2	0
Hre	1	1	0	2	0
Ra Glai	3	0	0	0	0
Mnong	1	0	0	0	0
Tho (4)	241	19	25	17	8
Xitieng	0	0	0	0	0
Kho Mu	31	0	6	2	0
Bru Van Kieu	4	1	1	0	0
Co Tu	5	3	0	0	0
Giay	1	0	0	0	0
Ta Oi	16	0	0	0	0

Source: Statistics Data at District level, Province Level 2011

2) The Poor

2.683 Little information was collected regarding the poor from city/provincial government. According to the statistics, the rate of the poor people is still quite high in Thanh Hoa and Nghe An provinces.

2.684 The poverty ratio of each city/province is shown in the table below.

Table 2.3.25 Poverty Rate by Province

No	Provinces	Poverty Rate by Provinces (%)				
		2004	2006	2008	2010	2011
	Whole Country	18.1	15.5	13.4	14.2	11.8
	Red River Region	-	-	-	-	6.5

	Central Coast Area		-	-	-	14.5
1	Ha Noi	-	-	6.6	5.3	3.1
2	Ha Nam	-	12,8	11.6	12.0	10.7
3	Nam Dinh	-	12	10.6	10.0	8.3
4	Ninh Binh	-	14,3	13.0	12.2	9.9
5	Thanh Hoa	-	27,5	24.9	25.4	20.4
6	Nghe An	-	26	22.5	24.8	18.8

Note: Poverty Rate in 2010 by the Government' poverty lines for period 2011-2015 are 400 thousand VNDs per month for the rural and 500 thousand VNDs per capital per month for the urban area.

Source: JICA Study Team based on Statistical Handbook of Vietnam, 2011, Statistical Year Book Provinces and District, 2011, Viet Nam Household Living Standards Survey, 2010 and some data provided by Statistics office at District level, 2011

2.4 Others

2.4.1 Climate Change

2.685 All city/provinces are aware of the potential threat of the climate change to the area especially by the rise of sea level. Also the tendency of the change of temperature, rainfall and some cases of extreme weather (ex. typhoons) are discussed in this item.

Table 2.4.1 Climate Change at Each Province

No	Province / City	Available documents	Description
1	Hanoi	Five-year environmental report 2006-2010 periods, chapter 8. Heading 8.1, pp.120-123.	Hanoi City faces typical phenomenon of climate change; abnormal climate phenomenon and scarcity of surface water. The winter temperature increases faster than summer temperatures, especially bitterly cold days in winter and record hot days in summer.
2	Ha Nam	Annual environmental status report, chapter 9, heading 9.1 & 9.2, pp.57-58.	In the trend of economic integration, Ha Nam socio economic development is quite quick and strong. The development uses a large amount of fuel when firing gas emission causing air pollution. There is some typical gas causing greenhouse effect (CO ₂ , NO _x , CH ₄ , CFC...) which is increasing quickly.
3	Nam Dinh	Five-year environmental report 2005-2009 periods, chapter VI. Heading 9.1.3, pp.120-124.	The climate change impacts to most of the world's nations and domains; Nam Dinh is involved in the global climate change. Hence, the climate change has affected to the socio-economic development, the ecological environment, the human, etc. of Nam Dinh.
4	Ninh Binh	Five-Year Env.Report 2006-2010, chapter 1, Heading 1.2, pp.4-5.	Almost 40% of Ninh Binh is in low land area, roughly above the sea level (1.5 m), and many places are even lower than the sea level, particularly in commune of Gia Trung of Gia Vien District (-0.4m).
5	Thanh Hoa	Five-Year Env.Report 2006-2010 periods, chapter IX, Heading 9.1, pp. 149-153.	Major green house gas sources in Thanh Hoa include industrial developments in recent years, which discharged a great amount of emission. There are totally about 958 production units in Thanh Hoa
6	Nghe An	Five-Year Env.Report 2005-2009, chapter I, Heading 1.2, pp. 8-9.	Nghe An is a poor province of Central Region, it has been developed with a diversified economy which has also taken part in increasing the greenhouse effects.

Source: DONRES, compiled by JICA Study Team

1) Climate Change in Hanoi City

(1) Abnormal Climate Phenomenon

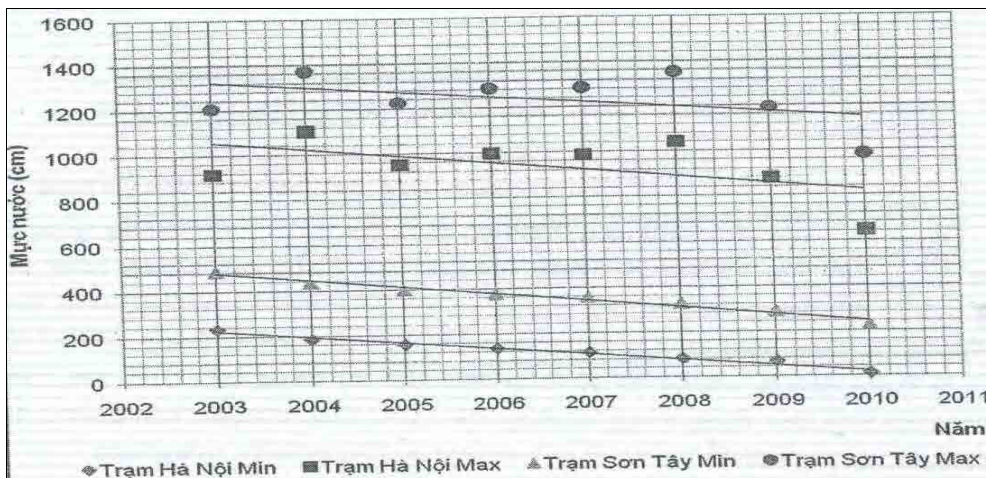
- (a) **Temperature:** the winter temperature increases faster than summer temperatures, especially bitterly cold days in winter and record hot days in summer. In 2007, the average annual temperature in Hanoi was 0.8–1.3 degrees higher than that of the period 1931–1940 and 0.4–0.5 degrees higher than the period 1991-2000 (Source: National Target Program to respond to climate change, MONRE, 2008).

- (b) **Rainfall:** The tendency of the average annual rainfall is not clear in the periods and in different areas. In recent years, the abnormal rainfall phenomenon with high frequency occurred in some urban areas, whereas some other areas were in the prolonged dryness.
- (c) **Cold Air:** cold air affected in two decades. The abnormal phenomena appeared more and more, and most recently, it was 30-day prolonged freezing in January and February 2008 in North Vietnam, including Hanoi (Source: National Target Program to respond to climate change, MONRE, 2008)

(2) Scarcity of Surface Water

2.686 The Red River is the main source of Hanoi's surface water. The Red River runs into Hanoi from Thuong Cat, Tu Liem Van Phuc commune, Thanh Tri district, about 30 km. The width of the river varies from 480 m to 1440 m (Hanoi station). The largest flow measured in 1996 was 14,700 m³/s, maximum speed at 2.08 m/s, the largest amount of suspended substance was 13,200 kg/s.

2.687 Drought, water shortage situation happened in the delta of the Red River basin systems on downstream in recent years. Particularly, in late 2006 and early 2007, from January to mid-March 2007, the shortage amount of water made up 45–55% making the water level of the Red River in Hanoi over-exhausted. Daily average water level was at 1.95m only, the minimum water level was 1.21 m (1.11m lower than the period 1956–1985), the average flow at 797 m³/s (166 m³/s lower than the period of 1956–1985).



Source: Statistics Data 2010, General Statistics Office

Figure 2.4.1 Average Water Levels in Duong River during the period 2005–2010

2) Climate Change in Ha Nam Province

(1) Greenhouse Gas Emission

2.688 In the trend of economic integration, Ha Nam socio economic development is quite quick and strong. The development uses a large amount of fuel when firing gas emission causing air pollution. There is some typical gas causing greenhouse effect (CO₂, NO_x, CH₄, CFC) which is increasing quickly. The estimated amount of gas causing greenhouse effect in 2009: CO₂: 7,322.38 tons/year; NO_x: 9,667.2 tons/year. The emission source causing greenhouse effect is the emissions from transportation activities and construction material production.

2.689 Followings are the loading situation of gas emission causing greenhouse effect in recent years and forecast in the future.

Table 2.4.2 Loading Amount of Gas Emission in Recent Years and in the Future

No	Year	Unit	NOx	CO2
1	2006	Ton/year	7,300	5,504.28
2	2007	Ton/year	7,523	5,990.40
3	2008	Ton/year	7,770	6,533.28
4	2009	Ton/year	9,659	7,322.38
5	2015	Ton/year	36,055	13,015.56
6	2020	Ton/year	37,854	15,515.84

Source: Ha Nam DONRE/2010

(2) Impact of Climate Change in Ha Nam

(a) Main Performance on Climate Change in Ha Nam

2.690 Being a province of Red Delta river, Ha Nam has to suffer from the climate change like other provinces in this region. Followings are main performance on climate change in Ha Nam:

- (i) The temperature is higher: the average temperature in 2007 in Ha Nam was 0.6°C higher than that in 2000. The intensity and the frequency of hot weather is much higher in recent years. Temperature is not stable, causing the disease development. The special hot temperature is in 2010, which is the longest time during 50 years, and the absolute high temperature is 1.2°C higher than the temperature before.
- (ii) Rainfall is lower in the dried season; number of days having drizzle rain is considerably lower. And the droughts appear more frequently. The river water level is very low, lead to the lack of water serving for production in some areas and risk of Nhue – Day river pollution, especially the river section passing Ha Nam Province.
- (iii) The frequency of cold atmosphere in the North and in Ha Nam is low remarkably. Number of serious cold days is lower, however, it happens heavily in long period in the beginning of 2008, it longs 38 days in January and in January.

(b) Impact of Climate Change to the Socio Economy and Ecological Environment

2.691 Climate change effect seriously to people health (especially children and old people), rate of people having cancel increase, and many new diseases appear. The unusual climate change also creates conditions for the disease development, causing remarkable damage on agricultural economic development.

2.692 Drought appears in long time in dried season, flood appears in rainy season as well as serious cold weather cause many diseases for rice and farm product leading to the reduction of plants and animals productivity and effect to provincial agricultural production.

(c) Action to Climate change in Ha Nam

2.693 Implement Decision No.158/2008/QĐ-TTg on 2nd December 2008 by Prime Minister that approved the national program on responding to the climate change, Official letter No.596/BTNMT-HTQT on 1st March 2010 by MONRE on

the construction of project list on climate change, Ha Nam Province has implemented following tasks:

2.694 Build action plan for the implementation of National program on responding to the climate change in order to respond to the climate change.

2.695 Propose list of projects on responding to the climate change.

3) Climate Change in Nam Dinh Province

(1) The climate change' impacts on Nam Dinh

2.696 The climate change impacts to most of the world's nations and domains; Nam Dinh is involved in the global climate change. Hence, the climate change has affected to the socio-economic development, the ecological environment, the human, etc. of Nam Dinh.

(a) Situation of Typhoons and Floods

2.697 For the damage: on Sep 27th 2005, No.7 typhoon (was named with Damarey as an international name) landed into Nam Dinh's coastal area. It damaged seriously for Nam Dinh Province, especially three coastal districts as Giao Thuy, Hai Hau and Nghia Hung. Total estimated damage was 1,889.25 billion VND; among 827.16 billion VND was the damage of the three coastal districts. The total damaged coastal embankment length was 19,054m. In addition, there was an area of 8,765ha of salinity intrusion (among, 265ha of rice-cultivation area, 950 ha of the other crop cultivation area and 3,000 ha of shrimp farms).

2.698 The climate change has also increased the no. of cold-air times with a denser density and the lower temperature. In addition, there are unusual sunny-days which last for a long duration with a high temperature.

(b) The Salinity Intrusion, Aggressivity

- **Salinity intrusion**

2.699 Based on the real monitoring data up to Jan 12th 2006: on Hong River's watershed, the salinity intrusion spread to Ha Mieu I lockage with 7.2‰ of the salinity, this location was 26km far from the sea. On Ninh River's watershed, the salinity intrusion spread to Muc 2 lockage with 1.7‰ of the salinity, this location was 37km far from the sea. On Day river's watershed, the salt-water spread to Binh Hai I lockage with 5‰ of the salinity; this location was 18km far from the sea. In 2009, the salinity intrusion occurs at the estuaries more greatly and earlier. For example, on Hong river's watershed, the salinities monitoring at Con Nhat lockgate were 6‰ on October 6th 2009, 23‰ on November 19th 2009 and 26.5‰ on December 16th 2009.

Table 2.4.3 The Salinity Monitored at Some Locations along Three Major Rivers of Nam Dinh

No.	Rivers	Monitored Locations	Distance (to the Estuaries)	Dates when the salinities are the highest one	S _{max} (‰)
1	Hong	H3	10	Dec 26 th	19.35
		H2	22	Dec 25 th	1.15
		H1	32	Dec 26 th	0.12
2	Day	D3	10	Dec 25 th	16.45
		D2	22	Dec 26 th	0.75

		D1	32	Dec 26 th	0.12
3	Ninh Co	NC3	10	Dec 26 th	26.70
		NC2	22	Dec 26 th	3.75
		NC1	32	Dec 25 th	0.48

Source: Vietnam Irrigation Institute, 2007.

- **The Aggressivity**

2.700 Among Nam Dinh's coastal areas, Hai Hau is the area where the beach has spread-forward larger to the land and the beach has been back-run at the embankment locations impacted directly with waves, tides, risen water-level and typhoons; therefore, the erosion occurs greatly at these locaions.

4) Climate Change in Ninh Binh Province

2.701 Almost 40% of Ninh Binh is in low land area, roughly above the sea level (1.5 m), and many places are even lower than the sea level, particularly in commune of Gia Trung of Gia Vien District (-0.4 m).

2.702 According to warnings from the United Nation Environment Program, global temperature is likely to increase by 1°C by 2025 and 4°C by end of this century. Such climb in temperature leads to climate change, and its direct effect is increased sea level. According to calculations of environment scientists, when the earth temperature goes up by 4°C, the sea level will increase 0.5–1.0 m. In Vietnam and particularly in Ninh Binh, as a consequence, loss of cultivation land is likely. In case that the sea level increases by 0.5m, 40% of land of Ninh Binh, mostly rice fields, will be below sea level, and the whole cultivation land will be salinated. Rice farming will be quite difficult.

2.703 In Ninh Binh Province, climate change is now making negative impacts: salinity intrusion is even more encroaching to the inland, affecting significantly production and life of coastal populations. Salinity intrusion has its negative impacts even on coastal protective forests, aquatic farms and various crops. To the north of the province, floods are frequent after heavy rains in the upstream of Boi and Lang rivers, finding their ways to Hoang Long River, and more than 10,000 of people in Nho Quang and Gia Vien are often facing months of inundations.

5) Climate Change in Thanh Hoa Province

(1) Green-House Gas Emission in Thanh Hoa

2.704 Major Green house gas sources in Thanh Hoa include industrial developments in recent years, which discharged a great amount of emission. There are totally about 958 production units in Thanh Hoa. And those emitting green-house gase are basically involved in:

- (i) Mining, construction material production
- (ii) Paper production
- (iii) Sugar and alchohol production
- (iv) Food processing

Table 2.4.4 Changes in Mining and Construction Material Production, Paper Production in Recent Years

Year	2006	2007	2008	2009
Cement (000 ton)	4,689	4,796	5,260	5,392
Roof tile (000 pcs)	12,278	12,650	17,202	21,903
Stone (000m ³)	2,265	5,271	4,369	5,283
Baked bricks (mil. pcs)	784	740	821	834
Paper (VND mil.)	360.1	388.9	412.8	435.2

Source: Thanh Hoa DONRE

2.705 The table shows a rising trend on output of the industries from 2006 to 2009. The output of each industry increased thanks to some basic reasons:

- (i) Increase the number of manufacturing establishments operating in each sector.
- (ii) Increase in power.
- (iii) Increase in volume due to advancements of technological level.

2.706 However, Thanh Hoa industrial output increased in recent years mainly due to two reasons: increase of the number of manufacturing establishments operating in each sector and increase of design capacity.

2.707 Thus, the output of industrial production last year increased that cause the increase of CO₂ emitted into the atmosphere, and mostly by CO₂ emissions from mining and construction materials production. Scientists believe that CO₂ emissions from cement production in the world accounts for approximately 5% of total CO₂ emissions by human activities.

2.708 Transportation is also a source of CO₂ emissions. The high growth rate of motorized vehicles in Thanh Hoa in recent years means the sharp increase in annual energy consumption, and thus inevitably emissions.

2.709 Agricultural sector contributes annual emissions with large amounts of greenhouse gases. The activities in the agricultural sector, which generate greenhouse gases, include:

- (i) Deforestation, burning of forests for cropping, construction of industrial zones, narrowing vegetation coverage (not only to increase a large amount of CO₂ emissions, but also to destroy valuable resources capable of absorbing CO₂).
- (ii) Activities such as land use conversion for urbanization and burning rice straw after are also a source of greenhouse gas emissions.
- (iii) Livestock wastes.
- (iv) The drying of wetlands is also a cause of release of CO₂ and CH₄. According to estimates by scientists, greenhouse gas emissions caused by global agricultural activities account for approximately 20% of total greenhouse gases generated by humans. In Vietnam, according to survey of greenhouse gases in 1994, the amount of CO₂ emissions in the agricultural sector was weighed about 52.45 million tons per year, accounting for 50.5% of total emissions.

2.710 Population growth also causes greenhouse gas emissions, because the bigger population is, the more CO₂ emissions are generated.

Table 2.4.5 Thanh Hoa Population, 2006–2009

Year	2006	2007	2008	2009
Population	3,682,000	3,697,200	3,712,500	3,400,239

Source: Thanh Hoa DONRE

2.711 The garbage dumping sites are also sources of CH₄ gas. On average and over the same period, the emissions arising from landfill are more than six times the amount of gas arising from the consumption of energy (as greenhouse effect caused by CH₄ is 21 times the effect by CO₂). The province of Thanh Hoa has about 33 landfill sites in urban areas and in rural areas, but they are not sanitary landfills, but all merely waste dumping sites without treatment facilities. Many of the sites have been overloaded, and by time local decomposition releases CH₄.

(2) Impacts of Climate Change in Thanh Hoa Province

(a) Status of Climate Change in Thanh Hoa

2.712 Climate and weather in recent years in Thanh Hoa have indulged more abnormal occurrences, which are way beyond the trend observed several decades ago. In fact, there has been an increase in extreme weather phenomena, increasingly shorter winter, longer summer, irregular droughts and floods, erratic rainfalls are expected. Both heavy rains and serious droughts are also on the rise, with the reduction of drizzle.

2.713 In 2006-2008, active coldness prolonged, and days of cold weather were more, and thus causing harms and damage to agriculture.

2.714 In 2009–2010, the winter is less cold wild summer is hotter and sunnier with regular droughts, storm, floods, and flash floods occurring both locally and elsewhere in the region. Saltwater intrusion into estuaries takes place more seriously, especially in dry months and especially in district of Hau Loc, Nga Son, Hoang Hoa along rivers of Hoang, Len, Lach Truong. Sea erosion takes place strongly in Tinh Gia, Hoang Hoa, Quang Xuong, Sam Son town.

2.715 Global warming up leads to speedy evaporation from the ocean and rivers, lakes and thus affecting formation and distribution of clouds, and as a result precipitation changes on a large scale. The average annual rainfall in Thanh Hoa Province in five years (2006–2010) changes significantly by each location, in different periods and on different areas. The rainfall increased in certain periods but decreases in others. The changing tendency of rainfall varies between regions. Annual rainfall is relatively large, but not evenly, more widespread heavy rains caused local flooding, tidal surge, not according to natural laws. In 2006-2007, rainfall pattern was relatively consistent with the tendency of rain during the rainy seasons. In 2008, rainfall increased sharply in November (up to over 100mm), while in the same period in the previous year rainfall is approximately 20mm.

2.716 According to the Office of the Thanh Hoa flood control Steering Committee, flood situation from 2005 is presents as follows:

2.717 In 2005, storm and tropical depression occurred regularly, including 2 storms, known as Number 6 and 7, with very strong magnitude, which landed directly in Thanh Hoa in a short time.

2.718 In 2006, Thanh Hoa was not affected directly by storms.

2.719 In 2007, Thanh Hoa was directly hit by four hurricanes (No. 1, No. 2, No. 4 and No. 5), especially the No. 5 storm which hit Thanh Hoa–Da Nang with gust of magnitude level 6 and level 7. Rising sea level combined with high tides caused rupture of dykes and the entire crop land area of Da Loc–Hau Lock, Quang Thach–Quang Xuong are salinated. In 2007, Thanh Hoa received five river floods, and with combined effects from the Storm 5, the most serious floods was recorded for the last 40 years. On the main rivers, such as Ma (at Ly Nhan) the flood level was 13.24m.

2.720 In 2008, Thanh Hoa got hit by 2 storms in September and October. Because of impacts of the storm 7, Thanh Hoa suffered from heavy rains, which caused flooding from 26/10–3/11, and serious damages to the local.

2.721 In 2009, Thanh Hoa was affected by 2 hurricanes: Hurricane 6 in August and Typhoon No. 10 in October, with wind speed at level 6, level 7. Flash floods, landslides occurred in Trieu Son causing great losses in lives and properties of the people.

2.722 The situation on the river salinization: According to salinity limit 1E, from the estuary upstream, the salinity intrusion into the river during surveys in 2010 are as follows: On the mainstream of Ma River, salinity reaches as much as 28 km (in 2009 only 23 km), while for Len River, 22 km; Lach Truong and Kenh De: the whole rivers; Hoat River: upto Au My, Quan Trang; Bao River: to Bao Van; Yen River and Hoang River: 26km, and Nhom River 23 km.

2.723 In recent years, damages caused by natural disasters are growing: in 2005, both heaviest drought and the most violent storms occurred, while in 2007 the domination was flood damage, which topped the historical data. In 2009, 2010 hot weather prolonged and river level decreased, lower than design level of the water pumping station and intake pipes by 0.5 to 1.2 m, resulting in draughts and the lack of water in 7,200 ha. One of the reasons was the effects of global climate change.

(b) Impacts of Climate Change

- **Economic and Social Aspects**

2.724 According to research by the World Bank in 2006, Vietnam was on the list of five countries most affected by sea level rise caused due to climate change. Thanh Hoa has the longest coastline of Vietnam, and local climate is featured by humid tropical monsoon, less-cold-and-rain winter, and hot and humid, summer and thus Thanh Hoa would also be greatly influenced by sea level rise as an impact of climate change. In recent years, Thanh Hoa frequently received natural disasters, floods occurrence with increasing damages and affects to local social and economic developments in the province.

- **Agricultural Sector**

2.725 Agricultural production is always faced with changes in conditions of weather, with increasing pests and diseases, which lead to reduced productivity and crop yields, and thus an increased risk for food security,

crop structure. In fact, crops in some areas have been altered by shortened winter crops, even with no winter crops, and longer summer crops. That requires changing farming techniques.

2.726 Climate change causes drought and high soil salinity, so much that rice fields are either droughted or salinated, and thus farmers were forced to switch to growing others crops suited to the new conditons.

2.727 Climate change is disrupting rainfall, sunshine and also imposing more risk of hot weather, more and longer rain, reducing a large amount of nutrients in local soil, which ends up in reduction of crop yields.

2.728 In coastal areas, temperatures rose and this caused dispersal of fisheries resources. The rising sea levels directly affect fisheries (sub-tropical species of high economic value fall in population), assets and other infrastructure, making it difficult for people living in this area.

2.729 With rising temperatures, animals consume more energy for respiration and other life activities, and that decreases productivity and quality seafood.

- **Impacts on industrial sector**

2.730 Rising temperatures affects the operation of equipment, manufacturing machinery, and increases costs for maintenance and operation of machineries, vehicles, manufacturing equipment, increasing costs for ventilation, cooling tunnel furnace operators and reduces productivity. Electricity consumption increases and that would leads to increase of production costs, and lower economic efficiency.

2.731 Industrial parks and industrial clusters face more risks of flooding and drainage challenges by floodwaters caused by rivers and sea level rise, particularly those with industrial waste and toxic chemicals built on lowlands.

2.732 Regarding sea dykes, river dykes to protect the drainage system, it is to adopt measures to limit the risks.

2.733 Climate change increases the difficulty of supplying water and raw materials for industries such as textiles and construction, manufacturing, mining and mineral processing, agriculture, forestry and aquaculture, information, media, and etc. Climate change also requires the industries to reconsider development plan, technical standards, and industry standards to adapt to the change.

2.734 The extreme climatic conditions increase frequency of natural disasters may shorten life of materials, components and machinery, equipment and buildings, which are costly to fix.

• **Impacts on the Ecosystem**

2.735 Temperature increases affect natural ecosystems, shifts the thermal boundary of the continental ecosystems and freshwater ecosystems, changes the structure of plants and animals in some areas; some native species of temperate and subtropical could be lost, leading to loss of biological diversity.

2.736 Climate change is seriously affecting forest coverage, changes distribution pattern of the boundary areas of primary and secondary forests, and increase risks of extinction againsts animal and plants with rare genetic resources.

2.737 Climate change increases the level of drought in the dry season, leading to an increased risk of forest fires, insect development, destructive diseases of forest trees.

2.738 Rising temperatures melt polar ice, while sea level changes of mangrove forest area; large areas of fertile land may be submerged in seawater. Sea level rise leads to salinity intrusion, affecting some aquatic species. Therefore, the quality of habitat for many aquatic species may get deteriorated.

2.739 Rainfall intensity and heavy rains makes the salt concentration decreases in a long time, and that may lead to mass distinction of brackish water organisms, especially the two shells of mollusks (oysters, clams, scallops.) which died because failing to adapt with salinity changes.

2.740 Subtropical species of high economic value may get either diminished or lost, while the majority of reef gets degraded and destroyed, physiological, biochemical changes take place in the relationship between corals and algae.

2.741 Phytoplankton species, the first link of the food chain for zooplankton is destroyed, and that dramatically reduces zooplankton, thereby reducing the principal food source of the animals middle and upper level.

- **Impacts on Human**

2.742 Climate change increases the likelihood of some tropical diseases such as malaria, and dengue, and accelerates growth and development of many types of bacteria and insects, disease-carrying hosts, increases the number of human infections.

2.743 Increased temperature changes of human circadian rhythm, increases negative impacts on human health, increases risks for diseases, leading to increased risks for older people, children, and people with cardiovascular problems, neurological diseases.

2.744 Climate change causes new diseases. In the past three decades, mankind has recorded 30 new diseases.

2.745 Changing rainfall and temperature facilitate infections. The number of deaths due to heat can raise as temperatures stay high in longer cycle than before.

2.746 Natural disasters such as hurricanes, surges, floods, droughts, heavy rains and landslides etc. increase in intensity and frequency, and human fatality also increases.

2.747 Mountainous and coastal areas are vulnerable to climate change than the delta areas. To the coastal areas, population are affected by floods, and several coastal regions will suffer more floods, landslides than others, from loss of land and mangroves area. Sea water intrusion will also affect the

supply of fresh water

6) Climate Change in Nghe An Province

2.748 The climate change has made up a serious consequence in the whole world. The major cause of the climate change is the increased concentrations of greenhouse gases (such as: CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, etc.). The greenhouse effect has risen the temperature of the lithosphere that causes of the climatic changes. Nghe An is a poor province of Central Region, it has been developed with a diversified economy which has also taken part in increasing the greenhouse effects.

2.749 Sources of the greenhouse gases:

- Livelihood activities: electric usage, transport vehicles, cooking, etc. Most of these activities must use the fossil fuels, such as: oil, coal, etc.
- Transport vehicles: cars, motorcycles.

2.750 The major vehicles of local people are motorcycles; there is averagely 1 motorcycle/1 household; thus, motorcycles also take part in rising the greenhouse gases. Besides, a large number of cars (the travelling means are used in the city, the provincial towns and the urban areas) and vans (for the freight transportation) is a significant source which takes part in increasing the greenhouse gases. It is estimated that each car will discharge 1.3 tons of CO₂ when it has taken a distance of 3,000km.

- Daily living activities of local people: the rural households using coal and fire-wood as the main fuels for cooking.
- The cleaning devices used in households: refrigerators, air-conditioners.

2.751 Nghe An is in the extremely hot climatic-zone; so the locality needs a great power volume for the cooling equipment in summer.

- Agriculture:** Nghe An is an poor province of which people earns living mainly by agricultural production. The provincial agricultural area covers 11.9% of total natural area, so the methane volume arisen from the used fertilizer is relatively large. Besides, agriculture activities are the major source of N₂O.
- Industry:** the industrial gas is arisen mainly from the refrigeration devices, air-conditioners, the activities relating to chemical reactions, etc.
- Cement factories:** Nghe An has some major cement factories (such as: 19/5, 12/9, Cau Duoc, Hoang Mai, etc.) which are one of the sources increasing the greenhouse gases significantly.
- Landfills:** at present, most of districts, city and provincial-town have had the landfills. The anaerobic decomposition process of solid waste generates a great volume of greenhouse gases, either.
- Medical waste incinerators:** Nghe An is a largest province in Vietnam. The no.of hospitals which have been developed with the medical-waste incinerators has been increased; however, these incinerators have had part in increasing the greenhouse gases.
- Decreased forest area:** The provincial forest area has been narrowed seriously; as

the the result, the greenhouse gases are absorbed badly.

2.752 **Hydroelectricity:** up to present, Nghe An has about 20 hydroelectric facilities of which the capacities are medium or small-size. The hydroelectric dams also generate a relatively great volume of greenhouse gases; because, when the flora species which reside in the hydroelectric reservoirs are decayed, they will generate a great volume of cacbonate. In addition, the flora benthos is continuously disintegrated in the non-oxygen condition and generates methane which is generated into the air when the water from the reservoirs runs through the dams' turbines. The rate of methane effect to the global warming is 21 times higher than the one of CO₂.

3 SOUTH SECTION

3.1 Natural Environment

3.1.1 Topography and Geographical Features

Table 3.1.1 Topography and Geographical Features at Each Province

No	Province/ City	Available Documents	Description
7	Khanh Hoa	5ECSR 2006-2010 periods, chapter 1, heading 1.1, pp.5.	Khanh Hoa lies in Northern Central Coastal Region. The province is bounded with Phu Yen to the north (the northernmost point is in 12°52'15" of northern latitude), with Ninh Thuan to the south (the southernmost point is in 11°42'50" of northern latitude), with Dak Lak and Lam Dong to the west (the westernmost point is in 108°40'33" of eastern longitude) and with Dong Sea to the east (the inland easternmost point is in 109°27'55" of eastern longitude).
8	Ninh Thuan	5ECSR 2006-2010 periods, chapter 1, heading 1.1, pp.2.	Ninh Thuan is a coastal province in the South Central Region. Provincial boundary is limited with the coordinate: longitude 108°09'08" to 109°14'25", latitude 11°8'14" to 11°9'15". Total natural land area is 3,358 km ² .
9	Binh Thuan	5ECSR of Binh Thuan Province (2005 – 2009), chapter I, heading 1.1, pp.9-10. See paragraph below.	Most of the territory has the low mountainous shape and the coastal delta spread along the coast in the direction from the Northeast to the Southwest, with about 160 km of the coast line, the widest area is 195 km, the narrowest one is 32km. The North is contiguous to the last flank of Truong Son mountain range; the South has the sandy hill range.
10	Dong Nai	5ECSR of Dong Nai Province (2006-2010), Part 4, chapter 1, heading 1.1, pp. 19-20.	Dong Nai possesses flat and plain terrain with mountains scattered sparsely, which tend to be lower from the north to the south.
11	Binh Duong	5ECSR of Binh Duong Province (2005-2010), chapter 1, heading 1.1: natural condition, pp.17-18.	Binh Duong locates within the interference zone between Southern Central Region Highlands and Mekong Delta; so Binh Duong is made up with the low hills or mountains, the terrain is flat, the geological ground is relatively stable and steady.
12	HCMC	5ECSR of HCMC (2005-2009), chapter 1, heading 1.1, pp. 1.	Ho Chi Minh City lies within 10°10' – 10°38' Northern latitude and 106°22' - 106°54' Eastern longitude, it borders to the north with Binh Duong, to the Northwest with Tay Ninh, to the east and northeast with Dong Nai, to the south east with Ba Ria – Vung Tau, to the west and southwest with Long An and Tien Giang.

Source: DONRE, compiled by JICA Study Team

1) Topography and Geographical Features of Khanh Hoa Province

3.1 The five-year environmental status report of Khanh Hoa Province summarizes the topography and geographical features of the province as follows.

3.2 Topography and geographical features: Khanh Hoa lies in Northern Central Coastal Region. The province is bounded with Phu Yen to the north (the northernmost point is in 12°52'15" of northern latitude), with Ninh Thuan to the south (the southernmost point is in 11°42'50" of northern latitude), with Dak Lak and Lam Dong to the west (the westernmost point is in 108°40'33" of eastern longitude) and with Dong Sea to the east (the inland easternmost point is in 109°27'55" of eastern longitude. this is also the easternmost point of Vietnam).

3.3 Besides the inland territory, Khanh Hoa also comprises the sea area, continental shelf, coastal islands and Truong Sa island-district. The air-space above this mainland and water area belongs to Khanh Hoa.

3.4 Khanh Hoa has lozenge shape, it is bounded with mountains at three sides, the last side is Dong Sea. As the crow flies, the provincial by-length is around 160 km (to north-south direction); while to the east-west direction, the breath is 60 km (at the widest location), 1 to 2 km (at the northern narrowest location) and 10 to 15 km (at the southern narrowest location).

3.5 Khanh Hoa has a total area of 5,217.6 km². The marine-water area is many times larger than the mainland one. The provincial coastal-line length is 385 km. Khanh Hoa has about 200 coastal small and large islands as well as atolls within Truong Sa archipelago which plays an important role in national security protection and economic development. The locality is considered to be the unique province which has three beautiful marine bays (Nha Trang, Van Phong, and Cam Ranh). This is an ideal condition to develop the provincial tourism and economy, especially to develop sea-ports, fishing and aquaculture.

3.6 Khanh Hoa is located at the advantageous location of transport (involving the railway, airway, road and marine-way). Hence, it is such an advantageous condition for the provincial economic and cultural exchanges with the other localities (due to NH1A and North-South railway run through Khanh Hoa).

3.7 The provincial geographical location acts a strategic role in the national security, because the locality is adjacent to the international maritime line; in addition, the province has the gateway to the sea (with Truong Sa island-district and Cam Ranh port).

2) Topography and Geological Features of Ninh Thuan Province

3.8 According to the five-year environmental status report of Ninh Thuan Province:

(a) **Topopgraphy:** Ninh Thuan is a coastal province in the South Central Region. In the province, there are transportation axis namely NH1A, Thong Nhat Railway and NH27. This province has favorable conditions to connect with the Focal Economic Zone in the South and areas in the tourism region of Da Lat – Phan Rang Thap Cham – Nha Trang.

3.9 Provincial boundary is limited with the coordinate: longitude 108°09'08" to 109°14'25, latitude 11°8'14" to 11°9'15". Total natural land area is 3,358 km². It borders with other provinces as follows:

- (i) In the North, it borders with Khanh Hoa Province
- (ii) In the South, it borders with Binh Thuan Province
- (iii) In the West, it borders with Lam Dong Province
- (iv) In the East, it borders with the South China Sea
- (v) Border line: 498km (Statistical Yearbook 2009)

(b) **Geographical Features:** Ninh Thuan is a transitional region between the narrow coastal lowland of Phan Rang and Lam Dong highland. The topography includes: mountain, lowland, coastal land and transitional area between mountainous area and lowland. The slope is lowering from the North West to South East. The elevation of each region fluctuates as following:

- (i) Mountainous topography: the elevation fluctuates from 200 to 1,200 m. The highest elevation is ranging from 1,500 to 1,780 m, and the peak E Lam Thuong is 1,200 m.

- (ii) Transitional area between mountainous area and coastal area: the elevation fluctuates from 50 to 200 m, and its average elevation is 80 to 100 m.
- (iii) Lowland: the elevation fluctuates from 10 to 50 m. The common elevation in the coastal area is 2 to 5 m.

3) Topography and Geographical Features of Binh Thuan Province

3.10 The five-year environmental status report of Binh Thuan Province summarizes the topography and geographical features of the province as follows.

(a) **Topography:** Most of the territory has the low mountainous shape and the coastal delta spread along the coast in the direction from the Northeast to the Southwest, with about 160 km of the coast, the widest area is 195 km, the narrowest one is 32 km. The North is contiguous to the last flank of Truong Son mountain range; the South has the sandy hill range. In general, the geography is classified complicatedly; the rivers and the springs are short, including 4 kinds of geography as below:

- (i) The coastal sandy hills and sandbank which accounted for 18.2% the natural area, are mainly the waving red, white, yellow sandy hills and classified along the coast from Tuy Phong to Ham Tan districts, the widest area is Bac Binh district (about 52 km in length, 20 km in width).
- (ii) The alluvium delta areas, which accounted for about 9.4% the natural areas, are formed mainly from the alluvium of the river and spring systems, including the small and narrow coastal alluvium delta from the valley of Long Song river to Ding river: Tuy Phong delta (Long Song river), Phan Ri, Mao river (Luy river), Phan Thiet (Quao river, Ca Ty river) and the delta of La Nga river valley (Duc Linh, Tanh Linh)
- (iii) The low and medium mountainous areas, which accounted for 40.7% the natural areas, centralize mainly in the North and the Northwest of the province. They are the main parts of Truong Son mountain range, from the Northeast to Southwest, from the North of Bac Binh Province to the Northeast of Duc Linh Province, with a high downward gradient, and a complicated geography.
- (iv) The moundy hill areas, which accounted for 31.7% the natural areas, is the transformed form of height of the low mountainous areas, stretching in the direction of Northeast- Southwest from Tuy Phong to Duc Linh districts.

3.11 The above geographic characteristics facilitate the province to develop the diversified and rich agro- forestry production. However, there still have some difficulties in the re-claiming investment, field improvements, production costs and infrastructure arrangement.

(b) **Geographical features:** Binh Thuan is a coastal province in the southeast area, which borders to Ninh Thuan Province in the North and the Northeast, Lam Dong Province in the Northwest, Dong Nai Province in the West, Vung Tau Province in the Southwest and it is bounded by East Sea in the East and the Southeast.

3.12 It is located 200 km away from Ho Chi Minh City, 250 km from Nha Trang City. The province is connected by NH1A, North-South Railway line and NH28 (to Phan Thiet City and Highland Central Provinces) and by NH55 to petro service Centre and Vung Tau. This is contiguous to East Sea, etc, which gives the convenient conditions for the province to strengthen, expand the relationship for economic exchanges and development to the southeast, Tay Nguyen provinces, South centre coast area and to

the country. The attraction of the cities and the large economic, cultural, political centres such as Ho Chi Minh City, Vung Tau, Da Lat, Nha Trang., bringing Binh Thuan the ability to stimulate and develop the variety of goods production receiving the technological advances.

- (v) Total natural area: 783,047.13 ha
- (vi) Geographic coordinates: 10°33'42"- 11°33'18" North latitude
107°23'41"- 108°52'42" East longitude

3.13 Binh Thuan Province has 178km of 1A national highway and 189 km of North-South railway, 28 national highway connected with the South Tay Nguyen provinces and 55 national highway connected with Ba Ria- Vung Tau Province.

4) Topography and Geographical Features of Dong Nai Province

3.14 The five-year environmental status report of Dong Nai Province summarizes the topography and geographical features of the province as follows.

(a) **Topography:** Dong Nai possesses flat and plain terrain with mountains scattered sparsely, which tend to be lower from the north to the south. Terrain can be divided into main types as follows:

(i) Flat terrain includes two main types:

- River terraces are about 5 - 10m high; there are places in which river terraces are only 2 - 5m high along rivers, which create narrow strips with its width varying from tens of m to several km. Soil of this terrain type is mainly modern alluvium;
- Depressed terrain on salt-marsh deposits: includes depressed land in Dong Nai with height varying from 0,3m to 2m, there are places even lower than sea level, therefore, usually suffering from flood tide, river and canal network is interlacing, covered by mangrove forests. Natural materials are not homogeneous, with much clay and organic materials deposits;

(ii) Wavy hill terrain: Height varies from 20m to 200m. This type of terrain includes Basalt Mountains; terrain surface is flat, slope, with inclination varying from 30 to 80. This terrain type covers an area much larger than other types, covering almost every basalt and ancient alluvium. Soil on this type of terrain is mostly red-yellow soil and grey soil;

(iii) Low mountain terrain: includes mountains scattered sparsely, which are the end part of Truong Son mountain range with height ranging from 200 to 800 m. This type of terrain is mainly seen in the Northern Province in the boundary area between Tan Phu and Lam Dong district; this terrain type also includes several mountains in Dinh Quan, Xuan Loc district. All of these mountains have a height ranging from 20 to 300m; "parent" rocks are open to the air in groups with main rock types including granite, clay shale.

(b) **Geographical Features:** Geology structure is divided into types as follows:

(i) Pre-kainozoi generation includes such systems as: Trias Buu Long bed (T₂abl); Jura bed in the downstream of Đăc krong (J₁đk) and Jura bed in the midstream of Ma Da (J₂amđ); Tra My bed (J₂a-bjtm); and Creta bed in the downstream of Long Binh (K₁lb);

- (ii) Kainozoi generation, bottom-up order: Dai Nga bed (N_1^3) including basalt rock and red soil; Ba Mieu bed (N_2^{2bm}) including sediment of middle size grain and fine grain; Tuc Trung bed (N_2-Q_1) including basalt rock and red soil; Trang Bom bed (Q_1^{1tb}) including fine grain sediment and coarse and crushed grain sediment; Xuan Loc bed (Q_1^{2xl}) including basalt rock, laterite red soil; Thu Duc bed (Q_1^{2-3td}) including sediment of middle size, fine; coarse grain; Soc Lu bed (Q_1^3sl), Cay Gao basalt (Q_1^3cg), Phuoc Tan basalt (Q_1^3pt); Plio Pleistocen friable sediment weakly links Cu Chi bed (Q_1^3cc) an on the top is material of coarse and fine grain Holocen (Q_2).

3.15 In Dong Nai, there are 10 soil types. Three main soil types, accounting for the highest percentage in the province include: grey soil 40.1%, convenient for the development of industry, agriculture and construction; black soil 22.4% and red soil 19.3%. Next comes alluvium 4.8%; Gley soil 4.6%; brown soil 1.9%; thin layer soil 0.5%; pumice soil 0.4%; sandy soil 0.1%; patchy layering soil 0.02%. Some main soil types are as follows:

- (i) Grey soil: formed on ancient alluvial sedimentary rock, a small percentage is formed on granite rock. Grey soil is divided into 5 units of class 2 and 17 units of level 3, mainly distributed in Vinh Cuu (31.5%) and evenly scattered in Dinh Quan, Xuan Loc, Long Thanh, Tan Phu. In Long Khanh, this soil type does not exist;
- (ii) Black soil: This soil type is formed on pumice basalt rock, divided into 3 units of class 2 and 15 units of class 3, concentrated in Xuan Loc (27.8%), Thong Nhat (20.9%), Tan Phu (18.2%), Dinh Quan (17.4%) and scattered in other provinces. In Nhon Trach, this type of soil does not exist;
- (iii) Red soil: mainly formed on basalt rock, mainly concentrated in Long Khanh town (37.4%) and scattered in other districts, this type does not exist in Bien Hoa and Nhon Trach;
- (iv) Alluvial soil: formed thanks to alluvial deposit from rivers. The area of alluvium free from alum in the province is 5,817ha and the area of alluvium containing alum is 22,052ha. Alluvium soil is distributed in Bien Hoa (6.5%) and southern districts like: Nhon Trach (71.4%), Long Thanh (15.0%);
- (v) Gley soil: including humus gley soil free from alum (24,308ha) and gley soil containing alum (2,450ha), mainly suitable for rice growing, distributed in Tan Phu district (48.2%), Vinh Cuu (18.5%), Long Thanh (16.7%), Nhon Trach (5.0%) and Bien Hoa (6.1%).

5) Topography and Geographical Features of Binh Duong Province

3.16 The five-year environmental status report of Binh Duong Province summarizes the topography and geographical features of the province as follows.

- (a) **Topography:** Binh Duong locates within the interference zone between Southern Central Region Highlands and Mekong Delta; so Binh Duong is made up with the low hills or mountains, the terrain is flat, the geological ground is relatively stable and steady. The most popular terrain is performed with the sequence ancient alluvial hills of which the average height is 20 to 25m (higher than the sea level) and the average slope is below 3 to 150. Especially, there are some low mountains rising in the flatland areas, such as ChauThoi mountain in Di An (82m), the three mountains as Ong Cao

(284.6m), La Tha (198m) and Cau (155m) of DauTieng district.

3.17 To the south – north direction, depending on the height, there are 3 main terrains as follows:

- (i) The zone of alluvial valleys: these ones are located along Dong Nai river, Saigon River and Be river. This is the lowland zone which is raised newly with the silt. The zone is relatively fertile, flat; its average level is 6 to 10m.
- (ii) The flatland zone: the zone is adjacent the alluvial valley zone; its terrain is relatively flat; the topographic slope is 3to 120 and the average level is 10 to 30m.
- (iii) The zone of relatively corrugated low hills: this one is located in the ancient alluvial ground. The zone is performed mainly with the low hills which have the relatively flat tops and are located sequentially.

3.18 Although, Binh Duong is bounded with the large rivers, the province is affected less with the floods and inundation (excepting some lowland locations along Saigon river and Dong Nai one), because the average level of ground is 20 to 25 m.

3.19 However, in the recent years, with the development of the urban areas, the industrial zones, the production clusters as well as the large-size mineral exploitation progress (mainly at the east of Di An district, the south of Tan Uyen district, My Phuoc district town of Ben Cat district) have changed the terrain that has destroyed the natural features and made up many negative impacts, such as: the ground surface washout and the slope erosion.

- (b) **Geographical features:** Being located within Southeast Region, Binh Duong is one of the seven provinces/ cities of Southern Focal Economic Zone (SFEZ) which is one of Vietnam's most dynamic economic zones and be considered as a place which attracts a numerous of foreign investors as well as produces goods focally with a great productivity and modern and advanced high-technologies. Besides, Binh Duong bounds HCMC to the north. Hence, the locality has a strategic economic and politic location; It is bounded with two large rivers which are the Saigon river (at the west) and Dong Nai river (at the east). The geographical coordinates of Binh Duong are 10°51'–11°30' of the northern latitude and 106°20'–106°58' of the eastern longitude.

3.20 Binh Duong is bounded by Dong Nai to the east, by Tay Ninh and HCMC to the west, by HCM to the south and by Binh Phuoc to the north. Binh Duong has 1 provincial town and 6 districts (covering in 11 ward, 9 district towns and 71 communes). The provincial major urban area is Thu Dau Mot provincial town which is the administrative – economic – cultural hub of Binh Duong.

6) Topography and Geographical Features of Ho Chi Minh City

- (a) **Topography:** HCMC lies within 10°10'–10°38' Northern latitude and 106°22'-106°54' Eastern longitude, it borders to the north with Binh Duong, to the Northwest with Tay Ninh, to the east and northeast with Dong Nai, to the south east with Ba Ria–Vung Tau, to the west and southwest with Long An and Tien Giang.

3.21 HCMC is about 1,730km away from Hanoi, the capital, on road. It lies at the international crossroads of sea routes from North to South from East to West, the center of the Southeast Asia region. The center of the city is 50km from the East Sea. This is a transportation hub connecting provinces in the region and an international gateway.

(b) **Geographical Features:** HCMC lies within the transitional region of the Northeast Region and the Mekong River Delta. The general terrain is gradually lower from North to South and from East to West. It can be divided into 3 main regions:

- (i) The elevated region to the north – northeast and a part to the northwest (in the north of Cu Chi district, northeast of Thu Duc, and district 9) with rolling terrain and an average elevation of 10–25 m interspersed by hills at the highest height of 32m such as Long Binh hill (district 9).
- (ii) The lowland region in the South- Southwest and Southeast of the city (in the districts 9, 8, 7, Binh Chanh, Nha Be, Can Gio), this region has an average elevation of roughly 1m, the highest is 2m, and the lowest is 0.5 m.
- (iii) The medium region, distributed in the center of the city, with the majority of the old inner city, parts of district 2, Thu Duc, all of district 12 and Hoc Mon district. This region has an elevation of 5-10 m.

3.22 Generally, HCMC terrain is not complicated, but still rather rich for variable development.

3.1.2 Soil Erosion

Table 3.1.2 Soil Erosion Data at Each Province

No	Province/City	Available Documents	Description
7	Khanh Hoa	DOT's Summary Report for the meeting with JST. 5ECSR, chapter 8, Heading 8.1.2, pp.161.	Over the last few years, serious land erosion and slide in the river bank has become a local urgent matter in the Cai river (Nha Trang) and the Dinh river (Ninh Hoa). See the detail below.
8	Ninh Thuan	5ECSR, chapter 8, heading 8.1, pp.134	The coastal erosion results in land erosion, loss of housing, environmental destruction. The coastal erosion often associates with storms in Ninh Thuan.
9	Binh Thuan	5ECSR in Binh Thuan Province in 2005 – 2009, Chapter 1, heading 1.4 current status of land use, pp.13	Most of the rivers are short, narrow and have a high gradient. Rainfall is not evenly distributed according to time and space, which can cause erosion and wash away in case of rains and floods, especially given low plant coverage. With particular regard to the La Nga river, due to erosion, every year, water transports through Tao Pao station 161,000 ton sand and mud.
10	Dong Nai	Document prepared by DARD as the follow-up after the meeting with JST and Official letter No 1012/2008/SNN&PTNT-TL from Dong Nai DARD to MARD regarding to soil erosion situation along rivers in the province	Landslide is found in areas from the Dong Nai River to the junction Hieu Liem - Vinh Cuu district (to the downstream of Tri An hydropower plant) to Long Hung commune (Long Thanh). The most serious case was detected in the area of Bien Hoa city and many communes that have constituted a major of impacts on the lives and activities of people living in riverside areas.
11	Binh Duong	N/A	N/A
12	HCMC	5ECSR, chapter VIII, heading 8.1, pp.140-142	Land slide and erosion have been occurred frequently along some rivers and canals in the city area, causing considerable asset loss. DOT conducted a survey and evaluated 40 places where land slide and erosion are possibly.

Note: "N/A"- Not available in the reference document.

Source: DONRE, compiled by JICA Study Team

1) Soil Erosion in Khanh Hoa Province

3.23 In the Cai River (Nha Trang) and the Dinh river (Ninh Hoa), over the last few years, serious land erosion and slide in the river bank has become a local urgent matter. The Cai river (Nha Trang) originates from Chu Giao, Dak Lak Province flows into the East Sea at Nha Trang Gulf. The Cai river is the main source of domestic and production water supply in Khanh Hoa Province. In recent years, river banks have to face with serious land slide

and collapse. From 2007 to now large area of residential land, production land of households living along the river has been washed away in every rainy season. Many residential areas, gardens and crop cultivation land in Vinh Thanh, Vinh Ngoc commune (Nha Trang) and Dien Tho commune, etc. were intruded, adversely affecting the lives of many households. In the Dinh River (Ninh Hoa), land erosion in two river banks is also extremely serious, especially in sections which have yet to be protected by embankments in Ninh Xuan, Ninh Phu commune, etc.

2) Soil Erosion in Ninh Thuan Province

3.24 Coastal erosion-deposition is natural disaster formed by sea waves in combination with other factors (the increase of storms, rising sea levels, river flow, solidity of the rock shore, human activities, etc.), contributing to the increase or decrease in their intensity. The coastal erosion results in land erosion, loss of housing, environmental destruction and coastal erosion often associates with storms. In Ninh Thuan, Binh Thuan region, coastal erosion tends to become stronger and the erode sections will also increase.

3) Binh Thuan Province

3.25 45% of Binh Thuan area is located on the height of 300 m to 1,000 m. Soil of 12 – 200 slope has an area of 40,000 ha and soil of more than 200 slope has an area of 244,496 ha. Most of the rivers are short, narrow and have a high gradient. Rainfall is not evenly distributed according to time and space, which can cause erosion and wash away in case of rains and floods, especially given low plant coverage. With particular regard to the La Nga river, due to erosion, every year, water transports through Tao Pao station 161,000 ton sand and mud.

3.26 In the recent years, together with the growth of the growing and forest protection, the province has developed the agro-forestry projects, increasing the investment of the water resources constructions, watering pool in the dry areas such as Quao river, Da Bac, Ca Giay, etc., which helps minimize the land environment degradation in many areas in the provinces.

4) Soil erosion in Dong Nai Province

(1) Situation and Causes of Riverbank Landslide

(a) Landslide Situation

3.27 The inspection and field survey indicated a number of areas of the Dong Nai River having the occurrence of landslides. They are Nam Cat Tien (Tan Phu Dist); Tan Binh, Binh Loi, Tan An (Vinh Cuu Dist), Long Hung (Long Thanh dist); Communes: Tan Hanh, Hoa An, Hiep Hoa and Wards: Hoa Binh, Quyet Thang, Long Binh Tan, Thong Nhat, Tan Mai, Tam Hiep (Bien Hoa City).

3.28 Landslide is found in areas from the Dong Nai River to the junction Hieu Liem - Vinh Cuu district (to the downstream of Tri An hydropower plant) to Long Hung commune (Long Thanh). The most serious case was detected in the area of Bien Hoa City and many communes that have constituted a major of impacts on the lives and activities of people living in riverside areas.

(b) Causes

- External Factors

3.29 In recent years, the weather has been becoming more volatile and

unpredictable. Rainfall was with a great intensity, concentrated in a narrow area in a short time, resulting in rapid flash flooding, so that it was difficult to prevent local flooding occurred in many parts of the province.

3.30 Overexploitation of forests, especially watershed flood has increased the frequency of flood and its speed

- On the management:

3.31 There is no management body to be responsible for river protection, management and exploitation. Some rivers are co-managed and exploited by different with many sectors such as agriculture, transportation, construction, industry and local authorities.

3.32 Excessive exploitation activities over coastal area and river include sand mining, shipping, and construction

3.33 Construction activities in the upstream pay no attention to the interests of the downstream

3.34 Partial awareness of river protection and exploitation of people and localities where the river goes through

5) Soil Erosion in Ho Chi Minh City

3.35 Land slide and erosion have been occurred frequently along some rivers and canals in the city area, causing considerable asset loss. DOT conducted a survey and evaluated 40 places where land slide and erosion are possibly, specifically as follows:

Table 3.1.3 Possible Land Slide and Erosion Places in HCMC

No.	Erosion place	Eroded length (m)	Eroded width (m)
	District 2 (2 places)		
1	Giong Ong To Bridge area, Nguyen Thi Dinh Street	200	10
2	Sai Gon River, Binh An ward area	300	10
	District 3 (1 place)		
3	Te canal bank, bus stop area	70	10
	District 9 (1 place)		
	Tac River		
4	Long Dia landing berth area	350	10
	Binh Thanh district (8 places)		
	a. Thanh Da peninsula		
	Sai Gon River area		
5	Hoang Ty restaurant - Tu Tri restaurant section	1,500	15
6	Misa Bear Restaurant -La San embankment section, Mai Thon	322	10
7	Area opposite to D lot to Ly Hoan tennis court	200	10
8	Cong Doan tourism site - Bach Dan zone section	86	15
9	S lot to Du Thanh Cong household (No. 18.7NB, Xo Viet Nghe Tinh Road) section	180	10
	Thanh Da canal		
10	Section 1.2 from Thanh Da canal bridge to Petroleum block, Ward 21	350	10
11	Section 1.3 from upper Thanh Da canal bridge to Binh Trieu bridge, Ward 26	685	20
12	Section 1.4 from upper Thanh Da canal bridge to Cong Doan embankment, ward 27	705	15

No.	Erosion place	Eroded length (m)	Eroded width (m)
	Thu Duc district (4 places)		
	Sai Gon River		
13	Km32+200, street block NO. 5, Hiep Binh Phuoc ward	150	15
14	Km32+600, street block NO. 5, Hiep Binh Phuoc ward	350	15
15	Km33+500, street block No. 3, Hiep Binh Phuoc ward	250	10
16	Binh Quoi landing berth, Linh Dong ward	700	10
	Nha Be district (17 places)		
	Kinh River		
17	Lower Hiep Phuoc bridge (Hiep Phuoc commune)	350	10
18	Upper Hiep Phuoc bridge (Long Thoi commune)	150	10
	Giong Canal		
19	Kinh Lo - Giong canal confluence - to upper Giong canal (left bank)	500	10
20	200 m Giong canal bank toward upper area	1,000	10
	Muong Chuoi River		
21	Ba Chiem canal - Phuc Kien Bridge section (Nhon Duc commune)	600	15
22	Ba Chiem canal - Sa Sap canal (Nhon Duc commune)	850	15
	Phuoc Kieng River		
23	Upper Long Kien bridge area (right bank)	150	10
24	Lower Long Kien bridge area (left bank)	200	10
	Tom Canal		
25	Upper Ba Sau bridge (right bank)	150	10
26	Lower Tom canal bridge (right bank)	660	15
27	Upper Tom canal bridge (left bank)	362	15
	Phu Xuan River		
28	upper Phu Xuan bridge (right bank)	1,500	15
	Roi Canal		
29	Upper Phuoc Long bridge (right bank)	300	15
	Doi canal - Tom canal		
30	Phuoc Long Bridge to upper area, Tom canal confluence (left bank of Tom canal)	1,473	15
	Ong Lon Canal 2		
31	Phuoc Loc bridge - upper Ong Lon 2 canal bridge (Phuoc Loc commune)	200	10
32	Phuoc Loc bridge - lower Ong Lon 2 canal bridge (Phuoc Loc commune)	200	10
	Tac Ben Ro canal		
33	Tac Ben Ro canal, adjoining to Cay Kho canal (right bank)	150	10
	Can Gio District (7 places)		
34	Upper An Nghia bridge bank (left bank)	600	20
35	Upper An Nghia bridge (right bank)	900	20
36	Lower An Nghia bridge (left bank)	900	20
37	Soai Rap River- Ba Tong canal confluence (upper area)	850	15
38	Soai Rap River- Ba Tong canal confluence (lower area)	1,200	15
39	Tac and Cha River bank	500	10
40	Left bank of Soai Rap River (Binh Khanh ferry area)	1,200	15

Source: HCMC DOT/2009

3.1.3 Groundwater

Table 3.1.4 Ground Water Data at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	DOT's Summary Report for the meeting with JST and 5ECSR 2006-2010 Report, respectively.	The information on groundwater found in two documents, one of them is the five-year report, chapter 3, heading 3.2.1: groundwater resources.
8	Ninh Thuan	5ECSR of Ninh Thuan Province, 2006-2010 period, chapter 1, heading 1.1.5, pp.11.	Underground resource is not various in Ninh Thuan. There are 8 aquifers of water there.
9	Binh Thuan	5ECSR in Binh Thuan Province in 2005 – 2009 (Chapter 6)	Although, in BinhThuan, there are many aquifers, the underground water resources are not rich because of its uneven distribution in space. Besides, being a coastal province, Binh Thuan often has saltwater intrusion that led to the complicated changes in chemical elements of ground water.
10	Dong Nai	5ECSR of Dong Nai Province (2006-2010), chapter 3, heading 3.2: groundwater resources, pp. 82-84.	Ground water exploitation reservoirs in Dong Nai are: 4.907.788 m3/day of which active reservoirs is 4.114.408 m3/day and static reservoirs is 793.380m3/day.
11	Binh Duong	5ECSR in the period 2005-2010 of Binh Duong Province, chapter 1, heading 1.2, pp. 41-45	Binh Duong has a relative abundance ground-water volume; the depth of ground-water level is often 50 to200m; the ground-water mainly is interstitial-water and cleft-water. According to the evaluation, the total potentially exploitable volume is 1,627,317m3/day.
12	HCMC	5ECSR of HCMC (2005-2009), chapter III, heading 3.2, pp. 46-49	There are five main water aquifers with different water reserves in the HCMC Metropolitan Area, including: Holocene (open, no pressure), Upper Pleistocene (closed), Lower Pleistocene (closed), Upper Pliocene (closed), Lower Pliocene (closed) The closed aquifers are subdivided by clay layers, which are relatively water-proof (water containing).

Source: DONRE, compiled by JICA Study Team

1) Groundwater in Khanh Hoa Province

(1) Characteristics of Aquifers

(a) Pronous aquifer in Quaternary undivide-sediments (q)

3.36 This is distributed widely in Hon Gom peninsular, Cam Ranh peninsular, the low hilly area of Ninh Hoa district, along western mountainous slopes of Ninh Hoa and Dien Khanh, at the northern area of Nha Trang. In addition, this one is also distributed in the valleys. The components of aquifer is very diversified, the major ones are sand, clay, clay and beam, shingle. The total distributed area of q is 400 km². The thickness of the aquifer changes within 2 to 50 m (in Hon Gom and Cam Ranh); however, the most popular thickness is 5 to 12 m.

3.37 Based on the water volume of sediments, this pronous aquifer can be divided into the water zones as follows:

(i) Abundant water zone

3.38 This one is distributed in Hon Gom and Cam Ranh. The total districbuted area of this one is 80 km²; the thickness of the aquifer in this zone is 12 to 35 m. The major component of this water-zone is the fine-grained quartz sand. The static water-level is 0.8 to 2.8 m. The water distributed in this zone is super-light water of which the total mineralization is usually <0.1 to 0.2 g/l.

(ii) Medium water-volume zone

3.39 This is the pronous aquifer in dQ sediment which is distributed in Hon Tre island. This sediment contains the greatest water volume in Dao Tre, it

can be exploited to supply for the small-size water supply facilities (household-size).

(iii) Poor water-volume zone

3.40 Beside the sediments containing the abundant water volume of q, the left ones are the poor water-volume sediments; some sediment contains relatively great water-volume, however, their distributed area is insignificant. The thickness of the aquifer is 3.0 to 10m.

(b) Pronous Aquifer in Holocene Sediments (qh)

3.41 This one is distributed majorly in the Valley of Cai-Nha Trang River, Cai-Ninh Hoa River, the estuaries. This one is located within 4 flatland zones (Cam Ranh, Nha Trang, Ninh Hoa, Van Ninh). Total distribution area of this aquifer is 372 km². The popular thickness of this aquifer is 5 to 10m. The components of aquifer are sand, clay, clay and beam, shingle. Based on the water volume of sediments, this pronous aquifer can be divided into the water zones as follows:

(i) Medium water-volume zone

3.42 The sediments having the medium water-volume cover in most of flatlands and at the major estuaries' areas. The components of aquifer are sand, clay, clay and beam, shingle. The thickness of aquifer is 3 to 11m. The water of this zone is bicarbonate chlorua natri. Total mineralization is 0.2 to 0.5 g/l, so the water is classified to be the light-water.

(ii) Poor water-volume zone

3.43 These sediments are distributed at the downstream areas of Cai-Nha Trang River, Dong Bo River, Tra Duc river and some flatland zones. The components of aquifer are sandy clay, sludge mixed with flora relics. The thickness of the aquifer is 3 to 10 m. The groundwater of this zone is often affected with the salinization. The total mineralization is >1 to 3 g/l (this one of some locations is higher). Hence, this one lays a unimportant role in the water supply. At present, this zone is very advantageous for aquaculture (mainly for breeding shrimp and crab).

(c) Pronous Aquifer in Pleistocene Sediments (qp)

3.44 This one is distributed at the western flatlands, the southwest of Ninh Hoa district-town, the high flatland in Dien Tho, along mountainous root at the west of Nha Trang, along the western corridor of NH1A (from Cam Ranh to Ba Ngoi). The exposedly distributed area is around 26 km²; the rest is submerged underground of flatlands of Ninh Hoa, Nha Trang and Cam Ranh. The thickness of aquifer changes within 5 to 20 m.

3.45 The water of this aquifer is mainly the groundwater of which the static water-level is 0 to 7m (the popular one is 1 to 3m).

3.46 In summary, qp pronous aquifer is distributed in a large area, the aquifer has a relatively abundant water-volume which can supply water for small or moderate-size water supply facilities. However, in Nha Trang and some locations in Cam Ranh, the water is often affected with the salinization and the mineralization is > 1 g/l; so the aquifer's water in this area can not used to supply

for drinking and cooking demands.

(d) Fissure Aquifer in Jurassic Sediments (j)

3.47 This one is distributed in Da Ban, Hoa Huynh, Ninh An, Van Hung, Ninh Tan, Khanh Binh, To Hap district-town, Khanh Vinh; the total distributed area is 450 km². The composition is clay, sand, aggregated starch, limestone-mixed aggregated starch. The thickness of this aquifer is 1,000 m. The Jurassic sediments contain the poor water-volume. The popular mineralization is > 1g/l. The water-level changes by-season (0.3 to 0.4 m).

3.48 At the coastal areas (in Ninh Hoa, Nha Trang), the water of this aquifer is often affected with the salinization. Meanwhile, at the northwest area of Ninh Hoa, Khanh Vinh, Khanh Son, the aquifer has light-water which can be exploited to supply for the small-size water supply facilities of local people.

(2) Groundwater Reserves

3.49 The types of groundwater reserves which are aveluated are the natural dynamic reserve, the static reserve, the potential exploitable reserve and the forecasted exploitable reserve. According to the result of geological survey of the aquifers, the groundwater reserves are calculated by-area as follows:

Table 3.1.5 Groundwater Reserves of Khanh Hoa

Location	Dynamic reserve (m ³ /day)	Static reserve (m ³ /day)	Potential reserve (m ³ /day)	Potential supply (m ³ /day/ha)	Forecasted reserve (m ³ /day)	Forecasted supply (m ³ /day/ha)	Water layer (mm)
Van Ninh	153,931.51	6,509.70	160,441.21	4.73	94,507.11	2.78	0.214
Ninh Hoa	327,978.08	15,370.8	343,348.88	4.56	201,859.2	2.68	0.222
Dien Khanh	132,870.41	6,304.05	139,174.4	3.75	81,802.58	2.20	0.237
Nha Trang	38,386.00	4,800.00	43,156.00	4.37	30,478.88	2.57	0.209
Khanh Vinh	123,277.53	5,813.70	129,091.23	3.92	75,885.04	2.30	0.217
Khanh Son	141,866.85	5,677.80	147,544.65	3.86	86,993.78	2.27	0.191
Cam Ranh (the old one)	163,564.93	6,939.00	170,503.93	4.20	100,428.8	2.47	0.312

Source: Report on "the formulation of drought map and the domestic water shortage of Northern Central Region and Western Highlands" of Institute of Meteorology and Environment, 2008.

(a) Hot mineral Water Sources

- Danh Thach mineral water source is distributed in Danh Thach village (of Dien Tan commune, Dien Khanh district). Being at the depth of 220m underground; the measured temperature of mineral-water is over 72°C at the water-extraction tap. The source is located within the primitive mineral mulch mats, of which the area is 30ha, at the root of Hon Chuong Mountain. This source has been invested to be mined by Danh Thanh Mineral Water JSt Co. for many years.
- Vinh Phuong mineral water source is distributed in Dac Loc hamlet, Vinh Phuong commune, Nha Trang.
- The hot mineral-water mine is located at the depth of 96.7 m, the temperature of this mineral water is 57°C and the reserve is classified to be Level B (1,651m³/day), Level C1 (576 m³/day) and Level C2 (1,729 m³/day). The water has the chemical compositions of calcium sodium chloride, the great mineralization. This mineral water is classified as the medium-hot siliceous

fluoride water source which has been being mined for tourism development by Thap Ba Hot Mineral-Water Stream Tourism Center (under Sao Mai – 21st Century Ltd Co.).

- Phuoc Trung water source: this one is distributed at the northeast area of HonThi mountain in Phuoc Trung village, Phuoc Dong commune (this area is far 6m from Nha Trang City). The hot mineral water mine is located at the depth of 150 m under ground. The water is clear-water; it has the sulfur smell and the temperature of 37°C. The exploitable reserve of this mine is 125m³/day. This mineral water has the calcium sodium bicarbonate of chemical compositions, the small mineralization; so it is classified to be the warm siliceous fluoride water source which has been being exploited to product the bottled drinking water by Yen Sao – Khanh Hoa Co.
- Tu Bong mineral water source: this one is distributed at Tan Phuoc village, Van Phuoc commune, and Van Ninh district. This mineral water has the potassium sodium bicarbonate and potassium–sodium bicarbonate chloride of chemical compositions, the small mineralization; hence, this mineral water is classified to be extremely hot siliceous fluoride water source.
- Ba Ngoi mineral water source: this one is distributed in Tra Long hamlet, Cam Thinh Tay commune, Cam Ranh provincial-town. This mineral water has the sodium chloride of chemical compositions, the small mineralization; it is classified to be the medium-hot siliceous fluoride water source which has been mined since 1983; and it is exploited to produce the bottled drinking water with 650,000 to 1,700,000 liters/year.
- Some other mineral water sources which have not been mined: Vinh Thai mineral water source is distributed in Thai Thong, Vinh Thai commune, Nha Trang City (the mine is located at the depth of 38.5m under ground, the temperature of water is 29°C to 31.5°C); The mineral water source distributed at Suoi Dau Indistral Zone in Suoi Tan commune, Cam Lam district (the potential exploitation reserve is 330 m³/day, Khanh Hoa Mineral Water JSt Co. is formulating the project to mine this mineral water source in the coming time).

(b) Groundwater Quality

- The groundwater distributed within Khanh Hoa Province is majorily colorless, odorless and bland. At the area distributed with swamp marine sediments, the groundwater usually has bad quality and be light-yellow (the alum water); this groundwater type is popularly distributed in Van Thang, Van Khanh, Van Phuoc, Van Hung (of Van Ninh), Ninh Da, Ninh Phu, Ninh Quang, Ninh Ha, Ninh Binh, Ninh Loc, Ninh Son, Ninh Dong (of Ninh Hoa), the communes outside of Nha Trang City, Dien An, Dien Thanh, Dien Toan, Dien Phu, Dien Dien, Dien Son, Dien Khanh district-town (of Dien Khanh).
- The groundwater of which pH value is ranged within 5.4 to 9.7 (the most popular one is 7.5 to 8.5). This groundwater is the light alkaline water. The total merinalization fluctuates within a great ramge from super-light (M <0.2 g/l) to salinity (M > 10 g/l). The saline groundwater area is distributed at the estuaries, coastal range, a part of the qp aquifer and the j aquifer (which are distributed under ground of flatlands in Nha Trang, Ninh Hoa and Cam Ranh). The left groundwater area which is not affected with salinization is the

exploitable one to supply water for daily living activities.

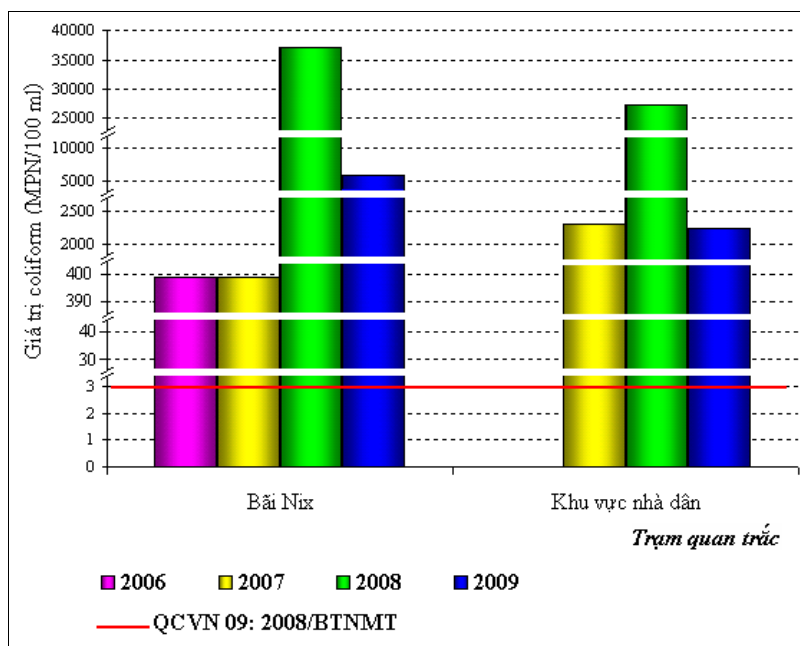
- The Cl⁻ ion concentration within the groundwater popularly is 20 to 200 mg /l (this one is 300 to 400 mg/l at some locations of which the groundwater has a great salinity). The total iron-ion concentration (Fe²⁺⁺, Fe³⁺) is ranged within the iron-ion trace to 3.2 mg/l. The popular NO₃⁻ concentration is 5 to 20 mg/l (this one reaches 120 mg/l at some locations).
- At some communes as Van Phu, Van Thang (of Van Ninh), Ninh Sim, Ninh Tay, Ninh Thuong, Ninh Than, Ninh Quang (of Ninh Hoa), Khanh Binh, Khanh Hiep (of Khanh Vinh), Cam Phuoc Tay, Nam Ba Ngoi (of Cam Ranh), Dien Tan Dien Lam, Suoi Tien (of Dien Khanh), Duong De (of Nha Trang), the groundwater has a relatively great concentration of fluoride (> 2.0 mg/l); hence, people are easily affected with fluorosis of teeth and bone, if they use this groundwater for drinking and cooking. In addition, the groundwater distributed at Ninh Van, Ninh Phuoc (of Ninh Hoa) and Vinh Luong (of Nha Trang) has the concentrations of HCO₃⁻ and Ca²⁺ being higher than the permitted standard of water used for drinking and cooking.
- As the result analysing the quality of water samples collected at the bored-holes and wells, most of groundwater has been polluted, the coliform indicator is usually higher than the permitted limitation of QCVN 09:2008/BTNMT.

Table 3.1.6 Result of Analyzing Water Samples in Khanh Hoa

Commune	Sample-collected locations	Coliform (MPN/100 ml)	
		Result	QCVN 09 :2008/BTNMT
Doc Let	Bored-hole	2.0x10 ⁴ to 4.6x10 ⁷	3
	Well	1.5x10 ³ to 4.6x10 ⁷	
Cam Thinh Dong	Bored-hole	4.3x10 ² to 9.3x10 ⁵	
	Well	2.8x10 ⁵ to 1.1x10 ⁸	

Note: MPN: Most probable number

Source:Assessment scheme on shallow groundwater supply capacity at Cam Thinh Dong commune, Cam Ranh town and Doc Let commune, Ninh Hoa Dist., Khanh Hoa province.



Source: Five Year Environmental Status Report/2006-2010, Khanh Hoa DONRE

Figure 3.1.1 Coliform Value in Well Water

2) Some Polluted Underground Water Area in Provincial Scope

(1) Underground Water Area with high Fluor Content (>1.2 mg/l)

3.50 These areas scattering in: Ninh Tho - Vạn Ninh, Ninh Hoa, right edge of Trau river, Son Thai, Khanh Thuong - Khanh Vinh, Cam Hiep Bac, Cam Hiep Dong and Cam Ranh. At these locations, underground water has minimum rate of fluoric at 1,5mg/l. At Ninh Hoa, there are 11 communes contaminated with fluoric in well water: Ninh Tay, Ninh Xuan, Ninh Thuong, Ninh Binh, Ninh Quang, Ninh Phung, Ninh Than, Ninh Trung, Ninh Dong, Ninh Hai, Ninh Ha. Besides, there are many small locations. According to result of adequation map measure in 1990 of Viet Tiep geology team at these localities, fluoric content id well is from 2,5-3 mg/l, some particular locations (Dong Xuan, Ninh Thuong) reach 9,4 mg/l and (Ninh Hai) 13mg/l. At Cam Ranh, Ta Long hamlet (Ba Ngoi), in 1999, 398 households with 250 wells have been investigated and discover 65% well contaminated by fluoric and 82% of health checked people has manifestation of teeth decay. Reason is formulation of high content of fluoric in well water of Khanh Hoa which has not been confirmed. However, by actual observation and basing on geological map, there is a connection between extending direction, interfere location of cracked zones formulating increase of fluoric content in underground water; hot mineral water containing high content of fluoric is considered as a source generating increase of fluoric content in well water of this area.

(2) Underground Water Contaminated with Cyanur (Content CN - >0,01 mg/l)

3.51 Industrial polluted area was discovered in urban Nha Trang area, Suoi Hiep, in Ninh Dong-Ninh Phung, Song Trau, Ninh Trung - Ninh Xuan, Khanh hiep, Khanh Binh and some area in south east Cam Ranh delta. Area is rather large. The following table list locations of high industrial content:

Table 3.1.7 Monitoring Result of Cyanua Content in Khanh Hoa

No.	Location	Location taking sample	X, km	Y, km	CN- mg/l
1	Dong Bo mountain	LK25VL	1,347,436	293,822	0.06
2	S n mountain	LK20VL	1,356,704	302,875	0.068
3	Urban Nha Trang	DL01	1,350.45	305.75	0.019
4	Vinh Trung	LK27	1,354,096	301,222	0.082
5	Urban Nha Trang	LK31	1,352,887	304,357	0.048
6	Vinh Thai	M13	1,351.00	302.00	0,039
7	Urban Nha Trang	M10	1,352.34	303.35	0.031
8	Urban Nha Trang	M11	1,352.75	303.75	0.02
9	Ninh Trung, Ninh Hoa	LK01	1,388.32	293,359	0.02
10	Cam Hai Bac, Cam Hai Tay	LK35	1,335.116	297,361	0.029

Source: 5ECSR 2006-2010, Khanh Hoa DONRE

3.52 Above locations are mostly in urban area, industrial zone, therefore, it is supposed that increase of industrial content in underground water is related to industrial activities in urban and residential area.

(3) Underground Water has High Content of Fe (>1 mg/l)

3.53 On provincial scope, 5 underground water area with Fe content higher than 1mg/l are discovered: To Hap River - Khanh Son; Dien Tan - Dien Khanh, Dien Loc, Dien Hoa - Dien Khanh; Ninh Giang, Ninh Da, northern Chu Rai - Ninh Hoa. Area is rather large. Increase of FE content in underground water is due to decomposition of iron from eroded lateritic cover of sedimentary rock, effusive rock.

3.54 With Fe content ≤ 5 mg/l, underground water is not Fe polluted according to environment specification, however, according national technical specification on water quality for living activities QCVN 02:2009/BYT, acceptable rate of Fe in water is 0.5mg/l, underground water in above locations shall be treated before being used for eating.

(4) Capacity of Underground Water

3.55 Types of capacity of underground water including natural active capacity, static capacity, potential exploitation capacity and forecast exploitation capacity. Based on hydrological investigation result of water layer, underground water capacity is calculated by area of localities in Khanh Hoa Province as follows:

Table 3.1.8 Underground Water Reserve

Locality	Active capacity (m3/ng)	Static capacity (m3/ng)	Potential capacity (m3/ng)	Potential Modun (m3/ng/ha)	Forecasted capacity (m3/ng)	Forecasted Modun (m3/ng/ha)	Water layer (mm)
Van Ninh	153,931.51	6509.70	160,441.21	4.73	94,507.11	2.78	0.214
Ninh Hoa	327,978.08	15,370.8	343,348.88	4.56	20,1859.2	2.68	0.222
Dien Khanh	132,870.41	6,304.05	139,174.46	3.75	81,802.58	2.20	0.237
Nha Trang	38,386.00	4,800.00	43,156.00	4.37	30,478.88	2.57	0.209
Khanh Vinh	123,277.53	5,813.70	129,091.23	3.92	75,885.04	2.30	0.217
Khanh Son	141,866.85	5,677.80	147,544.65	3.86	86,993.78	2.27	0.191
Cam Ranh (former)	163,564.93	6,939.00	170,503.93	4.20	100,428.8	2.47	0.312

Source: Report "Building drain map and water lack level for living activities in southern central area and Central highlands" of Hydrological science and environment institute, 2008"

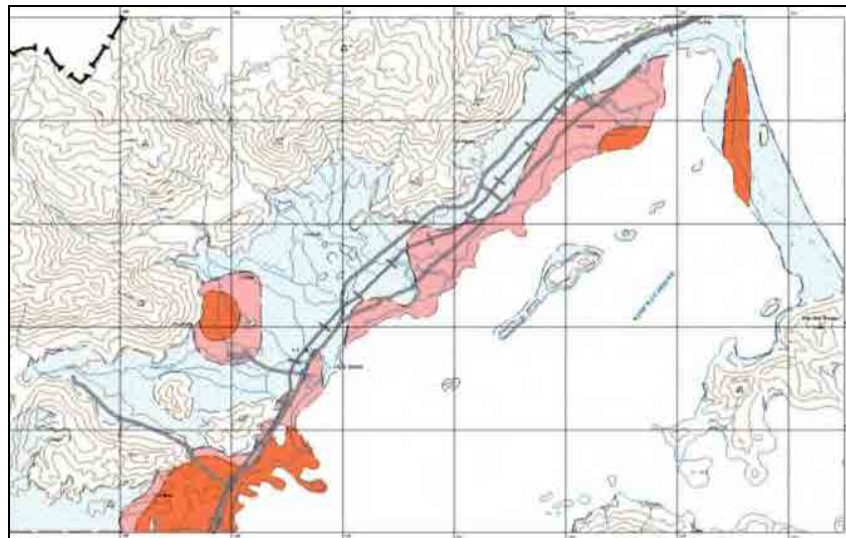
(5) Characteristics of Salinity of Underground Water

(a) Salinity by Area

3.56 According to symmetric depth document and water chemical analysis result, in Khanh Hoa Province, salinity zones of underground water area determined as follows:

- Van Ninh

3.57 Van Ninh zone: formulated a saline groundwater line lasting along the coastal range strip from Tu Bong to Van Gia district-town. The breath of this line is estimated to be, with total width from 100 to 1.000 m. The saline ground water. Salinity area is aroundabout 15 km².

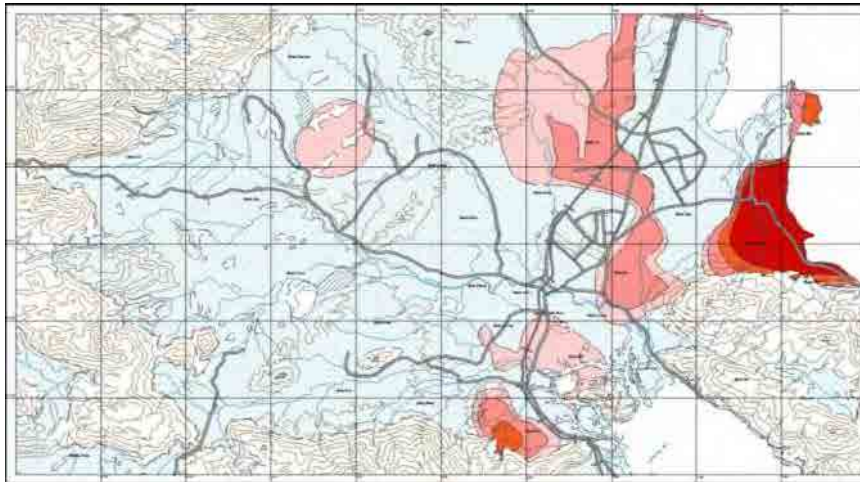


Source: 5ECSR 2006-2010, Khanh Hoa DONRE

Figure 3.1.2 Map of Saline Groundwater in Van Ninh Area

- Ninh Hoa

3.58 Area: salinity underground water area holds about 60km², extending from Hon Khoi to the south west crossing Ninh Hoa district-town to Ninh Loc. Besides, there is some small amount of salinity underground water scattering on coastal communes of Ninh Hoa district. In this area, the saline groundwater is distributed from surface to the bed of the aquifer (deep bottom including in the pronous aquifer).

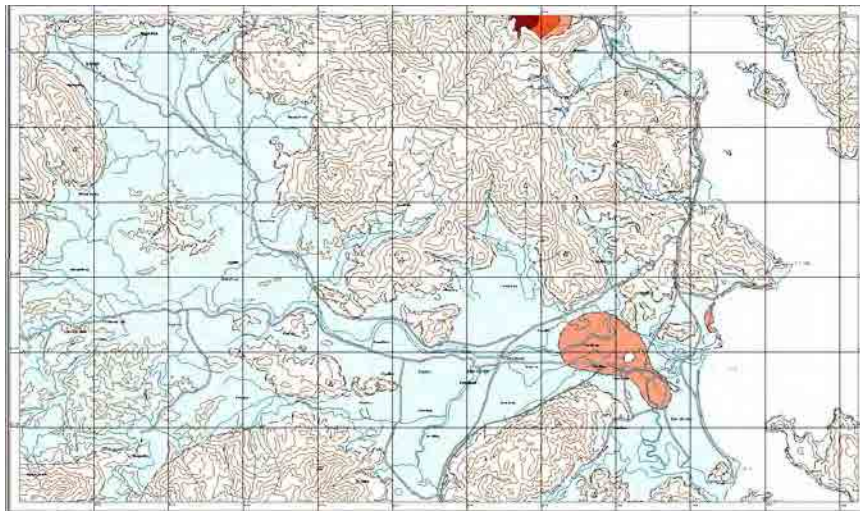


Source: 5ECSR 2006-2010, Khanh Hoa DONRE

Figure 3.1.3 Map of Saline Groundwater Sub-Zone in Ninh Hoa

- Nha Trang

3.59 The saline groundwater area has covered a relatively large area at the west of Nha Trang City (this zone coincides with the valley of Tac river). In addition, there are some narrow areas distributed at Bac Vinh Phuong, the north of Dien Khanh district-town, Suoi Hiep, Vinh Hai, etc. The total saline area is about 25 km².

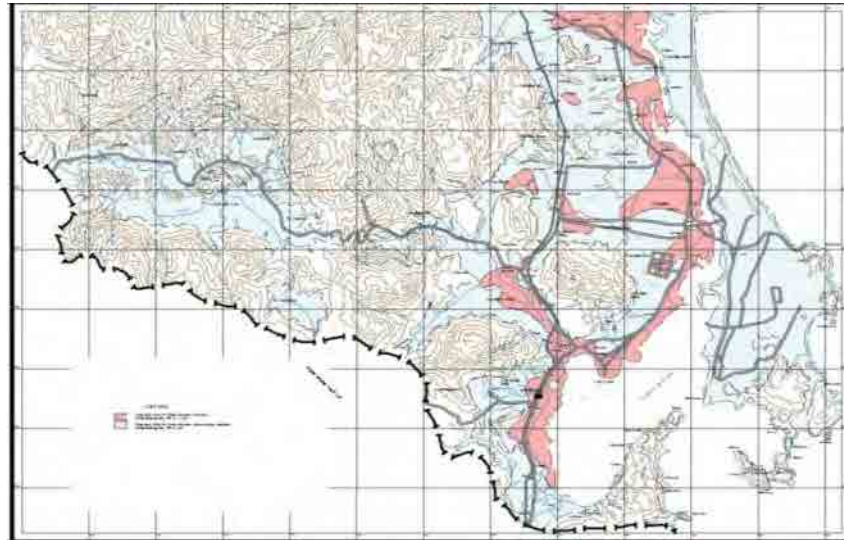


Source: 5ECSR 2006-2010, Khanh Hoa DONRE

Figure 3.1.4 Map of Saline Groundwater Sub-zone in Nha Trang

- Cam Ranh

3.60 The saline groundwater zone is prolonged area: Area of salinity underground water expands along NH1A (NH 1A from Suoi Tan, through to Cam Ranh and to the valley of Tra Duc stream); at some locations, the salty “tongue” has encroached 6 to 8km into the location salinity invade mainland. from 6 to 8 km.



Source: 5ECSR 2006-2010, Khanh Hoa DONRE

Figure 3.1.5 Map of Saline Groundwater Sub-Zone in Cam Ranh

(b) By-Depth Salinity

3.61 According to the symmetrically measured depth data and the water-sample to analyzing results, the boundary of saline groundwater area relatively coincides with the one of saline surface-water area. The major saline aquifers are the qp aquifer and the j one (under ground of flatlands in Nha Trang Ninh Hoa).

3) Groundwater in Ninh Thuan Province

3.62 Underground water: the studies on underground water in the province show that: in Ninh Thuan, underground resource is not various. There are 8 aquifers of water. The absorption capacity of land is low and water aquifer is thin. Underground water is mainly distributed in Phan Rang low land. In the province, there are 2 water aquifers which are able to meet the demand of fresh water, namely Holocen (in the north and along Cai River, Phan Rang) and Pleistocen–Holocen (surrounding Phuoc Dan Town, 20m in depth). The water quality changes frequently and complicatedly. Fresh water and alkaline water can be found in the same water containing unit.

4) Groundwater in Binh Thuan Province

(1) Characteristics of Groundwater

3.63 According to the 5ECSR of the province: Although, in Binh Thuan, there are many aquifers, the underground water resources are not rich because of its uneven distribution in space.

3.64 Besides, being a coastal province, Binh Thuan often has saltwater intrusion that led to the complicated changes in chemical elements of ground water. Moreover, increase in the number of business activities led to the water contamination in general and ground water in particular such as Binh Thuan, an area that ground water is stored in the sand layer near the ground.

3.65 “Master plan report on clean water supply and rural sanitation in Binh Thuan in the 2000-2010 period” delivered by University of Mining and Geology showed that: total estimated potential exploitation reserve of ground water in aquifers in Binh Thuan is 2,1 million cubic meter per day

3.66 In which:

- (i) Potential exploitation reserve in quaternary sediment aquifer without division is about 1,035 thousand cubic meter per day (accounting for 0.5%)
- (ii) Reserve of aquifers in Holocene sediment is about 27,911 thousand cubic meters per day (13%)
- (iii) Reserve of aquifers having Pleistocen sediment is 1.3 million cubic meters per day (57%)
- (iv) Reserve of Neogen- Pleistocen aquifer is about 23,334 thousand cubic meter per day (10.1%)
- (v) Reserve of aquifers in creating basalt formations is 204,800 cubic meter per day (9.5%) and reserve of Mezozoi sediment aquifer us 19,635 thousand cubic meter per day (9.2 %)
- (vi) Potential exploitation reserve is estimated based on static reserve and live reserve.

(2) Causes of Groundwater Pollution

- (a) **Water Salinity:** in recent years, exploitation of fresh water layer in coastal sand dune for agriculture production, aquaculture breeding are increasing such as in Phuoc The, Vinh Hao, Chi Cong, Phan Ri Thanh, Hoa Phu. The consequence is saltwater intrusion and reduce in reserve of ground water.
- (b) **Increasing Urban Development:** strong development of urban areas producing water water has great impacts on ground water's quality in some regions.

5) Groundwater in Dong Nai Province

(1) Natural Resources of Ground Water

3.67 Based on the study of Federation of southern water resources investigation and planning – MONRE, ground water exploitation reservoirs in Dong Nai is: 4,907,788 m³/day of which active reservoirs is 4,114,408 m³/day and static reservoirs is 793,380 m³/day.

3.68 Based on monitoring result of the province and national monitoring results of 6 regions (Nhon Trach, Long Khanh, Dinh Quan, Long Thanh, Thong Nhat, Trang Bom), ground water in general meets technical standards (QCVN 09:2008/BTNMT) and can be used for domestic purposes. However, content of such indicators as Amoni, COD, Fe in some areas fails to meet QCVN due to geology and socio-economic impacts.

3.69 Due to impacts of climate, hydrometeorological conditonss, ground water level in 2008 - 2009 is stable, however in 2010, the level decreased compared with the period 2008, 2009.

(2) Developments in Quality of Ground Water

3.70 Ground water is natural resources of vital importance; therefore, it is necessary to combine protection and sustainable exploitation of this type of natural resources. However, over the last periods, the rapid urbanization and industrialization have deteriorated ground water reservoirs.

3.71 Every year, centre for environment monitoring and engineering (Dong Nai DONRE) sampled and analysed ground water in the entire province. Monitoring data in the period 2006-2010 in the entire province is attached in 5ECSR.

3.72 According to monitoring data at 13 drilling localities in Nhon Trach, Dinh Quan,

Long Khanh (Dong Nai monitoring network) and data collected from 19 projects (national monitoring network), it is possible to present such comments as follows:

(i) Nhon Trach Area

3.73 In 2010, ground water level in almost every monitoring works in Nhon Trach decreased due to impacts of climate change, however, degree of change is not high.

3.74 Ground water of Pliocen aquifer (n2) in Nhon Trach area has rather good quality, with most of its indicators meeting QCVN 09/2008 BTNMT. However content of N, COD, Phenol, lead is high.

(ii) Long Thanh Area

3.75 Ground water level of Pliocen aquifer in Long Thanh district is mostly belonging to destroyed natural dynamics, climate like dynamics; in 2010, ground water level in almost every monitoring works in Long Thanh was affected by extraordinary climate changes. However, degree of change is not high.

3.76 Ground water level of Pliocen aquifer (n2) in Long Thanh area has rather good quality, with most of its indicators meeting QCVN09/2008 BTNMT. However Nitrate and Amoni content are high, exceeding permitted level, which proves that water is being contaminated. As a result, it is necessary to treat water before it is used for domestic activities.

(iii) Long Khanh Area

3.77 Ground water level of mid Bazan Pleistocen aquifer (β_{qp2}) in Long Khanh town belongs to natural dynamics area, which is prone to exploitation impacts and extraordinary climate change. Water level dramatically declines (climate dynamics).

3.78 Quality of ground water at mid bazan Pleistocen aquifer (β_{qp2}) at 3 monitoring works ĐN53, ĐN55, ĐN58 is rather good, with most of its indicators meeting TCVN 5955:1995, except for pH at ĐN58.

(iv) Thong Nhat Area

3.79 Ground water level of mid Bazan Pleistocen aquifer (β_{qp2}) in Long Khanh town belongs to natural dynamics area, which is impacted by climate change. Water level tends to decrease compare with 2009, climate dynamic types.

3.80 Quality of water in mid Bazan pleistocen (β_{qp2}) at 2 monitoring works Q071070 và QN011 is very good, meeting QCVN09/2008 BTNMT.

(v) Dinh Quan Area

3.81 Law of changes in water level of such aquifers as upper Bazan Pleistocen trên (β_{qp3}), lower Bazan Pliocen - Pleistocen (β_{n2-qp2}) and Jura (J1-2) in Dinh Quan area is located in natural dynamics area, meteorological dynamics type, ground water has direct hydraulic connection with rain water and always supplemented by rain water in rainy season. Due to extraordinary climate changes, water level of all aquifers tends to decline, climate dynamics.

3.82 Quality of water at upper bazan Pleistocen aquifer (β_{qp3}) is good, except for pH (QCVN 09:2008/BTNMT).

3.83 Quality of water in lower bazan pleistocen acquifer - Pliocen ($\beta n2 - qp1$) in 2 projects ĐN39, ĐN52 has high contents of Amoni and Nitrate, which are always higher than permitted level, proving that water is being contaminated.

3.84 Quality of ground water at Jura ($j1-2$) acquifer at 2 works ĐN37, ĐN38 is very good, meeting requirements for domestic use and QCVN 09:2008/BTNMT. Amoni content has always exceeded permitted level during monitoring period.

(vi) Trang Bom Area

3.85 Law of changes in water level of such acquifers as upper Bazan Pleistocen ($\beta qp3$), mid Bazan Pliocen ($\beta qp2$), hollow Pleistocen ($qp2-3$) in Trang Bom district is located in natural dynamics, belonging to climate dynamics type, ground water has direct hydraulic connection with rain water and always supplemented by rain water in rainy season. In 2010, due to climate change, water level experienced dramatic decline.

3.86 Quality of ground water at upper bazan Pleistocen acquifer ($\beta qp3$) meets QCVN 09:2008/BTNMT. However, Nitrat and amoni contents are higher, always higher than permitted level, showing that water is being contaminated.

3.87 Quality of ground water at mid bazan pliocen - Pliocen ($\beta qp2$) and Pleistocen is rather good except for position Q01007A which has high content of nitrat and amoni, showing that water is being contaminated.

6) Groundwater in Binh Duong Province

3.88 According to the (5ECSR 2005-2010), groundwater condition in Binh Duong Province is as follows.

(1) Ground-Water Resource

3.89 Binh Duong has a relative abundance ground-water volume; the depth of ground-water level is often 50 to 200m; the ground-water mainly is interstitial-water and cleft-water. According to the evaluation, the total potentially exploitable volume is $1,627,317m^3/day$. For the distribution characteristics, Binh Duong has the ground-water locations as follows:

- (a) **The interstitial-Water Aquifer in the Upper and Middle Pleistocene-sediments:** the distribution area is not wide; the depth of aquifer is thin (1.6 to 20 m). The ground-water of this aquifer is the un-pressure or local-pressure light-water which can self-supply or is supplemented from the surface-water sources in the dry-season and the rainy-season. The quality of this aquifer is good; however, the above shallower weak absorbent layer is thin, the aquifer is vulnerably polluted because of the human's daily living activities. This water area covers approximately in $923 km^2$ and exposes on the terrain surface/ ground; this area extends from Long Tan (DauTieng) to An Dien (Ben Cat) and finishes at Thu Dau Mot.
- (b) **The Interstitial-water Aquifer in the Lower Pleistocene-Sediments:** this aquifer is distributed from the central location of the region to the western frontier (the location near by Saigon river). It covers $1,928 km^2$ of area and exposes on the terrain surface/ ground. This area extends from An Long (PhuGiao) to Dong Hoa (Di An). Thought, this aquifer covers in a large area, its thickness is small (1.26 to

29.5m). As the analysed data, thought the water of this aquifer is good, the aquifer locates under the thin ground (at some locations, the depth of the aquifer is so shallow), so this aquifer is easily susceptible polluted with the human's daily living activities. The water from this aquifer can't supply for the industrial demands; this one can be utilized to supply for only the needs of local people. However, this water source is relatively important for the localities where the in-lower Pleistocene sediment interstitial-water aquifer exists, especially Binh Duong. At present, the provincial people are exploiting water from this aquifer for the daily living activities and irrigation.

- (c) **The Interstitial-water Aquifer in the Middle Pliocene-Sediments:** this one belongs to Ba Mieu formation and is distributed in a very large area of 2,362 km² which extends from Phu Giao district, passes Tan Uyen and to Saigon river. The thickness of the aquifer is great, the water quality is good. However, the aquifer is located under the thin ground (at some locations, the depth of the aquifer is so shallow), so this aquifer is easily susceptible polluted with the human's daily living activities. This water source can be exploited to meet the demands of industrial operation as well as daily living activities. At present, this aquifer is being exploited actively to supply for the old and new industrial zones and urban areas
- (d) **The interstitial-water Aquifer in the Lower Pliocene-Sediments:** this one is distributed largely in the whole province, it has a great thickness, and good-quality water. This is one of two important aquifer of Binh Duong. However, with a rapid economic development, this aquifer is being exploited with a great volume; especially at some locations where the industrial clusters, the urban residential zones are located concentratedly.
- (e) **Underground Water Area with high Fluor Content (>1.2 mg/l):** the potential of exploitable water is limited; because this aquifer is thin and located deeply in a narrow area.

(2) Pollution Sources of Ground-Water

3.90 The ground water is polluted by the construction of the works' foundations. The wells are drilled, bored or filled with an insufficiently technical progress; so the dirty water go into the ground-water.

3.91 The water drainage infrastructure is not constructed comprehensively, so the industrial and urban waste water which can't be drained, but absorbs into the soil, hence, that affects to the ground-water. In some residential zones and some productive enterprises, there have not been any waste water drainage systems; some households and enterprises dig their self-absorption ponds to discharge waste-water into these ones. Hence, the waste water of these locations is drained via self-absorption that can pollute the ground-water aquifers.

(3) Situation of Ground-Water Quality

- (a) The situation at the monitor plants

3.92 As the monitored result, the water level changes depended on the space, time and season. The below diagrams show the changes of water level by-time, space and season in period 2005-2010.

- (i) The Middle and Upper Pleistocene-aquifer

3.93 The water-level rises gradually to 0.33m; the average risen rate of the water-level is 0.066m/year.

3.94 In particular, in the well of PhuHoa plant, the water-level rises with 0.91m; the average risen rate of the water-level is 0.182m/year.

(ii) The Lower Pleistocene-aquifer

3.95 The water-level tends to rise with 0.22m; the average risen rate of the water-level is 0.202m/year.

(iii) The Middle Pliocene aquifer

3.96 The water-level tends to rise with 0.11m; the average risen rate of the water-level is 0.022m/year. Particularly, in the wells of Song Than plant, the water-level rises with 1.71m; the average risen rate is 0.342m/year.

(iv) The Lower Pliocene aquifer

3.97 The water-level tends to decrease with 1.37m; the average decreased rate is 0.274m/year. Particularly, at Song Than plant, the water-level decreases 4.32m, the average decreased rate is 0.864m/year. On the contrast, in the wells of PhuHoa plant, the water-level rises 0.7m; the average risen rate is 0.14m/year.

3.98 In general, the water-levels of the aquifers at the monitored plants tend to rise; excluding the monitored plants which are near the area operating industrial activities, the lower Pliocene aquifer tends to decrease since the exploited water volume is larger than the supplemented one of the aquifer.

(b) Situation of Ground-Water Quality

3.99 As the monitored results, the ground-water quality shows that the water in the wells exploiting water from all aquifers has small rate of pH (3.1 to 6.9). The water quality at the monitored locations is relatively good. Most of the water's analysed indicators are in conformity with the permitted standards; such as: NH_4^+ , COD, NO_3^- , pH (3.9 to 6.1), Hg^{2+} , Cl^- , Fe^{2+} , Mn^{2+} . At some monitored locations of the lower aquifers, the coliform rates are higher than the permitted standard; this situation means that the ground-water at these locations seems to be polluted with the polluted factors from the above ground.

7) Groundwater in Ho Chi Minh City

(1) Groundwater Resource

3.100 There are five main water aquifers with different water reserves in the HCMC Metropolitan Area, including:

- Holocene (open, no pressure)
- Upper Pleistocene (closed)
- Lower Pleistocene (closed)
- Upper Pliocene (closed)
- Lower Pliocene (closed)

3.101 The closed aquifers are subdivided by clay layers, which are relatively water-proof (water containing).

3.102 The Holocene aquifer is about 1-2m to 10-40m thick in Binh Chanh and Can Gio. The aquifers are composed mostly of fine clay, fine earth, fine sand and sand-clay. In Cu Chi, Hoc Mon, Tan Binh and Thu Duc, shallow wells extract water from this aquifer. The ground water is refilled mostly by rain water or absorbed from river water. Water quality is affected significantly by both natural and human factors. Because the thinness of the aquifer, water extraction is easy and thus it supplies mostly for household scales.

3.103 The upper Pleistocene aquifer comprises fine – less fine sand, and is about 10 – 35m thick. Due to local hydrological relationship with rivers of Dong Nai and Saigon, the refilling rate is high. Water quality changes sharply by places, depending much on quality of absorbed surface water. Several households and small industries managed to extract water from this aquifer. Despite the large reserve, water quality is low, due to the mixture with polluted surface water.

3.104 The lower Pleistocene aquifer comprises of both raw and broad grain sand. The aquifer is about 60-80m deep at Binh Chanh and Can Gio, 30-50m to the north and Thu Duc. The thickness is about 50 – 80m. Water reserve is high, and water quality is also high. Hoc Mon Water Plant is now extracting water from this aquifer.

3.105 The upper Pliocene aquifer covers all of the HCMC area, about 110 – 150m deep in Binh Chanh and Can Gio, and about 60 – 100m to the north. This aquifer comprises broad-grai sand on top of finer-grain sand. The aquifer thickness is about 50 – 100m in Binh chanh. Water reserve is high, and water quality is also high.

3.106 The lower Pliocene aquifer covers about 1,150 km² and not the whole HCMC. The average depth of this aquifer is 190 – 210m in Binh Chanh and Can Gio, 110 – 130m to the north. The composition of this aquifer is similar to the upper Pliocene aquifer. Its thickness is about 20 – 30m. Water reserve is high, and water quality is high.

3.107 In general, all of the four closed aquifers can be used for water extraction, thanks to large water reserve and high water quality. The aquifers are rather similar in terms of absorbing capacity, physical, chemical and hydrological conditions.

(2) Water Reserve for Extraction

3.108 Survey on water extraction capacity has been conducted by the Geo-Hydrology Union 8, and the findings were as follows:

3.109 Upper Pleistocene (closed): potential reserve is 1,307,000 m³/day with well yards, 15-20 wells, to extract about 25,000 - 30,000 m³/day, and the top productivity areas include Hoc Mon and Cu Chi.

3.110 Lower Pleistocene (closed): potential reserve is 1,043,000 m³/day with well yards, 10-15 wells, to extract about 10,000 – 20,000 m³/day, and the top productivity areas include Binh chanh, Hoc Mon and Thu Duc.

3.111 Upper Pliocene (closed): potential reserve is 1,412,000 m³/day with well yards, 30-40 wells, to extract about 30,000 – 100,000 m³/day, and the top productivity areas include Binh Chanh and Hoc Mon.

3.112 Lower Pliocene (closed): potential reserve is 1,567,000 m³/day with well yards to extract about 35,000 m³/day, and the top productivity areas include Binh Chanh and

Hoc Mon.

3.113 The Geo-Hydrology Union 8 proposed a water extraction plan of about 400,000 m³ per day for the period 2001 to 2015 in the city, considering a safe level of 951,000 m³/day. This huge volume of ground water is an important reserve for the area.

(3) Pollution Sources against Ground Water

3.114 As mentioned, the city could extract water from 4 of the 5 aquifers, namely:

- Upper Pleistocene
- Lower Pleistocene
- Upper Pliocene
- Lower Pliocene

3.115 Though these aquifers have good water reserve and high water quality, they are vulnerable to pollution due to infiltration of surface water via operating wells of households and small industries which are not designed and operated in a proper manner.

3.116 Wells of Hoc Mon Water plant show concentration of Fe²⁺ between 10 and 25 mg/l, treated by alkalization and sedimentation method. Wells in Go Vap and airport area contained low concentration of iron, and is now supplying directly to the network, after disinfection process. Micro-organism test samples on raw water from wells connected to lower Pleistocene and Pliocene aquifers of Saigon Water Supply Corporation showed good results: no micro-organism pollution.

(a) Influences from Salinity Intrusion

3.117 Considering the presence of fresh water in groundwater aquifers in HCMC area, it is to divide into three broad zones:

- Zone 1 to the north with all aquifers containing fresh water
- Zone 2 to the south with all aquifers containing brackish and salty water
- Zone 3 with aquifers containing both fresh water and salty waters.

3.118 Ground fresh water can meet the required quality as supply sources for residential and industrial purposes. However, pH level and iron concentration are constantly higher than the permitted level, hence requiring treatments. Holocene aquifer and Pleistocene aquifers are contaminated at some places with bacteria and other matter, hence requiring treatments.

(b) Influences from Ground Water Extraction

3.119 According to rough inventory, the city has now more than 200,000 drill wells extracting ground water, mostly from two Pleistocene aquifers and upper Pliocene aquifer. Pleistocene wells tend to serve residential purposes (150,000 wells) thanks to easier operation and sufficient water reserve, except for some places in Binh Chanh, District 8, Nha Be and Can Gio where water in these aquifers is salty.

3.120 Upper Pliocene aquifer is used mostly for industrial purposes and for water supply plants within the city which supply water for industrial parks,

companies, industrial units in HCMC. This aquifer is to support the developments of HCMC thanks to wide coverage, stable quality and reserve, easy operation.

3.121 In general, almost all households have their own well for ground water extraction, especially for new urbanized areas, namely Go Vap, Binh Chanh, Tan Binh, Tan Phu, Hoc Mon, Cu Chi and District 12.

3.122 Most of companies are using ground water. About more than 20,000 companies are operating “ground water extraction facilities” without licenses. These companies are in industrial parks and water plants, including Tam Hiep Water Plant, Binh Tri Dong Water Plant, Tay Bac Cu Chi Industrial Park (12 companies, 37 wells), Tan Thoi Hiep Industrial Park (20 companies, 26 wells), Tan Binh Industrial Park (79 companies, 89 wells), Tan Tao Industrial Park (16 companies, 22 wells), Vinh Loc Industrial Park (27 companies, 36 wells), Thanh Cong Textile Company (8200 m³/day/6 wells), Thang Loi Textile (8,400 m³/day/7 wells), Tan Binh Oil (5,740 m³/day/6 wells), Vifon (7,600 m³/day/4 wells), Thong Nhat Milk (1,500 m³/day/2 wells), Saigon Beer (7,500 m³/day), 16 Captage wells of HCMC Water Supply Plant.

3.123 Since 2000, along with industrial developments in the city, a huge volume of ground water has been extracted from Pliocene aquifer, and this is the main cause to trigger the reducing water level in upper Pliocene aquifer, which even shows the risk of depletion in the future.

(c) Influences from Urban Residential Waste Water

3.124 Observation shows that it is residential waste water containing organic matter and nutrient that is polluting water sources in various places, especially causing serious micro-organism pollution.

3.125 People living along canals and rivers in the area and other human activities are all discharging wastes to the water bodies without proper treatment. This is also a major source for increasing pollutions against both ground water and surface water in HCMC.

3.126 Besides, water aquifers in some places are suffering “local” pollutions, such as in Dong Thanh Landfill Site (Hoc Mon), waste water zone of Linh Trung Processing Zone which discharges to Binh Tho Stream in Binh Tho Ward, Thu Duc district, and agricultural zone in Ward 17, Go Vap district. However, thanks to the 5m water-proof layer beneath the polluted Pleistocene aquifer, lower aquifers are not yet affected by the pollution.

3.127 As the city is adjoined by the sea and crossed by a dense network of canals, and as the city has several places lower than sea level, drainage is always problematic, which also complicates pollutions against surface and ground water.

3.1.4 Protected Areas

1) Special-use Forest (national parks, nature reserves, species/habitat conservation area, landscape protection area, and scientific research and experimental forest)

Table 3.1.9 Special-Use Forest Area by Province

No	Province/City	Type	Name of Special-use Forest	Area (ha)
7	Khanh Hoa	NR	Hon Ba Nature Reserve	21,000
8	Ninh Thuan	NP	Nui Chua National Park	22,513
		NP	Phuoc Binh National Park	19,814
9	Binh Thuan	NR	Nui Ong Nature Reserve	25,468
		NR	Ta Kou Nature Reserve	11,866
10	Dong Nai	NP	Cat Tien National Park	71,350*
		NR	Dong Nai Cultural and Tourism Reserve Area	50,000
11	Binh Duong		No information on special use forest.	-
12	HCMC		No information on special use forest.	-
Total				222,011

Source: MARD and DONRE, compiled by JICA Study Team

NP: National Park / NR: Nature Reserve

*Cat Tien National Park stretches out in three provinces, or Dong Nai, Lam Dong and Binh Phuoc

(1) Cat Tien National Park

- (a) **Cat Tien National Park is located in the area of 3 provinces namely:** Dong Nai, Lam Dong, Binh Phuoc. The head office is situated in Tan Phu district, Dong Nai Province.
- (b) **Detailed geographical locations are as follows:** Cat Tien National Park lies in such districts as: Cat Tien, Bao Loc (Lam Dong Province), Tan Phu, Vinh Cuu (Dong Nai Province), Bu Dang (Binh Phuoc Province). Cat Tien National Park is located in the transitional area from Southern Central Highland to the Mekong River Delta.
- (c) **Flora and Fauna System:** There are 1,610 types of plants, among which 31 are listed as scarce plants and 23 types endemic to Cat Tien. Most of flora in Cat Tien National parks is of great value. Details are as follows:
 - (i) + 38 species have a value of gene preservation.
 - (ii) + 22 species have a value of being endemic to local area.
 - (iii) + 511 species of woody plant (176 are precious wood)
 - (iv) + 550 species of medicinal plants. Hundreds of species have essence and special values in use.

Table 3.1.10 Fauna Species in Cat Tien National Park

Level of Classification	Total Species		Vietnam Red Book		IUCN Red Book
	Total	Compared with total species in Vietnam (%)	Total	Compared with total species in Vietnam	
The Mammal	60 (92)	25 (38)	15 (32)	20 (39)	16 (26)
Bird	283 (335)	34 (40)	18 (21)	22 (26)	15 (16)
Reptile	46 (60)	18 (23)	14 (17)	33 (40)	5 (8)
Amphibian	23 (32)	22 (30)	1 (2)	9 (18)	0
Fresh fish	99 (130)	21 (28)	6 (9)	18 (27)	1
Butterfly	435 (439)	43 (44)	n.a	n.a	n.a

Note: Data out of () is data already checked and data lying in () is estimated data. Types of forests and geographical areas, which are habitats of tropical fauna: 60 species of mammals, 46 species of reptiles, 23 species of amphibian, 283 species of birds, 99 fishes, and many species of insects.

Source: DONRE, compiled by JICA Study Team

(2) Hon Ba Nature Reserve: Has an Area of about 21,000 ha, located in the area of 4 districts: Dien Khanh, Cam Lam, Khanh Vinh and Khanh Son (Khanh Hoa); is the **only** special use forest in Khanh Hoa with many different types, including: (1) – Sub-tropical evergreen closed forest on medium mountains (at the height of 1,000 – 1,600m); including evergreen closed forest with a mixture of broadleaf trees and sub-tropical coniferous trees; (2) Sub-tropical evergreen closed forest on low mountains (at the height of 500-1,000m); (3) - Tropical humid evergreen closed forests (at the height of less than 500m) and (4) – tropical secondary forests, inclusive of supporting forests with a mixture of bamboo and trees, forests recovered after rice and crop cultivation, scattered grassland, trees and shrubs, etc .

3.128 According to unpublished information, Hon Ba is an area diverse in plant species composition, with initial statistics of 592 vascular plant species, 401 branches and 120 families, of which: Pines and Ferns have 73 species; gymnosperms have eight species and angiosperms 511 species. In addition to the conifer tree component, in this area appeared species of families which are only distributed along the belt of sub-tropical or temperate climate: such as Ericaceae, Aceraceae, Lauraceae families, Cyatheaceae. There are 43 rare plant species listed in Vietnam Red Book, which include *Pinus krempfii*, *Fokienia hodginsii*, Hong-ray *Rhodoleia championii*, red type (*Azelia xylocarpa*), Trac cord (*Dalbergia annamensis*), *Diospyros mun*, *Dialium cochinchinensis*. In particular, *Pinus krempfii* is specides endemic to Vietnam, *tabernaemontana granulosa* is new endemic species, only found on the Hon Ba and Ninh Hoa (Khanh Hoa). According to preliminary statistics, Hon Ba forest fauna includes 255 species, belonging to 88 families of 4 classes: mammals, birds, reptiles and amphibians. Especially, black-shanked douc (*Pygathrix nigripes*) and white-cheeked gibbons are included in Hon Ba forest fauna system.

3.129 Most of studies on changes in diversity of terrestrial flora and fauna and in the composition and quantity of forest flora and fauna in Khanh Hoa have yet to be carried out, except for initial documentation on Black-shanked Douc langurs (*Pygathrix nigripes*). In May 2007, together with experts of Frankfurt Zoological Society (FZS), Forest Inventory and Planning Institute (Ministry of Agriculture and Rural Development) and Khanh Hoa FPD (forest protection department) made a preliminary survey on Hon Heo (Ninh Hoa), and listed about 115 individuals. This is a leaf-eating monkey species of the rare Primate in our country with features such as green face, just eat the leaves, very difficult to tame and nurture, and often appear in a group.

(3) Nui Chua National Park

3.130 According to the year 1999 statistic data of Ho Chi Minh No.2 Forest Planning and Surveying Sub-institute as well as based on the file attached with Decision No.1654/QD dated April 22nd year 2002 of Ninh Thuan PC chairman (regarding to allocating land and granting the land-use right permit for Nui Chua Natural Reservation Zone; the land-use situation and forest resources of Nui Chua zone are presented as below:

3.131 Total natural area is 22,513.6 ha and area is divided as follows.

Table 3.1.11 Landuse in Nui Chua National Park

Natural Area	Area (ha)
Forested-area	11,222.2
+ Natural forests	10,921.3
+ Planted forests	300.9
Un-forested area (IA, IB, IC, and etc.)	10,426.0
+ Rocky mountains	907.9
+ Sandy dunes, alluvial-grounds	71.7
+ IA	1,520.9
+ IB	7,921.0
+ IC	4.5
Agricultural land	865.4
Total	22,513.6

Note: IA (open land without grass), IB(open land with shrubs), IC(open land with scattered trees)

Source: Ninh Thuan DONRE

3.132 The total natural forest-area is 10,921.3 ha covering 48.5%; the left forested-area rate is relatively high. 90% of natural forests are allocated to be protected, so the deforests have been reduced. The rate of planted forests has been small. Generally, the reforestation is fragmented, scattered. The plant growth is poor and bad due to the poor soil condition with the inert-rocky grounds, harsh climate; hence, the forests have bad protective efficiency; they have not met the requirements of protective function.

3.133 The vacancy area covers a relative high rate (46.3%); while the agricultural protection area covers 3.8%. The kaingin-area comprises paddy-fields, specialized cultivation area of crops, agricultural cultivation gardens, fixed kaingin area and unfixed one. Most of these mentioned cultivation land-use types is developed by the nomadic farming habit. People deforest, self-manage and self-use; after a few years when the land was emaciated, these people leave and move to the new location for living and cultivation. This situation links to the risk of the degradation of natural resources as well as the declined quality of forests, unless there are positive prevention measures.

2) Wetland Reserves

3.134 In 2001, the National Environment Agency (now the Viet Nam Environment Protection Agency/VEPA) recommended 68 wetland sites as having environmental and biodiversity values. This list contains more comprehensive data than any prior documents, and is regarded that it could serve as the foundation for the identification of wetlands of national and international importance. Following table shows the Isited wetland sites of the target sections.

Table 3.1.12 Wetland Reserves

No	Province/City	Name of Protected Area	Area (ha)
7	Khanh Hoa	- No wetland reserve exists.	-
8	Ninh Thuan	Nai Marsh	700
9	Binh Thuan	Bien Lac Lake	2,000
10	Dong Nai	Nam Cat Tien	4,300
		Tri An Lake	32,300
11	Binh Duong	- No wetland reserve exists.	-
12	HCMC	- No wetland reserve exists.	-
Total			39,300

Source: Viet Nam Environment Protection Agency (2005). Overview of

Wetlands Status in Viet Nam Following 15 Years of Ramsar Convention Implementation. Hanoi, Viet Nam. 72 pp.

3) Marine Protected Areas

3.135 The MARD has submitted the Primer Minister a plan to establish a system of 15 marine protected areas (MPA) (233,974 ha of marine-based water area and 64,147 ha of inland area). This plan aims to allocate 2% of the country's marine area for biodiversity conservation by 2010. Currently 4 MPAs is officialized, one of which falls in the target sections in Khanh Hoa Province (Nha Trang Bay Marine Protected Area).

Table 3.1.13 Marine Protected Areas

No	Province/City	Name of protected area	Inland area (ha)	Marine area (ha)
7	Khanh Hoa	Nha Trang Bay	3,000	12,000
		Nam Yet (Planned)	15,000	20,000
8	Ninh Thuan	-MPA is not yet planned.	-	-
9	Binh Thuan	Hon Cau (Planned)	110	12,390
		Phu Quy (Planned)	2,300	16,680
10	Dong Nai	-MPA is not yet planned.	-	-
11	Binh Duong	-MPA is not yet planned.	500	6,200
12	HCMC	-MPA is not yet planned.	-	-
Total			20,910	67,270

Source: Website of Vietnam Development Forum
 (<http://www.vdf.org.vn/Doc/2009/119WSVuThiHoaiThu21Oct09.pdf>)

(1) Mangrove Forest Ecosystem in Khanh Hoa Province

3.136 Khanh Hoa Province Khanh Hoa Province possesses favorable natural conditions for developing mangrove forests. However, in recent years, area of mangrove forests is decreased due to the deforestation for the construction of shrimp ponds. Based on studies (Khanh Hoa DONRE, 2009), area of Khanh Hoa mangrove forest is about 104.08 ha, of which real mangrove forests no longer exist. There are only narrow strips of mangrove trees distributed along ponds, swamps, and aquaculture ponds near the coast of swamps, bays and gates of small rivers.

(2) Khanh Hoa Mangrove Forest

Table 3.1.14 Khanh Hoa Mangrove Forest Area

No	Survey areas	Area (ha)
1	Along the shore of Van Phong bay	17.70
2	Along the shore of Nha Phu lagoon	37.33
3	Vinh Truong river gate (Nha Trang)	15.64
4	Along Thuy Trieu lagoon shore	14.30
5	Along Cam Ranh bay shore	19.11
Total Area		104.08

Source: Khanh Hoa DONRE, 2009

3.137 Compared with the area of 3,000 ha before 1975, mangrove forest area has experienced a severe reduction, only equal to 3.0% initial area. In other words, up to 96.6% Khanh Hoa mangrove forest was lost for a variety of reasons.

(3) Coral Reef Ecosystem in Khanh Hoa Province

3.138 Khanh Hoa coastal areas have the most developed and diverse coral reefs. According to a study (Tong Phuoc Hoang Son, 2008) Khanh Hoa coastal areas have

435 coral species of 79 breeds and 21 families; 274 coral reef fish species of 111 breeds and 35 families; invertebrate animals living on coral reefs in Khanh Hoa coastal areas are also diverse with 121 molluscs species of 62 breeds and 34 families.

(4) Seagrass Ecosystem in Khanh Hoa Province

3.139 Khanh Hoa coastal areas have many lagoons and airtight bays. A summary report (by Khanh Hoa DONRE, 2009) shows that seagrass ecosystem in Khanh Hoa has 12 sea weed species of 7 branches and 2 families.

3.140 There are much in common between Khanh Hoa seagrass components and Phillipines as well as other countries in ASEAN sea grass components. Many of sea grass components have individuals of big size such as *Enhalus acoroides*, *Thalassia hemprichii*; *Cymodocea rotundata*, *Cymodocea serrulata* which shall make up a thick seagrass field with uni-species or multi-species and the area of tens or hundreds of ha.

3.141 Seagrass is often seen in shallow water areas of quiet lagoons, bays like Van Phong bay, Nha Phu lagoon, Nha Trang bay, Thuy Trieu lagoon, Cam Ranh Bay with total area of 1,862 ha.

3.142 Seagrass in Thuy Trieu lagoon and Cam Ranh Bay are continuously distributed with total area of 1,153 ha.

3.143 Seagrass area and no of seaweed species in Khanh Hoa is shown in the table below.

Table 3.1.15 Seagrass Area, No of Seaweed Species in Khanh Hoa

No	Survey area	Area (ha)	No of species
1	Nha Trang bay	78	10
2	Van Phong bay	600	9
3	Thuy Trieu lagoon	548	7
4	Cam Ranh bay	605	7
5	Nha Phu lagoon	31	4
Total Area		1,862	37

Source: Khanh Hoa DONRE, 2009

4) Protected Areas by International Treaty/Agreement (Ramsar sites, World Heritages and ASEAN Heritages)

3.144 Following areas are protected by international treaties on the natural environment. There are not World Natural Heritages or ASEAN Heritages in the target provinces in the South section.

Table 3.1.16 Protected Areas by International Treaty

No	Province/City	Type	Name of protected area	Area (ha)
7	Khanh Hoa	-	No natural protected area by international treaties exists.	-
8	Ninh Thuan	-	No natural protected area by international treaties exists.	-
9	Binh Thuan	-	No natural protected area by international treaties exists.	-
10	Dong Nai	Ramsar site	Bau Sau (Crocodile Lake) Wetlands and Seasonal Floodplains	13,759
		Biosphere reserve	Cat Tien	728,756
11	Binh Duong	-	No natural protected area by international treaties exists.	-

12	HCMC	Biosphere reserve	Can Gio Mangrove	75,740
Total				818,255

Source: DONRE, compiled by JICA Study Team

5) Other Important Areas of Concern (IBA and EBA)

3.145 According to the information from Birdlife International, following Important Bird Area (IBA) and Endemic Bird Area (EBA) are found in the target section.

Table 3.1.17 Other Important Areas of Concern

No	Province/City	Type	Name of Protected Area	Area (ha)
7	Khanh Hoa		No IBA exists.	-
8	Ninh Thuan	IBA	Phuoc Binh	23,597
9	Binh Thuan		No IBA exists.	-
10	Dong Nai	IBA	Nam Cat Tien	38,302
11	Binh Duong		No IBA exists.	-
12	HCMC	IBA	Can Gio	75,740
	Ninh Thuan - Dong Nai	EBA	South Vietnamese Lowland	3,000,000
	Small part in Ninh Thuan	EBA	Da Lat Plateau	600,000
Total		IBA		137,639
		EBA		3,600,000

Source: Birdlife International Webpage (2012). EBA area stretches from Ninh Thuan to Dong Nai, including Lam Dong Province

3.1.5 Landscape

3.146 So far, the only information available on important landscape is the landscape protection area category under the special use forest. However, besides these areas, there are other areas of natural and cultural importance. Especially the coastal area between Khanh Hoa and Binh Thuan is famous as beach resort, where a lot of tourists are attracted. Following table shows the major landscapes known in the city/provinces in the south section.

Table 3.1.18 Landscape

No	Province/City	Description
7	Khanh Hoa	- Coastal area
8	Ninh Thuan	- Coastal area
9	Binh Thuan	- Coastal area
10	Dong Nai	- Dong Nai Cultural and Tourism Reserve Area
11	Binh Duong	- No information was available.
12	HCMC	- Cultural relics in HCMC area

Source: DONRE, compiled by JICA Study Team

3.1.6 Forest

3.147 The forest area is classified into three categories, namely protection forest, production forest, and special-use forest. The special use forest is the protected areas discussed in 2.1.4 above. The protection forest is mainly situated in the mountain area for soil conservation, river bank for erosion control, and for coastal area for wind break and sand protection.

3.148 In the south section, Khanh Hoa, Ninh Thuan and Binh Thuan Province have large forest areas while other provinces have less than 30% of the forest area due to development.

Table 3.1.19 Forest Area by Type

						Cal.Unit: Ha
No	Province/City	Forest Ratio	Protection	Production	Special-use	Sub-total
7	Khanh Hoa	42.7%	96,006.60	36,120.30	16,090.20	148,217.10
8	Ninh Thuan	43.7%	111,950.00	34,572.00	39,736.00	186,258.00
9	Binh Thuan	35.8%	142,478.00	172,735.00	31,065.00	346,278.00
10	Dong Nai	28.4%	40,644.00	37,355.00	99,439.00	177,438.00
11	Binh Duong	3.4%	3,388.15	11,749.98	0.00	15,138.13
12	HCMC	18.6%	33,285.00	800.00	29.00	34,114.00
	Total	-	427,751.75	293,332.28	186,359.20	907,443.23

Source: DONRE/DARD of each province, compiled by JICA Study Team

1) Forest in Khanh Hoa Province

(1) Distribution, Area and Structure of Eco-system

3.149 According to statistics by Forest protection department as of 31st December, 2009, total area of land having forest in Khanh Hoa is 202,587.7ha (exclusive of Truong Sa), among which natural forest covers 166,467.5 ha, 82.2% total area of land having forests (Table 3.1.21). Compared with total land area of the province, the forest coverage is 42.7%, the highest coverage rate belongs to Khanh Vinh district (73.1%) and Khanh Son (51.4%). The lowest coverage rate belongs to Nha Trang (7.3%) and Cam Ranh (12.4%).

3.150 In terms of classification of forest types, according to data of forest protection department, wood forest accounts for the majority of natural forest (146,994 ha/161,959 ha). In addition, there are other types of forests like bamboo forest, mixed wood forest-bamboo, forest on rocky mountains and mangrove forests.

3.151 According to data in 2009, special use forest in Khanh Hoa increased compared with 2000 (Table 3.1.21), however, only accounted for 7.9% land having forests. This national rate is 16% (2,061,675 ha/12,966,822 ha) (according to data in 2007). The area of protection forest tends to decrease, especially in the period 2006-2009, at present, it accounts for 47.4% total land having forest (Table 3.1.21).

Table 3.1.20 Forest Cover Changes in Khanh Hoa

Types of Forests	2009	2008	2006	2000
Land having forests	202,587.7	194,393.3	189,464.8	181,789.5
Natural forest	166,467.5	161,959.0	163,008.2	159,180.5
Planted forest	36,120.3	32,434.3	26,456.6	17,849.0
%natural forest/land having forests	82.2	83.3	86.0	87.6
Special use forest	16,090.2	16,090.2	14,305.3	9,793.0
%special use forest/land having forests	7.9	8.3	7.6	5.4
Protection forest	96,006.6	93,858.0	113,742.9	97,742.0
%Protection forest/land having forest	47.4	48.3	60.0	53.8
Mangrove forest	13.0	N/A	N/A	N/A

Note: N/A: Not data available in reference documents

Source: Annual Statistics of Khanh Hoa Forest Protection Department

3.152 The statistics over the years (2000, 2006, 2008, and 2009) shows that the area of forest land gradually increases mainly thanks to afforestation. In 2009 there are more than 1,000ha forest newly planted in Khanh Son, Khanh Vinh, Cam Lam and Ninh Hoa (about 200ha each district). In 2009, only more than 21ha forest was planted

in Nha Trang City and 23.4ha in Van Ninh district.

3.153 According to Khanh Hoa Forest protection department, 7.5 ha forest were cut down in 2009, among which 1.7 ha are natural forest and 5.7 ha are planted forest.

2) Forest in Ninh Thuan Province

3.154 Total area of forestry land is 187,778.33 ha (4,743.95 ha of planted forest), making up 55.9% of total natural area of the province. Because of that the province is at the coastal area and dryness, forest land is composed of protection forest and specialized forest 85.09). Because of wood exploitation with high volume for socio-economic development demand, they are of rich and medium forests decreases, and the area of poor and new forest increases. Area of rich forest is about 7,000 ha, making up 4.6%; medium forest 20,000 ha, making up 13.2 %. Wood reserve is about 11 million m³. The coverage in dry season is at medium level, which affects the regional climate a lot. Forest resources in Ninh Thuan Province are likely to decrease because of deforestation for cultivation, burning wood for coal.

3) Forest in Binh Thuan Province

3.155 Classifying special use forests; reviewing, planning and developing the system of special use forests by application of the model for stable forest management.

3.156 In the period of 2006-2010, Binh Thuan Province has implemented forest planning and has classified forest into 3 types. Of these, the natural forest area of the whole province is 370,012 ha including 428 subzones. In the past year, the provincial authorities paid particular attention to the natural forests, especially primeval forests at the head of rivers, as nature preservation areas.

3.157 Currently, there are 112,376 ha of forest area that is preserved. Formal policy commitments to preserve forests have recognized as a first step the need to socialize the protection works that contribute to management of natural forests effectively, and reduce deforestation by minority groups for agriculture.

3.158 The 5 million hectare afforestation project is continuing, in particular focusing on forests at the head of rivers, which are degraded, and sensitive eco-systems.

3.159 The forestry area contracted to the economic organizations and households are 30,130 ha (statistics of December, 2007). This figure is expected to increase to 40,000 ha.

3.160 In 2008, there was 37,000 ha of area under reforestation and it is planned to expand this to 45,000 ha.

4) Forest in Dong Nai Province

(1) Developments in Forest Areas

3.161 Results of implementing a number of targets in forestry (Table 3.1.21) show that over the last 5 years, forestry production value obtained annual growth of 7,2 %/year, higher than targets stipulated in planning (3.0 %/year). Forest coverage increased from 26.5 % in 2006 to 29.8 % in 2010.

Table 3.1.21 Indicators of Forestry Development

No	Evaluation indicators	Unit	Planning 2010	Implementation					Average increase 06-09
				2005	2006	2007	2008	2009	
I	Outcome indicators								
1	Growth rate of production value of forestry	%	3.0	107.1	126.5	96.3	101.4	100.8	7.2
2	Percentage of coverage	%	30	26.4	26.5	27.5	28.3	29.1	-
3	Density value in the total silviculture forestry	%	-	15.0	14.8	17.3	13.2	13.2	-
4	The proportion in the total exploitation of forest	%	-	44.5	44.6	51.5	50.0	49.4	-
II	Output indicators								-
1	Afforestation (total)	ha	-	214.6	258.0	208.5	318.2	350.0	-
	Afforestation in Protection forest	ha	-	214.6	208.0	128.5	218.2	100.0	-
	Afforestation in Production forest	ha	-	0.0	50.0	80.0	100.0	250.0	-
2	Regeneration	ha	-	290.5	293.1	160.8	150	-	-

Source: DARD, 2009

(2) Results of “5 Million Hectare Afforestation Project”

3.162 In the period 2006 – 2009, thanks to the 5 million hectare afforestation project, Dong Nai Province newly grows 1,549.7 ha forest (among which protection forest: 806.6 ha; special-use forest 121.9 ha; production forest 621.9 ha), protection forests having local big wood trees like: *Hopea*, *Dipterocarpaceae* and other local big wood trees, mixed with acacia and fruit trees as well as industrial trees. Density of each type meets regulated standards.

3.163 The zoning of areas for natural regeneration combined by planting additional industrial trees was implemented in 603.9 ha, with the main method being the growing of big trees. Object of zoning is forest area of IC, which has naturally regenerated wood trees and is convenient for growing additional local big wood trees. Additional plant species include: Golden oak, *Dipterocarpus alatus*, *Azalia xylocarpa*.

3.164 Forest care: area of forest cared during the period 2006 - 2009 is 2,009.4ha. Area of newly planted forest is taken care of during 3 - 4 consecutive years. As a result, planted trees shall not be dominated by other types of vegetation. Every year, the investors grow additional plants for 2 year old forests. Works are implemented in accordance with technical standards.

5) Forest in Binh Duong Province

3.165 According to the surveyed data of 2010, the forest area of the whole province is 15,138 ha which increased 2,487.39 ha compared with the data of 2005. This total area is distributed as follows:

3.166 Protection forests: 3,388.15 ha, among:

- Natural forests: 497.06 ha;
- Planted forests: 2,841.77 ha;
- Others: 49.32 ha.

3.167 Production forests: 11,749.98 ha, among:

- Natural productive forests: 385.9 ha;
- Planted productive forests: 5,394.01 ha;

- Land for productive forest afforestation: 5,970.07 ha.

3.168 Binh Duong's entire forestry land has a complex slope steep terrain with many rivers and streams. This land is distributed mainly in Dau Tieng protective forest, D strategic war base (the productive forest of Tan Uyen district), the productive forest of Phu Binh Forestry Farm (in Phu Giao district). The major flora formation comprises Bau Tra Beng (*Dipterocarpus obtusifolius Teijsm*) and Tram (*Syzygium cumini*) which cover in an area of 523 ha and be distributed in Cau Mountain protective forest, Dau Tieng; Tram (*Melaleuca*), Truong, Binh Linh, Sam (*Memecylaceae*) which cover in an area of 3,578 ha in Phu Giao; Tram (*Melaleuca*), Truong, Sam (*Memecylaceae*), alang-grass (*Imperata cylindrica*) which cover in an area of 723 ha in D strategic was base.

6) Forest in Ho Chi Minh City

3.169 Based on The July 15th 2010 Decision No.3122/QD-UBND of HCM People's Committee (regarding to approval on the specific data of forest and forestry-land area up to Dec 31st 2009, HCMC has totally 41,634.04ha of forestry area which covers 19.9% of the municipal natural area.

3.170 Forests are mainly located in Can Gio, Binh Chanh, Cu Chi among of which Can Gio salt-marsh forest covers mostly of the municipal forest area (94%). The left area ration is of the natural secondary forest and the afforested ones which are distributed in Cu Chi and Binh Chanh. Particularly, Can Gio Salt-Marsh Forest is not only the protection forest but also The World's Natural Biosphere Reserve which was ratified by UNESCO in 2000.

3.171 The forest situation has changed as in the bellow table since 2000.

Table 3.1.22 The Change of Forest Area by-Year (2000 to 2005 to 2009)

Types of forest	2000 (ha)	2005 (ha)	2009 (ha)
Planned forests	32,696.5	33,771.5	33,659.10
Specialized forest	24.9	24.9	26.35
Protection forest	30,735.2	31,657.4	31,271.19
Production forest	1,931.4	2,089.2	2,361.56
Unplanned forests			5,294.85
Total	32,696.5	33,771.5	38,953.95
Ratio of forest cover	15.6%	16.1%	18.6%

Source: DARD, 2010.

3.172 By 2010, HCMC has 41,540 ha of forestry area among of which the unplanned forestry area is 38,954 ha, the planned one is 33,659 ha, and, the unplanned sylvestral-crop area is 5,295 ha (based on Decision No.3122_QD-UBND dated July 15, 2010 of HCM People's Committee), specifically as follows: *Acacia auriculiformis*.

- In Binh Chanh:** 832.91 ha of planned forests, 1,790.46 ha of unplanned forests. The main plants are Tram-bong-vang (*Acacia auriculiformis*), Tram-cu (*Melaleuca cajuputy* Powell) and Bach-dang (*Eucalyptus spp.*).
- In Can Gio:** 31,967.48 ha of planned forests. The major tree in this forest is mangrove (*Rhizophora apiculata* Blume). Besides, there are also other flora species which mainly live in the salt-marsh forest.
- In Cu Chi:** 500.26 ha of planned forests which are mostly the tropical ones; 2,765.62 ha of unplanned forests in which the main trees are Tram-bong-vang (*Acacia*

auriculiformis), Tram-cu (*Melaleuca cajuputy* Powell) and Bach-dang (*Eucalyptus spp.*).

(d) **In Hoc Mon:** 305.41ha of planned forests which are the tropical ones; 540.15 ha of unplanned forests in which Tram-bong-vang (*Acacia auriculiformis*), Tram-cu (*Melaleuca cajuputy* Powell) and Bach-dang (*Eucalyptus spp.*) are mainly planted.

(e) **In District 9:** 56.61 ha of planned forests and 198.62 ha of unplanned forests in which Tram-bong-vang (*Acacia auriculiformis*) and Bach-dang (*Eucalyptus spp.*) are planted.

3.1.7 Biodiversity

Table 3.1.23 Characteristics on Biodiversity at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	5ECSR 2006-2010 period, chapter 6, pp.141-151.	Diversified marine eco-system is a distinct feature of Khanh Hoa with the existence of mangrove forest, marine grass and coral reefs
8	Ninh Thuan	5ECSR 2006–2010 period, chapter 6, pp. 96-109.	Ninh Thuan's forest has high biodiversity with many types of forests: green thick forest, deciduous forest, taiga, mixed forest, bamboo forest.
9	Binh Thuan	5ECSR 2005 – 2009 period, chapter 7, heading, 7, pp.92-96. See the paragraph below	In Binh Thuan, there are two recognized nature preservation areas: Ta Cu nature preservation area and Bien Lac nature preservation area. Binh Thuan Provincial Authority is proposing to establish Cu Lao Cau Island (Tuy Phong district) as a Marine Protected.
10	Dong Nai	5ECSR 2006-2010 period, chapter 6, pp. 109-120. See the paragraph below	In Dong Nai Province, areas having high and typical biodiversity include Tri An lake, Long Thanh – Nhon Trach mangrove forest and Nam Cat Tien national park. Current biodiversity in those areas are as follows:
11	Binh Duong	5ECSR 2005-2010 period, chapter 6, pp.84-88. As shown below	There are some the in-wetland malaleuca forests which play the important ecological role. Most of these forests are the artificial ones which are mainly located in Dau Tieng district (surrounding Dau Tieng lake).
12	HCMC	5ECSR 2005-2009 period, chapter VI, pp. 103-117.	HCMC has facing many challenges in biodiversity protection. HCMC is the largest consumption market and is one of 5 hot-spots of illegal wild animal trading. Number of aquatic species has been reduced significantly in Can Gio sea zone and in Dong Nai – Sai Gon River system due to improper and illegal fishing

Source: DONRE, compiled by JICA Study Team

1) Biodiversity in Khanh Hoa Province

(1) Current Situation and Changes in Marine Eco system

(a) Distribution, area and structure of eco-system

3.173 Diversified marine eco-system is a distinct feature of Khanh Hoa with the existence of mangrove forest, marine grass and coral reefs.

3.174 Coral reef—the most typical feature of tropical climate—is widely distributed along coastal area in Khanh Hoa Province and Truong Sa. In coastal areas, fringing reeds are commonly found in shallow water area and surrounding islands, concentrating in 3 main areas, including: Van Phong, Nha Trang and Cam Ranh bay. In addition, platform reefs are also recorded in big shallow beaches and Tide shallow beaches as well as a number of small shallow beaches. Total area of coral reefs are is estimated to be more than 2,000 ha (Tong Phuoc Hoang Son, 2008).

Regions having a large area of coral reef includes: The east of Hon Gom peninsula, the west of Ben Goi (from Hon Bip to Ran Trao), in channels like Co Co and Cua Be, surrounding My Giang island (Van Phong bay), Ninh Van(Ninh Hoa), big shallow beaches, surrounding islands of NhaTrang bay, tide shallow beaches, surrounding islands of Cam Ranh Bay.

3.175 Recent studies (by Vo Si Tuan and his colleagues,2005,2008) show that the coverage of dead coral reef tends to increasecombined by the decrease in the coverage rate of live coral reef in such areas like Hon Den,Bai Tre (Van Phong bay);Hon Vung,Hon Mieu (Nha Trang bay).It is necessary to pay attention to the average annual change in the coverage of coral reefs in Nha Trang bay during the period of 2003–2007 (only about 3%), much smaller than the period 1994-2002 (13.2%).It means that coral reefs experienced heavy depression during the period before2002and there is little possibility that they will recover to the status quo in 1990. According to surveys, depressed coral reefs in Cum Meo (Van Phong bay); surrounding Hon Rua, Hon Mieu (Nha Trang bay) still can not recover. The praise worthy point is that coral reefs in protected areas in Nha Trang bay are remained in good conditions with the stable coverage of live coral reefs.

3.176 The loss of coral reefs has been due to the construction of projects in coastal areas. The most typical case is the loss of coral reefs in the northeast of Hon Tam –which used to be the place to monitor coral reefs in 2002.

3.177 According to the most recent survey (Nguyen Xuan Hoa, 2009), mangrove forest land in Khanh Hoa is about 104.08 ha distributed sparsely in the form of narrow mangrove trees strips, in ponds, swamps, aquaculture ponds near swamps sides, bays and mouths of small rivers.Among which, the mangrove forest near Nha Phu swamp has the largest area at 37.33 ha, the next is Cam Ranh bay with total area of 19.11 ha. Mangrove forest in other areas includes: Van Phong bay: 17.70 ha, Nha Trang bay: 5.64 ha and Thuy Trieu swamp:14.30 ha.

3.178 Mangrove forest in Khanh Hoa prvince has experienced serious depression.Loss of mangrove forest over the 30 years is as follows:the south of Cam Ranh bay:180 ha;Thuy Trieu swamp:260 ha; Nha Trang:260 ha; Nha Phu pond:700 ha; Van Phong bay:470 ha and Ben Goi bay:480 ha (Tong Phuoc Hoang Son, materials not announced).

3.179 According to Nguyen Xuan Hoa (2009) total area of marine grass in Khanh Hoa is about 1.831 ha. Sea grass is distributed in shallow water area in swamps, bay with small waves like Van Phong bay, Nha Phu swamp, Nha Trang bay, Thuy Trieu bay, Cam Ranh bay.Several sea grasses having large area include: Tuan Le, Xuan Tu, Hon Khoi (Van Phong bay); Cam Hoa (Thuy Trieu swamp); Cam Phuc Nam, Cam Phuc Bac, Cam Thinh Dong (Cam Ranh bay).

3.180 Like coral reefs, area of sea grass is also being decreased due to the encroachment of projects in coastal areas. Until now, there are no statistics on this matter, except for data on 15 ha loss recorded in Dam Gia (Nha Trang bay).

(2) Causes of Depression

(a) Unreasonable Exploitation of Natural Resources

3.181 There are many cases of illegal exploitation of forest resources and animals. Regarding marine resources, overexploitation is the most serious cause of depression. Over the last few years, the rapid economic development has led to an increase in the exploitation of natural resources. Means of exploitation are also improved.

3.182 The demand of China and Hong Kong market for natural resources is putting high pressure. In fact, the exploitation of fish from coral reefs is not controlled and monitored, even in nature reserves. In addition, there are also cases of exploiting specialty like sea cucumbers and lobster, etc. and ornamental fish for export. In interviews conducted in sea reserves in Nha Trang bay, fisherman community is well aware of the reduction in natural resources.

3.183 According to results of monitoring coral reefs during the period 2002–2007 in Khanh Hoa, the diversity of fish, invertebrate animals, molluscs, crustaceans is reducing in almost every monitoring area. Fish of small size (length < 10cm) accounts for the highest percentage in almost every coral reef and fish of larger size is remained at low percentage, except for the core area of sea reserves. Such fishes as *Serranidae* and *Lutjanidae* are very scarce and *Lethrinidae* can not be found in cross sections of monitoring areas. Such species as *Trochus* spp. And *Holothuridae*, *Stichopodidae*, *Turbomarmoratus*, and *Panulirus* spp. are scarce in almost every monitoring area. The reason are continuous fishing and there is no solution to improve fish resources. The scarcity and disappearance of *Tridacna* spp. And *Stenopus hispidus* also reflect the decline in natural resources.

3.184 The irrationality is also shown in the exploitation of scarce creatures. There are very few details on current exploitation of living things in Khanh Hoa, except for some information relating to *Pygathrix nigripes*. This is scarce animals, which need protecting on global scale (recorded in red book of IUCN), and also listed in appendix IB of CITES treaty—the type prohibited to be hunted. However, the hunting of this species is common in many places of Khanh Hoa. In December, 2007, there were 2 cases of *Pygathrix nigripes* killed in Ea Krongru-Ninh Hoa. By the end of January, 2009, in Hon Heo mountainous area (Ninh Hoa district) there were 2 *Pygathrix nigripes* killed. On March 11, 2009, 5 *Pygathrix nigripes* were killed in Cam Loc, Hon Ba nature reserves.

3.185 Scarce marine creatures recorded in Red book of IUCN have been still traded without control and limit, including such scarce and important species as: *Tridacna maxima*, *Testudinata*, *Charonia tritonis*, *Cypraeidae*.

(b) Destructive Exploitation

3.186 Destructive exploitation means include: explosives, agent, small-mesh net, etc. There are very few statistics on the use of destructive exploitation. Based on quick assessment technique (Maltatow), there are about 10% of survey areas suffering from fishing by explosives and the highest percentage was recorded in Hon Tre, where almost 1/3 areas were affected to a wide range of extent. However, the result of survey based on cross-section method shows that the use of explosive in fishing is decreasing. On the other hand, fisherman is turning to commonly use anesthetic substances (compounds of *Cyanua*). Although there is no clear evidence of the use of toxic substances in fishing on coral reefs but there are signs of this type of fishing in Hon Mun, Hon Mot, Hon Mieu, Hon Tre and

especially in Hon Vung (Nha Trang Bay). Bottle containing toxic substances to sprinkle on coral reefs were found on a coral reef in Hon Mot.

(c) Development of Economic Infrastructure

3.187 Reclaiming vacant land for agricultural purpose is having negative effects on forest biodiversity however there are no data to prove its details. Meanwhile, reclaiming mangrove forest for aquaculture purpose was a serious case recorded some years ago. About 3,000 ha of mangrove forest were turned into aquaculture land before 2000 (Khanh Hoa environmental report, 2001). At present, although aquaculture activities only obtained low productivity, it is difficult to turn this land area back into land for developing mangrove forest. In addition, mangrove forest is also encroached to construct roads, residential areas like in the downstream area of the Cai River (Ninh Hoa), Ninh Ich (Ninh Hoa), Cam Hoa, Cam Hai Dong, Cam Hai Tay (Thuy Trieu swamp), Cam Thinh Dong (Cam Ranh bay) or encroached to produce salt in Hon Khoi (Ninh Hoa) or the western Cam Ranh.

3.188 The embankment of aquaculture ponds has negative effect on seagrass, which already happened in Hon Khoi, Van Hung (Van Phong bay), Cam Hoa, Cai Hai Dong (Thuy Trieu swamp), Cam Hai Tay, Cam Phuc, Cam Nghia, Ban Thang (Cam Ranh bay).

3.189 Over the last few years, many projects have been constructed to develop tourism, fish port, residential areas, etc. Typical examples of affected areas: destruction of roads when construction entrance road to Hon Ba tourism area, destruction of mangrove forest when constructing Song Lo tourism area, filling coral reefs, encroaching sea when constructing Bai Tien tourism area, Hon Tam tourism area, filling coral reefs due to encroachment of sea to develop tourism area in Dam Gia (Hon Tre) in Nha Trang bay and construct residential area in Phu Quy residential areas.

3.190 In order to maintain canals and ditches, the dredging is also implemented in a few districts of provinces. The most recent dredging was conducted in the Quan Truong river, aimed at serving the operation of Hon Ro. These activities can increase the alluvial deposit, causing harm to seagrass and subaqueous biomen. Coastal construction projects and islands are also causing alluvial deposit. Recent studies show that coral reefs in Hon Mieu, Hon Tam (Nha Trang Bay) are being depressed due to alluvial deposit.

3.191 The development of residential areas, factories specialized in processing agricultural products, aquaculture ponds are also causes of biodiversity depression along coastal areas. Many years ago, there were signs of coastal reef depression due to the overgrowth of large algae. The rapid development of large algae in the northern Hon Tre is affecting the provision of nutrition to coastal reefs (Pham Van Thom and Vo Si Tuan 1997)

3.192 This situation can cause obstacles to the development of coral reefs in Hon Tre, Hon Mieu, Hon Tam (Nha Trang bay). Waste from sugar production company is also providing nutrition to the development of *Chaetomorpha*, *Enteromorpha*, which grows strongly to make a thick algae carpet covering seagrass in Thuy Trieu swamp and cause death to part of sea grass in Dong Ba Thin.

(d) Uncontrolled Tourism

3.193 Eco-tourism, in its actual meaning, has not existed in Khanh Hoa although there have been a wide range of areas called "ecotourism area". Over the last few years, the number of tourists in Khanh Hoa has experienced a strong development. One of the most important influences of tourism development is an increase in demand for souvenirs, which called for the exploitation of wild animals and natural resources. As a result, illegal trading of wild and scarce animals is happening without control and strict management.

3.194 The anchoring of tourism ships and boats is commonly happening in many places in the area, even in the core area in Hon Mun of sea reserves. According to survey data in 2002, about 10% of travel tours around Hon Mun have signs of causing influence due to ship anchoring. Coral reefs next to fishery villages in the southeast of Hon Tre, Hon Mot and coral reefs next to Hon Tam tourism area are also significantly affected. Destruction caused by ship anchoring is limited in places where there are mooring systems but damages tend to increase in other places.

3.195 In addition, tourism is also causing harm to coral reefs and seagrass due to waste from cruise ship, passengers' diving and illegal exploitation of marine creatures.

(e) Natural Disasters

3.196 There are not many documents on the impacts on biodiversity in Khanh Hoa. Irregular storms with high frequency, deforestation in watershed forests, destruction of flora system in the islands, reclamation, coal exploitation, damages of mangrove forests have increased waste dumped into rivers and seas. These influences can lead to biodiversity depression.

3.197 Over the last few years, no cases of bleaching coral reefs have been detected like in 1998. However, the impacts of El Niño and warming process in sea water are potential impact on coral reefs in Khanh Hoa.

(3) Impacts of Biodiversity Depression

3.198 Biodiversity can have negative impacts on socio-economic fields. In fact, forest eco-system depression is the main cause of natural disasters. The destruction of sea grass, coral reefs has undermined the ability to protect sea banks prevent erosion. Biodiversity damages also decrease the ability to add natural breeds to the development of help fulbiomen.

3.199 Significant decrease in water resources has led to such impacts as: low exploitation efficiency; low income and profit. Water resources are depleting;

3.200 Therefore, offshore fishing is required. Poor resources can make people resort to destructive exploitation. This can cause competition among residents and social instability.

3.201 Ecosystem depression has negatively impacted marine tourism. In order to maintain and develop marine tourism, it is necessary to protect biodiversity as well as coral reefs.

3.202 It is also necessary to pay attention to the disappearance of scarce living

things (like sea turtles and *Pygathrix nigripes*), which means the decrease in the ability to attract tourists, especially senior travelers.

(a) Forecast of changes in biodiversity

3.203 Changes in biodiversity depend on socio-economic activities in the entire province and the attention of leaders.

3.204 Khanh Hoa is enjoying rapid growth and shall continue developing in the future. Biodiversity can continue to be depressed if there are no timely solutions.

3.205 At present, in the province, there are plans for developing planted forests; proposals for recovering mangrove forests and coral reefs; ideas of protecting spawning grounds of marine turtles; protecting *Pygathrix nigripes* community; ideas of models to manage coral reefs in Ran Trao. The operation of sea reserves in Nha Trang is also contributing to the protection of biodiversity.

3.206 In general, Khanh Hoa Province has implemented activities aimed at carrying out National Biodiversity Action Plan like: decision on the establishment of marine reserves in Nha Trang bay in 2002, Hon Ba Nature reserves in 2005. The province approved results of reviewing and planning 3 forest types, decision on coral reef management and transportation, etc.

3.207 However, biodiversity protection in Khanh Hoa is also showing some disadvantages. Area of nature reserves is still small compared with national policy. Management policy is still lacking in efficiency.

3.208 The main reason is the lack of guidelines from the province. It is necessary to determine mechanism and agencies in charge of coordinating biodiversity protection.

3.209 In Khanh Hoa, there are many enterprises enjoying benefits. However, these beneficiaries have not contributed much to biodiversity protection and preservation

2) Biodiversity in Ninh Thuan Province

(1) Forest biodiversity

3.210 Ninh Thuan's forest has high biodiversity with many types of forests: green thick forest, deciduous forest, taiga, mixed forest, bamboo forest.

- Flora: 1,185 species of 652 branches, 172 families, 46 ordines, 6 phylums.
- Fauna: 114 specie, 42 branches, 16 families. Wild animals: 55 species, 22 branches, 8 families. Reptile: 33 species, 9 branches, 2 families. Amphibians: 12 species, 4 branches, 1 family.

(a) **Biodiversity in savanna area**

3.211 Ninh Thuan is the only province in the country (except for Bac Binh and Tuy Phong District of Binh Thuan) and in Asian region has typical savanna. Land area of savanna is 63,816 ha. There are many typical plants can be found in the savanna such as: *Galinsoga parvifloram*, *Gymnocalycinum damsii*, *Cyatheales*, etc.). Especially, Neem tree originated from Sahara (Africa) has been adapted itself with Ninh Thuan climate and covered the vacant land.

3.212 There are 47 species which typify the coastal sand dune areas. Among

which, there are many species that have highly economic values.

(b) National parks and nature reserves

3.213 In Ninh Thuan, there is 1 nature reserve and 1 national park: Nui Chua National Park and Phuoc Binh Nature Reserve.

(2) Changes in the biodiversity degradation

3.214 There are a lot of changes in the natural forest ecosystem. The coverage is increasing but the increased forest area is grown forest so the biodiversity value is not high. Most of natural forest is under degradation. In addition, the decrease in forest area is caused by deforestation, uncontrollable exploitation and use of forest land, forest fire. This is a great threat for the biodiversity values of forest ecosystem including fauna and flora depending on forests.

3.215 At present, there is a decrease in the area of important natural ecosystem areas. The number of wild animals has been in decline. Many species are on the verge of extinction. Wild gene sources are also in the process of recession. The degradation of biodiversity will lead to the ecological imbalance, and directly affect the living environment of human, threatens the sustainable of the country.

3.216 The total number of wild fauna and flora which is under the risk of extinction is 882 species (Vietnam Red Book, 2007), increasing by 161 species compared to the last publication (1992, 1996, and 2000). Especially, up to present, 9 fauna species and 2 Orchard species are extinct. The number of other rare creatures has been under decline in terms of number. The reasons for the loss of biodiversity are the changes in habitations, over-exploitation of resources; environmental pollution and climate changes.

3.217 In Vietnam, land restructure, especially the conversion of forest land to land for industrial crops is happening every year. The construction of infrastructure such as roads, hydroelectricity dam has caused the degradation and loss of natural landscape. The illegal exploitation of wood, hunting, trafficking of wild animals are big challenges to management levels.

3.218 Besides, the activities causing environmental pollution such as discharging on untreated waste to rivers, lakes, air also cause pollution to living environment at rivers and coastal areas. The import of alien creatures has not been controlled strictly, for example: the import of 40 ton of *Trachemys scripta elegans*.

3.219 Therefore, the action to preserve biodiversity must be done regularly with specific orientation in order to ensure the balance between socio-economic development demand and community demand of a healthy living environment.

3.220 To 2020, the goal of Vietnam is to reduce pressure on biodiversity in order to preserve, rehabilitate and appropriately use ecosystems, creatures and genes. Priority programs include biodiversity plan, improvement of reserves system, preserve rare species, etc. by solutions of policy, organization, human resources development, technology, international cooperation, financial investment.

3.221 The fauna species are also under decrease in number, many of them are on the verge of extinction. The conversion of land use, from forest land to agricultural land, leads to the decrease in forest area and number of fauna and flora due to the

loss of habitation. In addition, illegal hunting and animal trafficking also affect the number of animals. At present, although this issue has been paid a lot of attention but the natural resources are still at risk. The import of alien creature is also a reason for the degradation of biodiversity.

3.222 In addition, urban waste, waste water from industrial zones, urban areas have not been treated appropriately so there is a large amount of organic substances, heavy metal, and toxic substance in receiving source. Therefore, there is a decrease in the number of creature in the river areas. Pollutants absorbed in solid can cause danger to creature and affect living environment.

(3) Impacts by the degradation of biodiversity

3.223 The biodiversity degradation has great impacts on socio-economic development and natural environment:

3.224 The decrease in the number of useful birds and insects will lead to the increase in the number of harmful insects, which affects the quality and agricultural productivity, and increases the cost of insect prevention. The use of pesticide, stimulants may affect health people, animals, and cause environmental pollution and increase the cost of pollution recovery.

3.225 The local agricultural plants might be lost if there is no good protection mechanism.

3.226 The degradation of biodiversity might lead to the decline in landscape diversity which affects the natural landscape and tourism potentials. Natural forests, national parks are attractive ecological tourism spots. If maintained and protected, they will be high economical potentials of the province. Natural forest is to keep biodiversity, natural structure; therefore; once natural forest is lost, there will be no basis to implement preservation activities and rehabilitation of the forest in the future.

3.227 The loss of natural forest will lead to the decline in number of plants, herbs and local vegetation, which affect the quality and quantity of seedling for the forest rehabilitation in the future. The decline in forest resources, especially protective forest, will cause erosion, landslide, drought and flash flood.

3.228 In water ecosystem, there are many aquatic plants, plankton and creatures living at river bed which can minimize the water pollution and clean the water ecosystem. The degradation of biodiversity will lead to the decrease in or loss of the number of those creatures and destroy self-cleaning mechanism.

3.229 Biodiversity does not only provide social welfare such as food, medicine, construction material, energy but also special values for biological technology, agricultural production forestry, aquaculture, industry, health and tourism. Moreover, it is an important component of the food security strategy, poverty reduction of the country in general and of the province in particular. However, the over-exploitation of natural resources and inappropriate development plans has great impacts on biodiversity.

3.230 The changing trends of ecosystem, diversity of species and gene show the extinction trend of creatures. Local species is under loss due to the import of new species or alien species.

3.231 The degradation of biodiversity leads to the ecological imbalance, which directly affects human living environment, threatens sustainable development. On the other hand, creatures and ecosystem is the source to provide food, tools and fuels. Therefore, the degradation of ecosystem will affect food security, and then people have to face with poverty, decline in genetic source, climate change and natural disaster.

3.232 The recovery of ecosystem, forest resource, diversity of species and gene in order to preserve biodiversity, prevent the extinction of rare species is an urgent issue.

(4) Reasons for Degradation

3.233 Like other provinces, biodiversity in Ninh Thuan is under degradation: decrease in quality and functions of the ecosystem, extinction of many species. In some cases, genetic diversity of important species is also degrading because of the loss in habitation. The threats to biodiversity in Ninh Thuan are various and affect each other.

(a) Direct Reasons

- Exploitation of wood and non-wood products

3.234 Illegal exploitation of wood and non-wood products: is a serious threat because exploitation focuses on some high quality and valuable products based on people demands. The illegal exploitation results in the extinction of some species decrease in forest quality and productivity, and loss of habitation of many wild animals.

3.235 The legal exploitation of forest products in low quality forest, although the technical process is ensured, might cause some effects such as: the preparation of way leading to forest create good conditions for illegal activities, the operation of vehicles frightens wild animals, etc.

- Illegal hunting and animal trafficking and over-exploitation of seafood

3.236 The illegal hunting for commercial purposes results in the extinction of many species.

3.237 In some areas, the over-hunting leads to the decrease in the number of species so the wild animal community is likely to be affected by alien species; and the recovery ability of ecosystem is decreases.

- Uncontrolled emigration and encroachment of forest land

3.238 Uncontrolled emigration and encroachment of forest land are reasons for the loss of forests which negatively affect the lives of many wild animals. It is needed to have policies to prevent the conversion of forest land, invest in other livelihoods which are not dependent on forest, and find out measures to protect forests.

- Forest fire

3.239 Forest fire causes serious damage in terms of economy, living environment of creatures, and decline on biodiversity and destruction of natural landscape.

(b) Objective Reasons

- Environmental pollution

3.240 Industrial waste, pesticide and fertilizer, chemical substances used in mineral exploitation, domestic waste which cause in environmental pollution kill creatures. In addition, the deposition of alluvium decreases water quality, threatens the existence of aquatic plants and decline biodiversity.

3.241 Environmental pollution due to different waste is a major reason threatening biodiversity: kill, decrease the number of species, destroy structure and habitation of creature.

3.242 Waste water with high content of nutrients causes “algal bloom” in lakes, which threatens the living environment of many aquatic creatures. Red tide, green tide phenomena at water areas are resulted from the increase in nutritive waste.

- Penetration of alien animals and plants.

3.243 Nowadays, trading activities among countries, regions are becoming more and more convenient; many species have been imported for purposes such as cultivation, animal growing. Many of them have become harmful species which threaten the existence of local species in Ninh Thuan.

3.244 In recent years, many alien creatures have penetrated into the country, typically *Pomacea caniculata*, *Mimosa pigra*. The penetration of alien creature is the potential threats to biodiversity. The uncontrollable development results in the bad effects to the environment and biodiversity; decrease in productivity and impacts on human health.

- Tourism development

3.245 With favorable natural conditions, Ninh Thuan has been developing tourism as a key industry. In recent years, the number of tourist coming to Ninh Thuan reaches 360 thousand people, which results in the increase in waste and other negative impacts on the environment. Therefore, if waste is not controlled strictly, and the awareness about environmental protection is not raised, environmental will definitely happen.

- Conversion of land use

3.246 The conversion of forest land and wetland to agricultural land, the expansion of urbanized areas and development of infrastructure development has led to the destruction of ecosystem and landscape. The increase in economic plants is a major reason for the loss of forest in recent years.

3.247 Socio-economic development is an inevitable demand. The economic development plan of the province is to improve transportation network, construct hydroelectricity plants, exploit mineral, and expand agricultural land. In order to construct those facilities, it is needed to convert forest land to construct infrastructure. This action will excite people to exploit forest products, encroach forest land illegally which threaten wild animals.

3.248 Irrigation dams, lakes, hydroelectricity lakes are to regulate water level and flow in dry and rainy season. However, the changes in natural water flow

will affect the lives of aquatic plants and fish. Chemical substances used in some mineral exploitation sectors and expansion of agricultural cultivation will pollute water environment and even kill aquatic creature downstream.

- Population growth

3.249 The population growth requires the increase in many basic demands, especially land resources for agricultural production. Poor people and ethnic people living near forests are dependent on forest so the forest can be over-exploited.

- Exploitation and unsustainable use of biological resources.

3.250 Biodiversity resources are exploited and used unsustainably. This situation is shown in the following activities:

- Over exploitation of aquatic products,
- Uncontrollable exploitation of wood products
- Illegal exploitation and trafficking of wild animals

- Natural disaster

3.251 Natural disaster has great impacts on many aspects of biodiversity. The major impacts are as follows: destruction of living environment and habitation, decrease in the number of creature, destruction of nutrient, water source, changes in characteristic, habits of some creatures, and changes in genetic structures.

- Mechanism, policy, laws on biodiversity management are insufficient

3.252 Most of ministries, departments at central government and local government express that there are difficulties in implementing preservation activities due to the lack of legal documents. For example, Ministry of Trade and Industry said that there was a lack of documents on the State management of biological safety in research, production, business, food import of Genetically Modified Organism (GMO).

3.253 The provision in Law on Biodiversity 2008 stipulates that “Ministry of Natural Resources and Environment is responsible for the State Management of Biodiversity”. However, the assignment of state management fo biodiversity in Law on Biodiversity 2008 did not satisfy all the criteria because it stipulates that “Ministries, ministerial department, within its responsibilities and authorites, implement the state management on biodiversity according to the assignment by the Government”; therefore, the ministries, and other sectors still wait for the assignment of the Government.

3.254 Regarding penal responsibility, Law 37/2009/QH 12 amended some provisions of Penal Code which provides stipulations on the crime related biodiversity preservation (Article 182-191).

3.255 The regulations on the responsibilities of ministries, sectors about the state management of biodiversity in Law on Forest Protection and Development 2004, Law on Maritime Products, Decree 109 and Decree 1 by the Government satisfied all the criteria namely legality, authority but it did not

meet the criteria of biodiversity characteristics. Before the promulgation of Law on biodiversity 2008, the approach on functions and authorities of ministries, sectors was based on the category of natural ecosystem, components of biodiversity such as: forest, sea, wetland, while those components must be seen as a whole.

3.256 If the assignment of the government still follows the above said approach which means that different ecosystem will be managed by different departments, the new approach of Law in biodiversity 2008 will not be valuable. If there is no new improvement in the biodiversity protection and management, the overlap in terms of functions, responsibilities among ministries, sectors is unavoidable.

3.257 Therefore, in order to improve the management system and strengthen responsibilities of sectors, it is needed to soon clarify the management functions among ministries and sectors. Specifically, it is needed to revise some overlapping functions between MONRE and MARD; shift some functions of Department of Forestry and Maritime Product of MARD to other state management agencies of MONRE; to assign functions and responsibilities about biological safety to the Department of Science Technology and Environment under Ministry of Trade and Industry, MOC, MOH, Ministry of Science and Technology.

- **Insufficient awareness of biodiversity values**

3.258 Up to now, people only see the tangible values of the ecosystem like wood and forest products and we haven't understand well about other intangible resources such as environmental service; therefore, we haven't paid attention to long-term values of biodiversity.

(5) Forecast of the Biodiversity Degradation

3.259 At present, although forest and biodiversity has been improved and stable, the pressure from socio-economic development process still leads to the decline in forest resources, forest fire, deforestation, and illegal hunting. There is a risk of decline or loss of wetland, flora corridor and fauna groups. In addition, the import and cross-breeding of animals and plants might reduce the quality and quantity of local animals and plants.

(a) Forecast of Terrestrial Fauna and Flora System

3.260 Vertebrate area (animal, bird, reptile, and amphibian) in Ninh Thuan is being affected; the number of species is declining due to the over-exploitation of human, especially, rare and valuable species which can be used for food, medicine and trading. At present, some mammals do not appear any longer where they used to.

3.261 The preservation activity in Nui Chua National Park and Phuoc Binh National Reserves is paid more attention. Staffs working here are train periodically in order to improve the skills of natural resource protection.

3.262 According to the forecast, Ninh Thuan province will focus on the preservation of national parks by implementing projects related to preservation, improvement of equipments, education for staffs. It is expected that biodiversity in

Ninh Thuan Province will be kept in the future and some rare animals will be rehabilitated.

(b) Forecast of Maritime Biodiversity in Ninh Thuan Province

3.263 Due to the decreased water quality and illegal fishing activities, the aquatic resources have been decreased in both quality and quantity. When reservoirs are established, there will be many local fish and imported fish living in the same reservoirs, therefore, there will be both advantages and disadvantages changes. This should be studied and the environment and sustainable development should be considered as well.

3.264 Together with the forest resource protection, the capacity improvement is implemented quite well. However, the maritime resource protection is more difficult and complicated. The capacity building and staff training is taken place periodically and will be strengthened in the future. Therefore, maritime biodiversity in Ninh Thuan Province will be various in the future and it is expected to be able to recover some rare species, especially to develop and preserve coral and turtle.

3) Biodiversity in Binh Thuan Province

(1) Biodiversity Conservation and Development

(a) Preserving and developing the biodiversity in land

3.265 Classifying special use forests; reviewing, planning and developing the system of special use forests by application of the model for stable forest management.

3.266 In the period of 2006-2010, Binh Thuan Province has implemented forest planning and has classified forest into 3 types. Of these, the natural forest area of the whole province is 370,012 ha including 428 subzones. In the past year, the provincial authorities paid particular attention to the natural forests, especially primeval forests at the head of rivers, as nature preservation areas.

3.267 Currently, there are 112,376 ha of forest area that is preserved. Formal policy commitments to preserve forests have recognized as a first step the need to socialize the protection works that contribute to management of natural forests effectively, and reduce deforestation by minority groups for agriculture.

3.268 The 5 million hectare afforestation project is continuing, in particular focusing on forests at the head of rivers, which are degraded, and sensitive ecosystems.

3.269 The forestry area contracted to the economic organizations and households are 30,130 ha (statistics of December 2007). This figure is expected to increase to 40,000 ha.

3.270 In 2008, there was 37,000 ha of area under reforestation and it is planned to expand this to 45,000 ha.

(b) Establishing and proposing the nature preservation areas

3.271 In Binh Thuan, there are two recognized nature preservation areas: Ta Cu nature preservation area and Bien Lac nature preservation area. Binh Thuan

Provincial Authority is proposing to establish Cu Lao Cau Island (Tuy Phong district) as a Marine Protected Area.

Table 3.1.24 List of Protected Areas in Binh Thuan Province

Name of preservation area	Scale (ha)	Type	Potentials for protection
Lac Sea- Ong Mountain	25,468.5	Nature Reserve	Biodiversity
Takou	10,831.5	Nature Reserve	Biodiversity
Cu Lao Cau	12,500.0	Nature Reserve	Biodiversity

Source: Five Year Environmental Status Report/2005-2009, Binh Thuan DONRE

(c) Preserving and developing the biodiversity in wetlands and marine wetlands

3.272 In order to preserve and develop the biodiversity to recreate the resources of prawn parents, Binh Thuan Province has bred 3,450,000 prawns in the Chi Cong and Tien Thanh sea area.

3.273 Moreover, Binh Thuan are implementing two pilot projects on model of joint managing the seafood resources in the Hoa Thang sea area and establishing the preservation area in Cu Lao Cau Island.

(d) Agriculture biodiversity preservation and development

3.274 In breeding activities, we should apply safely biological raising methods, prevent all external factors that may bring diseases into raising units; transfer the breeding small-size mode into centralized mode towards industry and having injecting process strictly.

3.275 In cultivation, many activities protecting biodiversity are deployed: applying and developing the program “3 increase and 3 decrease” in production to use fertilizer suitably and appropriately with the rice growth, limiting the use of protecting plant drug for the sake of public health and environment.

3.276 Releasing the parasitic bee living in stag beetle into the natural environment in order to reduce honey and restrain the sabotage of these insects in coconut trees and joint protect the scene of tourism area.

3.277 Deploying the master management program of epidemic in cashew by yellow ants that are the main method applied in Duc Linh district and Tanh Linh district.

3.278 Using micro-organic fertilizer cultivated trees instead of cattle manure, in particular, with the area of dragon fruit.

(2) Sustainable Use of Creatures

(a) Sustainable use of wood resource and forestry products except wood

3.279 Preventing, checking, controlling and punishing seriously with the illegal exploitation and use of creatures.

3.280 Strengthening patrols to stem and punish strictly with all illegal creature exploitations, business. According to the statistics of 2007, there were 3,427 cases violating seafood resource.

3.281 Besides, based on the seafood law and instructions documents to implement, forest development and protection law has hold many activities to raise awareness, for example: prohibiting to use the destructive means or

methods with seafood resource; forbidding to use harmful chemicals or antibiotic drug to preserve seafood; protecting and reforesting, preventing forest burning; banning to deforest.

(b) Managing and controlling strictly all creatures invading.

3.282 Strengthening propaganda on the mass media about the danger of bird flu virus in poultry, symptoms of blue ear disease and how to recognition, disease prevention for poultry and infection protection for human.

(3) Achievements and Challenges of the Process to Implement Biodiversity Action Plan

3.283 Biological resource is running out of and its recovery is limited. The reasons for these facts are the low awareness of people in protecting biodiversity.

3.284 Organization system and managing ability on protecting biodiversity haven't met the requirements yet; investment capital for this work is not enough.

3.285 Suggesting and proposing in order to strengthen the implementation of biodiversity action plan

3.286 Developing propaganda programs and training to raise the awareness of people in the work of protecting and safely managing biodiversity.

3.287 After the biodiversity law passed, Ministry of natural resource and environment establish a proposal plan to complete organization and strengthen the ability for state managements organizations in biodiversity and safely biology; perfecting the mechanism, policy system, legal documents on biodiversity and biological safety management.

3.288 Demanding the support of Ministries, central branches in the work of building and proposal for Cu Lao Cau preservation area (Tuy Phong district, Binh Thuan Province) to be national marine creature preservation area.

4) Biodiversity in Dong Nai Province

(1) Current Conditions of Biodiversity and Developments in Biodiversity Degradation

(a) Forest Resources

- Developments in Forest Areas

3.289 Results of implementing a number of targets in agriculture show that over the last 5 years, forestry production value obtained annual growth of 7.2%/year, higher than targets stipulated in planning (3.0%/year). Forest coverage increased from 26.5% in 2006 to 29.8% in 2010.

- Results of "5 million hectare afforestation project"

3.290 In the period 2006 – 2009, thanks to the 5 million hectare afforestation project, Dong Nai Province newly grows 1,549.7 ha forest (among which protection forest: 806.6 ha; special-use forest 121.9 ha; production forest 621.9 ha), protection forests having local big wood trees like: Hopea, Dipterocarpaceae and other local big wood trees, mixed with acacia and fruit trees as well as industrial trees. Density of each type meets regulated

standards.

(b) Biodiversity Resources

3.291 In Dong Nai province, areas having high and typical biodiversity include Tri An lake, Long Thanh – Nhon Trach mangrove forest and Nam Cat Tien national park. Current biodiversity in those areas are as follows:

- Tri An Lake

3.292 Current Management

3.293 Tri An lake is 65km to the northeastern Hochiminh City and located in the northwestern Dong Nai. The east of Tri An lake is next to Dinh Quan district, the west adjacent to Vinh Cuu district and the south contiguous to Thong Nhat district. Tri An lake is aimed at serving the development of hydro power, exploitation of water resources and development of tourism in Dong Nai Province.

3.294 Economic development: At present, in Tri An lake, economic development activities are mainly in agricultural and industrial production. Industrial production experiences slow growth, except for 2 sugar cane factories and , factory, which can produce 1,260m³ waste water per day and night, negatively impacting water quality in Tri An lake, the area next to La Nga bridge.

- Long Thanh – Nhon Trach mangrove forest

3.295 Current management: mangrove forest in the state forest enterprise Long Thanh is located in administrative boundary of 4 communes including: Phuoc Anh, Long Tho (Nhon Trach district); Phuoc Thai commune, Long Phuoc (Long Thanh district). Total natural area of Long Thanh mangrove forest is 7,952.67 ha, of which: In Nhon Trach district, there are 7,060 ha forest, including 4,036 ha land having forest and 3,024 ha land not covered with forest; and in Long Thanh district, there are 1,467 ha forest.

3.296 Mangrove protection forest takes part in the process of stabilizing alluvial deposit, preventing erosion due to tidal activities and other activities at river gate. In the forest, there are also other ecological processes like the transmission of alluvium and planktonss, creating balance for the development of shrimp larvae and fish. In general, protection of mangrove forest Long Thanh – Nhon Tranh has been effectively improved with rather good growth in forest area as well as natural resources

- Cat Tien National Park

3.297 Current management: Cat Tien national park is located in the area of 3 provinces namely Dong Nai, Lam Dong and Binh Phuoc. Area of adjusted forest is 71,920ha. Over the last few years, center for eco-tourism and environmental education of national park is in responsible for propaganda and communications appealing to 3 main subjects: tourists, students in the buffer zone and local residents. The center has obtained a number of achievements as follows: project on drawing up textbooks for students, training teachers, holding environmental competitions for students, organizing green club,

constructing gardens in schools; project on printing environmental propaganda handout, printing notebooks with environmental propaganda contents in 4 cover pages. Through propaganda and education activities, awareness of forest protection and management has been improved.

3.298 In the buffer zone of the national park and Bau Sau Nam Cat Tien (Bau Sau Nam Cat Tien is listed in Ramsar treaty regarding mangrove forest), there are many ethnic minorities. By 2000 deforestation in Nam Cat Tien was very serious at “red alarming level”, which posed threats to safety in Tri An lake, especially in rainy season and in case of flash floods. As a result, Dong Nai cooperated with Binh Phuoc and Lam Dong in the project “Cat Tien national park protection”, among which there are regulations on managing buffer zone in order to help ethnic minorities stabilize their life and production, improve living standards of residents in the buffer zone. Watershed forest is well protected. However, at present, there are still cases of illegal hunting of scarce animals and deforestation. Therefore, activities aimed at protecting Cat Tien national park are still being promoted.

(c) General Comments on Current Conditions of Forest and Biodiversity

3.299 Matters like deforestation, forest fires, and forest encroachment have decreased. Area of natural forest, protection forest, and important watershed forest has been stabilized, helping create jobs, improve living standards, ecosystems and promote socio-economic development.

3.300 The province has boosted biodiversity survey in the province area, especially in Cat Tien national park and Long Thanh – Nhon Trach protection mangrove forest. In these two areas, propaganda and education on environmental protection have been promoted among tourists, students in the buffer zone and local residents. In addition, it is necessary to further improve living standards of ethnic minorities with a view to raising their awareness of forest protection.

(d) Impacts of Biodiversity Degradation on Environment

3.301 The most serious impact is the influence on biodiversity itself. Decrease in the number of species shall lead to changes in indicators to assess ecosystem;

3.302 Impacts on flora carpet and ecosystems differ according to H index (Shannon-weiner Index). Regarding natural tropical humid forest, H index varies between 5.06 – 5.40 and regarding planted tropical humid forest, H index varies between 1.16 – 1.34;

3.303 Biodiversity decrease shall lead to the growth of some dominant species (classified into Cd category) (Simpson Index), which can pose obstacles to the development of other species and cause biodiversity conflicts. Value and meaning of Cd index are contrary to H index;

3.304 Biodiversity reduction can result in the decline in species in ecological population. The change is assessed by Species Richness (SR) index.

- Reduction in Water Quality and Reservoirs

3.305 Components of surface soil shall determine amount of water penetrating into ground water, and in the mean time determine the ability of

pollutants to be absorbed into ground water. When surface water contains many flora species whose root systems can limit penetration of waste water into ground water, pollution shall be limited and vice versa.

3.306 Biodiversity degradation shall contribute to an increase in water vaportation and a decline in water detention. The process of water detention of flora system is as follows:

3.307 The majority of water dropped onto the earth surface shall penetrate into deeper layer;

3.308 Rain water penetrating through surface soil from zone of aeration to zone of saturation, where all hollow spaces are filled with water. This type of water is also called ground water and its free surface is called level of ground water or simply called static water level;

3.309 Ground water running in soi-water zone is mainly in the form of streamline flow. Direction and speed of ground water running depend on typical characteristics of rocks like permeability, viscosity of water and hydraulic gradient of water;

3.310 Ground water can be divided into 2 zones: zone of aeration and zone of saturation;

3.311 Zone of aeration includes pores, which contain air;

3.312 In zone of saturation, all pores in soil are filled with water under static water pressure;

3.313 Plant root: humidity of water in this part is lower than saturation humidity;

3.314 Except for temporary saturation due to increasing ground water table or in case of rain or watering.

3.315 The depth from the surface soil to the end of root system: depends on soil type and plant type;

3.316 Intermediate zone: from root boundary line to upper boundary line of capillary layer. It is the buffer zone between the zone right next to the surface soil and the zone right next to ground water area;

3.317 Water flowing to zone of saturation shall have to run through intermediate zone. Water can be detained in this area due to capillary force and molecular gravity. Water will flow in top down direction when humidity of soil exceeds its ability to detain humidity.

3.318 As a result, biodiversity reduction shall impact water quality.

- Air pollution

3.319 Biodiversity degradation could lead to changes in the structure and components of living organisms, which could result in air pollution. Biodiveristy degradation shall reduce ability to absorb CO₂ in the air as well as the ability to clean air environment, reduce noise level.

- Soil and Underground Water Pollution

3.320 Biodiversity reduction in terms of flora system shall heavily impact the ability to self-absorb of soil environment. Soil permeability (K) depends on factors as follows:

3.321 Depth of ground water (D). During the reception of water from natural or hand made process, the infiltration of water from surface soil to ground water, zone of aeration is considered as a filtering layer, the thicker the filtering layer, the better ability to detain waste. If biodiversity degradation happens, ability to detain waste shall be reduced, therefore, there is a high probability of water pollution;

3.322 Annual amount of water added to ground water (R): water infiltration varies according to areas. Places, where biodiversity conditions are good, there shall be a high amount of precipitation, and vice versa. In addition, amount of rain water infiltrated into ground water is calculated based on annual average rainfall in the region multiplied by infiltration coefficient α (depending on surface water);

3.323 Terrain gradient, to some extent, shall increase or limit the infiltration ability. However, if flora system is in good conditions, ability to detain water shall be good accordingly.

3.324 As a result, soil penetration degree shall determine the self-infiltration ability of water, which has a great impact on ground water.

3.325 In addition, biodiversity degradation shall impact soil quality and porosity, especially fauna species living under soil. Biodiversity can help improve soil quality. On the contrary, biodiversity degradation can result in soil pollution.

(2) Causes of Biodiversity Degradation

3.326 Biodiversity, the most precious natural resources, is of great importance to people's life. However, at present, due to a variety of reasons, biodiversity is being degraded. The evident consequences are the reduction and loss of biodiversity functions like regulating water, preventing erosion, assimilating waste, cleaning environment, ensuring material cycles and natural energy, reducing natural disasters and damages due to climate change. Biodiversity degradation poses obstacles to socio-economic development due to the loss of value of natural resources, environment, especially in developing and least developed countries.

3.327 Causes of biodiversity degradation in Dong Nai Province are summarized as follows.

(a) Aquatic Flora and Fauna

3.328 Biodiversity degradation happening in aquatic ecosystems is mainly caused by human beings activities including:

- Exploitation of water sources for agricultural, industrial or domestic purposes;
- Construction of projects relating to dams and ports;
- Unsustainable exploitation of water resources without preservation methods;

- The activeness or lack of caution in importing alien fauna species which eat other kinds of animal species and parasitic flora or species competing with local flora system;
- Natural hazards happening in places where aquatic living things live: oil spill, chemical substances spill are also directly affecting aquatic living things.

(b) Terrestrial Flora and Fauna System

3.329 Biodiversity degradation of terrestrial flora and fauna system is mainly caused by human beings activities like:

- Overexploitation of forest resources, especially scarce flora species;
- Implementation of plannings for afforestation and forest car has not been good; There are no plans for protecting priority species, gene pools, managing in biodiversity bases, declaring and informing origins and status of species in the list of priority and protected species;
- Due to lack of detailed study or because of immediate profits, letting alien species cause harm to local species;
- Natural disasters like: drought, forest fires.

3.330 Forest area allocated to be admistered in Dong Nai during the period 2006 - 2009: 31.976,11ha. Annual forest area allocated to be managed averages 7.994 ha protection forest and special use forest, which are strictly protected. According to Decision No 631/QĐ.UBT dated 24/2/1997 by provincial people's committee and directive 20/CT.CT-UBT dated 5/4/1997 regarding the closing of natural forests managed by Dong Nai. Up to now, deforestation, forest fire, forest encroachment has decreased. Forest quality has been improved; helping create jobs and improved living standards for people, improving provincial eco-systems.

3.331 Forest fire prevention and protection are actively implemented at the end of rainy season; Protection forest management unit cooperates with localities on drawing up plans for forest fires prevention; organizing propaganda on responsibilities of authorities, people, therefore, the number of forest fires has dramatically decreased compared with previous years (in 2006 there are only 2 forest fires, causing damages to 1.13 ha planted forest; in 3 consecutive years 2007, 2008, 2009 there are no forest fires).

(3) Forecast of Developments in Biodiversity Degradation

(a) Impacts of Human Activities

3.332 Exploitation of mineral resources and water for production and domestic activities shall increase the danger of biodiversity degradation.

3.333 Exploitation of water for production and domestic activities: Until 2020, Dong Nai shall put 8,729 ha into industrial operation, with the quota of 40 m³/ha, which is a great amount. In addition, pressure from such matters as population growth, Dong Nai requires a high amount of water for domestic activities. Proportional to amount of water exploited is amount of waste water dumped into surface water, which can impact on aquatic living organisms, part of biodiversity;

- Fishing: Amount of aquatic products exploited is high, among which, there are many scarce species. In addition, the destructive exploitation methods are also decreasing aquatic living organisms;

- Aquaculture: this process impacts natural living things by importing dominant alien species into local environment (raised marine living things). The dominance of raised marine living things is also causing natural biodiversity degradation;
- Exploitation of forest natural resources: during socio-economic development, forest areas have decreased, which also result in biodiversity degradation.

(b) Impacts of Nature

3.334 Natural impacts on biodiversity include forest fires and flood tide.

- Flood tide: flood tide can cause salt water intrusion, making some species exposed to extinction, on the other hand, helping adaptable species grow. It is this change that leads to biodiversity degradation.
- Forest fire: climate change and global warming are raising threats of forest fires. Forest fire is the main reason for biodiversity degradation. If there are no suitable forest protection plans, Dong Nai shall be in grave danger of biodiversity degradation

5) Biodiversity in Binh Duong Province

(1) Specific ecologies

Aquatic ecosystem

3.335 This one comprises lakes, ponds, reservoirs, rivers, rivulets and pools which cover in a total narrow area and are distributed unevenly. Depending on the seasons, the water-level is changed; in the rainy season, there are the temporary waters which disappeared in the dry season. In the entire province, there is nearly 11,200 ha of water-surface area, among, about 300 ha of lake-surface area supplies water for irrigation. The most major landscape types which should be focused most are as follows:

- (a) **Rivers** and springs: there are 3 major rivers which are under Dong Nai river system (Be river, Dong Nai river and Saigon one) and a system of distributaries and rivulets running into these rivers (Thi Tinh river which is a distributary of Saigon river; the rivulets as Ba Lot, Ba Hiep, Vinh Binh, Ong Co, etc.). Along these distributaries and rivulets, there are the flatland riverside-corridor flora ecosystems. This habitat covers in a small area with the flora range which is distributed in the low-grounds along the rivers and springs.
- (b) **Ponds and lakes, reservoirs:** Binh Duong has many artificial ponds, lakes and reservoirs which are located in locations which are potential for tourism development and environment development. Most of landscapes surrounding these ponds, lakes and reservoirs are the barren grounds which have no trees and no water-source protection systems.
- (c) **Malaleuca forest in the wetland:** there are some the in-wetland malaleuca forests which play the important ecological role. Most of these forests are the artificial ones which are mainly located in Dau Tieng district (surrounding Dau Tieng lake).

Agricultural ecosystem

3.336 This ecosystem comprises the habitat of fields, hilly fields, gardens and rural residential zones. This ecosystem is being narrowed gradually since the progress of industrialization, urbanization. The organisms have been affected with the impacts of the intensive farming, the fertilizer and pesticide usage. With a rapid industrialization, the agricultural ecosystem is only concentrated majorly at the northern area (Dau Tieng, Phu Giao, Tan Uyen) and a narrow area of Thuan An, Di An, Ben Cat, Thu Dau Mot.

Urban ecosystem

3.337 This ecosystem comprises urban forests, green parks, traffic green corridors, urban rivulets and canals' corridors, urban landscape lakes/ ponds/ reservoirs, historical zones and cultural areas, etc. which are distributed mainly in Thu Dau Mot provincial town, Ben Cat district.

(2) The Situation and Cause of Binh Duong's Biodiversity Degradation

3.338 With the current industrialization – modernization speed of Vietnam (in general) and of Binh Duong (in particular) as well as the economic re-structure with the industrial – service trend, Binh Duong's biodiversity has been decreased with many impact factors which are specified as follows:

- (a) The Development of IZs: this one of the major causes of the biodiversity degradation. The area of agricultural – sylvicultural – greenery land has been narrowed; so many creatures have lost their habitat. This change has affected to the ecological balance which leads to the disappearance of the local endemic species and the extinction risk of the rare specious species. Furthermore, the industrial activities make a huge waste volume which pollutes the air – water – soil environment as well as destroys the habitat of many animals, plants and micro-organisms.
- (b) The sylvicultural-to-agricultural land-use transfer has decreased the forest area that leads to the decline of flora species which has lost their habitat, then the number of animal species has been also increased subsequently.
- (c) The illegal wild-animal sale is one of the most specifically direct causes of the decrease of Binh Duong's flora and fauna species.

3.339 Decreased biodiversity of flora and fauna species: In 2009, Binh Duong review completely the situation of forests and forestry land in compliance with Instruction No.38/2005/CT-TTg of Prime Minister. As the result, the provincial area of forests and forestry land was decreased noticeably; this one has decreased from 19,014 ha (before being reviewed) to 15,138 ha (by 2010). Hence, the habitat space of flora and fauna is narrowed.

3.340 The industrial-crop area increases by-year. The area of rubber uninterruptedly increased from 73,740 ha (1996) to 94,585 ha (2000), 106,974 ha (2005) and 126,919 ha (by 2009). In addition, the area of plper nigrum increased from 175 ha to 485 ha in period 1996–2009. The specialized cultivation of crops will unbalance the flora species and biodiversity degradation of Binh Duong.

3.341 The decline of biological diversity

3.342 The biological diversity has been declined (such as: forests, wetlands, vegetation corridors, etc.). Some natural forest areas have been replaced with the new monotonous habitats (for example: the eucalyptus forests, acacia forests, rubber forests in Phu Giao, Dau Tieng, Tan Uyen) which are the habitats of a few flora and fauna species.

(3) Forecast on the Change of the Biodiversity Degradation

3.343 Some forecasted changes of the biodiversity degradation are presented as below:

- (a) **The loss of natural forests:** The biological diversity (such as: forests, wetlands, vegetation corridors, ect.) will be gradually disappeared and replaced with the mono-gender planted forests.
- (b) **The diversity of aquatic ecosystems is threatened seriously:** a huge volume of pesticides, pollutants in the industrial and domestic wastewater pollute the aquatic ecosystem seriously and threat the survival of aquatic species.
- (c) **The disappearance of purebred species:** with the condition that Binh Duong has not had the gene - seed conservation bank, the exotic plant or wild-animal breeding and naturalization management, the uncontrolled situation of hybrid progress within the wild environment and the captive breeding environment, the indigenous endemic purebred species will be degenerated gradually.
- (d) **The animals' upstream-to-urban area migration corridors:** the future land-use and urbanization progress will divide the natural vegetation corridors along Saigon river and Dong Nai river into fragments.

3.344 Hence, the province has conducted the project "Surveying and evaluating on Binh Duong's biodiversity to formulate the measures for managing and using sensibly the biological resources and ecosystems with the orientation of Binh Duong's stably socio-economic development targets up to 2010".

6) Biodiversity in HCMC

3.345 HCMC has facing many challenges in biodiversity protection. HCMC is the largest consumption market and is one of 5 hot-spots of illegal wild animal trading. Number of aquatic species has been reduced significantly in Can Gio sea zone and in Dong Nai – Sai Gon River system due to improper and illegal fishing.

3.346 HCMC is facing environmental pollution situation in industrialization and urbanization process. This situation also contributes to degradation of biodiversity in HCMC. Sai Gon and Dong Nai rivers receive huge domestic and industrial wastewater volume that affects seriously to mangrove forest – the city lung. Hollow land zones which used to be biological buffer zones have been occupied for urban development. New towns have been developed in districts 2, 7, 9, 12 while Nha Be and Binh Chanh districts have been developed as industrial centers, causes biological system change and degrading biodiversity. Riverside zones became death soil zones, changing ecological system. Air emission causes acid rain, reducing pH and affecting to biodiversity directly. Air emission also causes global warming, seawater rise and flooding, affecting to biodiversity in HCMC and Can Gio mangrove forest.

3.347 Biodiversity protection and development shall be considered as strategic and long-term task that requires public participation. Various actions have been carried out to protect the city ecological system and biodiversity. Can Gio mangrove forest has been developed as the best forest in Vietnam and on the world.

(1) Biodiversity of Can Gio Mangrove Forest

3.348 Can Gio mangrove forest is bordered to Long Tau River at the north, Xoai Rap and Dong Tranh River at the west and the south and the sea at the east, from 10°22'14" to 10°40'09" northern latitude to 106°46'12"-107°00'59" eastern longitude.

3.349 The Can Gio Forest was recognized as the first mangrove biosphere reserve in Vietnam by UNESCO in 2000, covering an area of 75,740 ha, including 4,721 ha core zone, 41,139 ha buffer zone and 29,880 ha transition zone. The Can Gio Forests is located in one of rural district of HCMC.

3.350 It is statistically reported that there are 371 species, including 28 animal species, 135 bird species, 41 reptile species 91 fish species, 34 crustacean species, etc.

(2) Pressures on Fauna of Can Gio Submerged Zone

- (i) Industrial pollution in Thi Vai River, especially pollution by wastewater of Vedan Company makes serious degradation of aquatic resources. Many fishing men must change their job for livelihood. Aquaculture in Thanh An and communes of Dong Nai Province has been seriously affected by the river water pollution.
- (ii) Industrial shrimp breeding has been expanded in Tam Thon Hiep which encroach habitat of *Lutra lutra* and *Aonyx cinerea* which are rare and precious animal species.
- (iii) River's bed fish net used to be developed considerably in Long Tau River but it has been banned for waterway navigation. The site survey result shows that there are many small pots in small tributaries, e.g. Cha La, Thieng Lieng, Vam Sat, etc. Small mesh threatens aquatic resources since mangrove forests are habitat of larva species and young shrimp and fish.
- (iv) Fishing by mosquito-net type has been banned but some small mesh net still utilizes to catch fish and shrimp in Can Gio biosphere reserve. Many young fish and shrimp are killed by this net type.
- (v) Unbridled breeding of *Macaca rhesus* and *Macaca leonina* on monkey island is unnecessary since they could transmit disease germs to *Macaca f. fascicularis*, contributing to degrading the indigenous animal species in the future.
- (vi) Oil spill: Oil spill in Long Tau River in 1995 and recently in Muong Chuoi canal caused great degradation of aquatic resources, affecting seriously on aquaculture. Oil spill may also occur in Can Gio submerged zone.

3.351 Sea encroaching project has adverse impacts on shell breeds in the locality.

(3) Recommendation by HCMC

- Can Gio Biosphere Reserve

3.352 Can Gio Biosphere Reserve has 294 animal, bird, mammal and reptile species, including 30 rare and precious species which are listed in Vietnam Red Book (2007).

3.353 There are 212 flora species, including 1 rare and precious species (Lumnitzera littorea). This zone also has 76 invertebrate fauna species.

3.354 Total 322 species are valuable for economic development.

Table 3.1.25 Fauna and Flora Species in Can Gio Submerged Zone (Excluding Small Invertebrate Fauna Species)

No.	Group	No. of Species	Rare and Precious Species No.	Valuable Species No.
1	Animal	28	6	28
2	Bird	125	5	135
3	Mammal and reptile	41	11	41
4	Fish	90	8	66
5	Crustacean	34	-	27
	Non-crustacean	2	-	1
6	Shell	40	-	24
7	Plant	212	1	-

Source: 5ECSR 2005-2009, HCMC DONRE

"-": No specified information is available

3.355 Followings are the recommendation on biodiversity management by the HCM in Five Year Environmental Status Report. These are regarded as necessary activities by the DONRE of HCMC.

- Biodiversity of Can Gio submerged zone shall be further researched, especially rare and precious species. Research on biodiversity and conservation as well as biodiversity monitoring is needed.
- Meretric lyrata was found in Can Gio in 2009. Merretric lyrata breeds density was high in August. However, the density has been reduced significantly. Detail monitoring shall be conducted to consider recovering Merretric lyrata breeding in Can Gio.
- River-bed net with small mesh shall be banned.
- Further studies and researches are necessary, especially researches on animal, mamal, bird, reptile, mollus (Bivalvae and Gastropoda). Modern research methodologies (i.e. photo trap) shall be applied to evaluate the communities and develop biodiversity database, promoting biodiversity protection and sustainable development. Biodiversity and protection researches are required, especially biodiversity monitoring programs.
- Can Gio mangrove forest is the sensitive ecosystem which could be affected by industrial production and oil spill incident. Reserves of aquaculture resources shall be evaluated to formulate proper protection and development plans, loss assessment in case of incidents, among others.
- Only wooden species are considered in Cu Chi district. Other species shall be further studied.
- Meretric lyrata was found in Can Gio in 2009. Merretric lyrata breeds density was high in August. However, the density has been reduced significantly. Detail monitoring shall be conducted to consider recovering Merretric lyrata breeding in Can Gio.

- River-bed net with small mesh and destroyed fishing method shall be banned.
- Proper cooperation between Binh Duong, Tay Ninh, Dong Nai and HCMC shall be established to handle pollution issues, rescuing Sai Gon River.

3.1.8 Flora and Fauna

3.356 Characteristics of flora and fauna at each province are outlined in Table 3.1.26.

Table 3.1.26 Characteristics of Flora and Fauna at Each Province

No	Province/ City	Available documents	Description
7	Khanh Hoa	5ECSR 2006-2010 period chapter 6, pp.142-146.	According to statistics by Forest Protection Department, Khanh Hoa forest has 871 species, 296 genus of 136 families, among which 10 families have more than 20 species.
8	Ninh Thuan	5ECSR 2006-2010 period, chapter 6, pp.97-101.	Flora and Fauna are diversified in Nui Chua National Park and Phuoc Binh Nature Reserve. For example; Flora: Vascular plants include: 1,265 species, 596 branches, 147 families, 85 sectors. Fauna: There are 306 species of wild animals of 89 families, 29 branches, 4 layers, in which 72 species of Mammalia, 181 species of Aves and 17 species of Amphibia in Nui Chua National Park
9	Binh Thuan	5ECSR 2005 – 2009 period, chapter VII, pp.92-94.	Fauna: Forest animals include 68 species, classified into 26 families and 11 groups, 133 bird species of 42 families. Flora: includes 752 species, classified into 447 branches, 150 families, 59 groups, in which there are 22 species classified into 19 branches and 16 families.
10	Dong Nai	Document prepared by DARD as the follow-up after the meeting with JST. 5ECSR 2006-2010 period, chapter 6, pp.111-117.	There are 1401 species, belonging to 623 genus, 156 families, 92 orders, 10 classes and 6 phylum; among which 30 species belonging to 27 genus, 18 families, 16 orders are listed as scarce species in Vietnam Red Book (2007)
11	Binh Duong	5ECSR 2005-2010 period of Binh Duong Province, chapter 6, pp.84-89.	According to the statistic data of Tropical Biology Institute, Binh Duong has 23 mammal species, 99 bird species, 19 species of amphibians, 40 species of reptiles, 67 fish species, 1084 species of vascular plants and many aquatic organisms
12	HCMC	5ECSR 2005-2009 period of HCMC, chapter VI, pp.103-115.	HCMC has 356 flora and fauna species, including 34 animal species, 141 bird species, 41 mammal and reptile species and 142 fish species. 35 rare and precious fauna species are named in Vietnam Red Book (2007), which are comprised of 7 animal species, 5 bird species, 11 mammal and reptile species and 12 fish species.

Source: DONRE, compiled by JICA Study Team

1) Flora and Fauna in Khanh Hoa Province

(1) Terrestrial Species Diversity

3.357 According to statistics by Forest Protection Department, Khanh Hoa forest has 871 species, 296 genus of 136 families, among which 10 families have more than 20 species, for example; *Dipterocarpaceae*, *Ebenaceae*, and *Annonaceae*. Khanh Hoa flora system includes species originating from Malaysia, Indonesia, temperate species, and species originating from India-Burma. However, local flora system still accounts for more than 52%. Until now, there are no data on fauna system in Khanh Hoa.

3.358 Hon Ba Nature Reserves is the only special use forest in Khanh Hoa with a variety

of forest types including:(1)– Subtropical closed evergreen tree in average mountain (the height from1,000-1,600m);among which there is closed evergreen tree with broad leave tree and subtropical coniferous tree; (2)–Subtropical closed evergreen forest in low mountains(height ranges from 500-1,000m); (3)–Closed tropical moist evergreen forest (height less than500m) and (4)–Tropical secondary forest.

3.359 According to information not released, Hon Ba has a diversified flora system, with intital data of 592 high level flora system, belonging to 401 genusand 120 families; among which: *Lycophyta* and *Pteridophyta* have 73 species, *Gymnospermae* has 8 species and basal angiosperms has 511 species. In addition to coniferous flora, in this area there are also species, which only exist in subtropical belt or temperate climate belt like: *Ericaceae*, *Aceraceae*, *Lauraceae*, and *Cyatheaceae*. There are 43 scarce species recorded in Viet Nam Red Book, most noticeably *Pinus krempfii*, *Fokieniahodginsii*, *Rhodoleiachampionii*, *Azeliaxylocarpa*, *Dalbergia annamensis*, *Diospyrosmun*, *Dialiumcochinchinensis*. *Pinus krempfii* is the endemic species of Vietnam, *Tabernaemontanagranulosais* endemic species only found in Hon Ba and Ninh Hoa (Khanh Hoa). According to draft summary, fauna system in Hon Ba has 255 species of 88 families; belonging to 4 classes: *Mammalia*, *Aves*, *Reptilia* and *Lissamphibia*. Especially, there are also *Pygathrix nigripes* and *Melogale cucphuongensis*.

3.360 In May, 2007, together with experts from Frankfurt (FZS), Institute for forest planning survey (DARD) and Khanh Hoa Forest Protection Department conductedrough surveys in Hon Deo (Ninh Hoa), and recorded about 115 fauna individual. This is monkey species eating leaves, belonging to scarce primate of Vietnam with characteristics as follows: blue face, only eating leaves, difficult to tame and raise and often living in groups.

(2) Marine Species Diversity

3.361 Khanh Hoa has the highest species diversity among coastal areas in Vietnam .According to results of a survey conducted byoceanography institute in Swiss counterparts during the period 2003–2007 (NUFU,2008), there are almost 1,700 species in Nha Trang bay,more than1,100 species in Van Phong bay. The number of species recorded in sea grass is respectively 311 and 238 (Table 3.1.27). There are almost 2,000 marine living things recorded in Khanh Hoa sea.

Table 3.1.27 Species Diversity of Coral Reefs and Sea Grass in Khanh Hoa Seas

Species	Coral Reefs		Seagrass		Total* (Khanh Hoa Sea)
	NhaTrang	Van Phong	NhaTrang	Van Phong	
Hard coral reefs	358	264	-	-	404
Sea grass			9	7	10
Alage	55	29			55
Fish	389	254	-	-	416
Mollusca	422	244	86	81	501
Crustacea	173	104	58	41	225
Echinodermata	62	46	14	10	84
Polychaeta	226	175	144	99	266
Total	1,685	1,116	311	238	1,961

Note: Total* number of the species in Khanh Hoa is not the sum of Nha Trang and Van Phong due to double count.
Source: NUFU, 2008.

3.362 Mangrove plants are diversified in Khanh Hoa with about 34 species among which there are 21 main species (by Nguyen Xuan Hoa, 2009). Common mangrove trees

include *Rhizophora apiculata*, *Rhizophora mucronata*, *Sonneratia alba*, *Avicennia alba*, *Avicennia marina*, *Excoecaria agallocha*. Compared with mangrove forest in the Southern Central, Khanh Hoa and Binh Dinh have the most diversified species.

3.363 There are 12 species of sea weeds, belonging to 7 genus and 2 families in Khanh Hoa seas. Among which, such species as *Enhalus acoroides*, *Thalassia hemprichii*, *Halophila ovalis*, *Halodule pinifolia*, *Cymodocea serrulata* are the most common. In the whole country, there are 15 species of sea weeds.

3.364 The change in biome structure has been supervised in studies on Nha Trang bay (by Vo Si Tuan and colleagues, 2004; Nguyen Van Long, 2009). For example, in the southeast of Hon Mieu, together with the decrease in coral reefs (only 7.2% in 2007) is the increase in the coverage of sea algae from negligible amount to 5.3%. This phenomenon has also been recorded southern Hon Tre (Nha Trang bay) (by Phan Van Thon and Vo Si Tuan, 1996). There has been a reduction in the number of fish species, some of which are closely linked with coral reefs like Chaetodontidae, Pomacanthidae, Acanthuridae in Nha Trang and Van Phong bay. The comparison between surveys (Nguyen Huu Dai, 1998 and Nguyen Xuan Hoa, 2009) shows changes in species *Enhalus acoroides*, with increasing number in Tuan Le and decrease in My Giang. Mangrove forest decreases in Tuan Le in area and has its structure changed, especially the decrease in the number of ancient cypress and *Avicennia* forest, which is being replaced by newly planted forest.

3.365 Until now, there are no detailed data on changes of marine creatures. Data collected during the supervision and monitoring of coral reefs (Vo Si Tuan and his colleagues, 2008) only provides information on the changes of several species. According to those data, species of high economic value are decreasing in number and facing danger of extinction in Khanh Hoa like *Charonia tritonis*, *Tridacna maxima*, and *Heterocentrotus mammilatus*, *Trochus nilotichus*. Other species are experiencing serious decrease in number like *Stenopus hispidus*, which is of high economic value in ornamental shrimp trading; *Panulirus* spp., *Holothuridae*, *Stichopodidae*—species of high trading value.

3.366 On the contrary, some species are experiencing rapid growth like *Acanthaster planci* eating coral reefs. These species are hardly found in 1998-1999; but exist in large number in 2002-2003 (20 individuals/400 m², equivalent to 500 individuals/ha). The most heavily affected is southern My Giang (Van Phong bay), southeast of Hon Mieu, the south west of Hon Mun, Bai Ngheo, Hon Mun (Nha Trang bay). From 2007 until now, the number of *Acanthaster* has decreased but still remained high.

3.367 In terms of scarce living things, sea turtles started to come back to Nha Trang bay in 2009 in Northern Hon Tre—which is protected by swiftlet. This, is a good sign of ecological preservation.

(3) List of Species in Vietnam Red Data Book

3.368 The list of endangered species of Khanh Hoa Province in Vietnam Red Data Book is shown in Table 3.1.28 on flora, and in Table 3.1.29 on fauna. Though it means the existence of these precious species within Khanh Hoa Province, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 3.1.28 Endangered Species in Khanh Hoa Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	
I		Magnoliophyta	NGÀNH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
1	4	<i>Altingia chinensis</i> (Champ.ex Benth) Oliv.ex Hance	Tầm	EN	A1a,c,d, B1+2b,c,e	Y
2	6	<i>Pentaspadon Poilanei</i> (Evrard&Tardieu) Phamh	Ngũ liệt Poilane	VU	B1+2e	Y
3	8	<i>Anaxagorea luzonensis</i> A. Gray	Quả đầu ngỗng	VU	A1c+2c, B1+3b	Y
4	26	<i>Kibatalia laurifolia</i> (Ridl.) Woodson	Thần linh lá nhỏ	VU	B1+2b,c	Y
5	28	<i>Melodinus honbaensis</i> A. Chev. ex Pitard	Giom hòn bà	EN	B1+2b,c	Y
6	31	<i>Rauwolfia chaudiocensis</i> Pierre ex Pitard	Phao lưới	VU	A1a,c,d	Y
7	35	<i>Rauwolfia Vietnamensis</i> Ly	Ba gác Việt Nam	EN	B1+2b,c	Y
8	38	<i>Tabernaemontana granulosa</i> Pitard	Lài mực	EN	B1+2b,c	Y
9	58	<i>Dischidia benghalensis</i> Colebr.	Song ly bengal	VU	B1+2b	Y
10	63	<i>Sarcostemma acidum</i> (Roxb.) Voigt	Tiết cần	EN	B1+2a	Y
11	64	<i>Spirella robinsonii</i> Cost.	Luân	CR	B1+2b	Y
12	74	<i>Colobogyne langbianensis</i> Gagnep.	Hoa riu	EN	B1+2a,b,c,d	Y
13	94	<i>Argusia argentea</i> (L.f.) Heine	Phong ba	VU	A1a	Y
14	99	<i>Afelia xylogarpa</i> (Kurz) Craib	Gỗ đỏ	EN	A1c,d	Y
15	100	<i>Sindora siamensis</i> Teysm.ex Miq.	Gụ mật	EN	A1a,c,d	Y
16	101	<i>Sindora tonkinensis</i> A.Chev.ex K.&S.S. Larsen	Gụ lau	EN	A1a,c,d+2d	Y
17	106	<i>Euonymus chinensis</i> Lindl	Đỗ trọng tía	EN	A1b,c,d	Y
18	110	<i>Lumnitzera littorea</i> (Jack) Voigt	Cóc đỏ	VU	A1a,c,d	Y
19	124	<i>Parashorea stellata</i> Kurz	Chò đen	VU	A1,b,c+2b,c, B1+2a,b,c	Y
20	125	<i>Shorea falata</i> J.E. Vidal	Sao lá cong	CR	A1c,d	Y
21	128	<i>Diospyros mun</i> A. Chev. Ex H. Lecomte	Mun	EN	A1c,d, B1+2a	Y
22	136	<i>Trigonostemon fragilis</i> (Gagnep.) Airy-Shaw	Tam thụ hùng đôn	VU	B1+2e	Y
23	139	<i>Dalbergia oliveri</i> Gamble ex Prain	Cắm lai	EN	A1a,c,d	Y
24	143	<i>Castanopsis ferox</i> (Roxb.) Spach	Cà ôi Vọng phu	VU	A1c,d	Y
25	144	<i>Castanopsis formosana</i>	Cà ôi đài loan	EN	B1+2b,e	Y
26	145	<i>Castanopsis hystrix</i> A. DC	Cà ôi (lá) đỏ	VU	A1c,d	Y
27	151	<i>Lithocarpus bacgiangensis</i> (Hickel & A. Camus) A. Camus	Dê Bắc Giang	VU	A1c,d	Y
28	155	<i>Lithocarpus fenestratus</i> (Roxb.) Rehd.	Dê lỗ	VU	A1c,d	Y
29	161	<i>Bo</i>	Sồi bông nhiều	EN	A1c,d	Y
30	164	<i>Lithocarpus vestitus</i> (Hickel & A. Camus) A. Camus	Dê cau lông trắng	EN	A1c,d	Y
31	193	<i>Barringtonia asiatica</i> (L.) Kurz	Bàng (quả) vuông	VU	A1d	Y
32	195	<i>Strychnos ignatii</i> Berg.	Mã tiền lông	VU	A1a,c	Y
33	201	<i>Macrosolen annamicus</i> Dans.	Đại cán việt	EN	B1+2b,c	Y
34	212	<i>Aglaia spectabilis</i> (Miq.) Jain & Bennet	Gội nếp	VU	A1a,c,d+2d	Y
35	227	<i>Osbornia octodonta</i> F. Muell.	Bát nha	VU	A1c	Y
36	229	<i>Indosinia involucrata</i> (Gagnep.) J. E. Vidal	Đông dương	CR	B1+2e	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	
37	230	<i>Melientha suavis</i> Pierre	Rau sắng	VU	B1+2e	Y
38	243	<i>Canthium dicoccum</i> (Gaertn.)	Xương cá	VU	A1c, B1+2c	Y
39	252	<i>Xanhtonneopsis robinsonii</i> Pitard	Xuân tôn	VU	A1a,c	Y
40	264	<i>Siphonodon celastrineus</i> Griff.	Xung da	VU	A1c,d	Y
41	268	<i>Camellia fleuryi</i> (A. Chev.) Sealy	Chè sốp	EN	A1c,d, B1+2b,c,e	Y
42	271	<i>Aquilaria crassna</i> Pierre ex Lecomte	Trâm hương	EN	A1c,d, B1+2b,c,e	Y
43	280	<i>Vitex ajugaeflora</i> Dop	Bình linh nghệ	VU	B1+2e	Y
44	282	<i>Tribulus terrestris</i> L.	Tật lê	EN	A1a,c,d, B1+2b,c	Y
II.2		Liliopsida	LỚP HÀNH			
45	292	<i>Calamus poilanei</i> Conrard	Song bột	EN	A1c,d+2c,d	Y
46	310	<i>Dioscorea dissimulans</i> Prain & Burk	Nân gừng	VU	B1+2b,c	Y
47	318	<i>Anoectochilus calcareus</i> Aver.	Kim tuyến đá vôi	EN	A1d	Y
48	333	<i>Dendrobium aphyllum</i> (Roxb.) C. Fisch.	Hạc vĩ	VU	B1+2e+3d	Y
49	342	<i>Dendrobium draconis</i> Reichb.f.	Nhất điểm hồng	VU	B1+2e+3d	Y
50	365	<i>Monomeria dichroma</i> (Rolfe) Schlechter	Đơn hành lưỡng sắc	EN	B1+2b,c	Y
51	368	<i>Paphiopedilum appletonianum</i> (Gower) Rolfe	Hài đài cuốn	VU	B1+2b,c,e	Y
52	39	<i>Paphiopedilum delenatii</i> Guillaum	Hài đỏ	CR	A1c,d+2d, B1+2b,c,e	Y
53	380	<i>Paphiopedilum villosum</i> (Lindl.) Stein	Hài lông	EN	B1+2b,c,e	Y
54	389	<i>Smilax elegantissima</i> Gagnep.	Kim cang nhiều tán	VU	B1+2b,c	Y
55	391	<i>Smilax poilanei</i> Gagnep.	Kim cang poilane	CR	B2b, 3d	Y
56	392	<i>Stemona cochinchinensis</i> Gagnep.	Bách bộ nam	VU	B1+2b,c	Y
57	396	<i>Tacca integrifolia</i> Ker-Gawl.	Ngải rơm	VU	A1a,c,d	Y
II		Pinophyta	NGÀNH THÔNG			
58	401	<i>Calocedrus macrolepis</i> Kuz	Bách xanh	EN	A1c,d, B1+2b,c	Y
59	408	<i>Cycas elongata</i> (Leandri) D.Y. Wang	Tuế lược thuôn	VU	A2c,d	Y
60	409	<i>Cycas inermis</i> Lour.	Tuế sơn trà	VU	A1a,c,d	Y
61	410	<i>Cycas lindstromii</i> S.L. Yang, K. D.hill & N.T.Hiep	Thiên tuế Lindstrom	VU	B1+2b,e	Y
62	414	<i>Cycas pectinata</i> Buch. - Ham.	Tuế lược	VU	A1a,c,d, B1+2b,c,e	Y
III		Polypodiophyta	NGÀNH DƯƠNG XÍ			
IV		Lycopodiophyta	NGÀNH THÔNG			
63	429	<i>Selaginella tamariscina</i> (Beauv.) Spring	Quyển bá trường sinh	VU	A1c,d	Y
V		Rhodophyta	NGÀNH RONG ĐỎ			
64	430	<i>Hydropuntia eucheumoides</i> (Harvey) Gurgel & Fredricq	Rong câu chân vịt	EN	A1a,c,d	Y
65	432	<i>Hypnea cornuta</i> (Lamx.) J. Agardh	Rong đồng sao	EN	A1a,c,d, B1+3c,d	Y
66	434	<i>Rhodogorgon carriebowensis</i> Norris & Bucher	Rong san hô caribê	VU	A1a,c	Y
67	435	<i>Betaphycus gelatinum</i> (Esper) Doty	Rong hồng vân	EN	A1a,c,d	Y
68	436	<i>Eucheuma arnoldii</i> W. v. Bosse	Rong hồng vân thối	EN	A1a,c,d	Y
69	437	<i>Kappaphycus cottonii</i> (W. v. Bosse) Doty	Rong kỳ lân	EN	A1a,c,d, B1+2b,e	Y
VI		Phaeophyta	NGÀNH RONG NÂU			
70	438	<i>Sargassum bicorne</i> J. Agardh	Rong mơ hai sừng	VU	A1c,d+2c	Y
71	439	<i>Sargassum congkinhii</i> Phamh.	Rong mơ công kính	VU	A1a,c,d	Y
72	441	<i>Sargassum tenerrimum</i> J. Agardh	Rong mơ mềm	EN	A1a,c,d	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	
73	442	<i>Turbinaria decurrens</i> Bory	Rong cùi bắp cạnh	VU	A1a,c,d, B1+2b,e	Y
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable. Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

Table 3.1.29 Endangered Species in Khanh Hoa Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Khanh Hoa
I		Animal	Thú			
1	2	<i>Cynopterus brachyotis</i>	Đơi chó tai ngắn	VU	A1c,d B2a,e	Y
2	9	<i>Nycticebus pygmaeus</i>	Cu li nhỏ	VU	A1c,d	Y
3	13	<i>Macaca fascicularis</i>	Khỉ đuôi dài	LR	nt	Y
4	20	<i>Trachypithecus villosus</i>	Voọc bạc	VU	A1c,d	Y
5	27	<i>Nomascus gabriellae</i>	Vượn đen má vàng	EN	A1c,d C2a	Y
6	49	<i>Prionailurus viverrinus</i>	Mèo cá	EN	A1c,d C1+2a	Y
7	51	<i>Panthera tigris corbetti</i>	Hồ đông dương	CR	A1d C1+2a	Y
8	56	<i>Dicerorhinus sumatrensis</i>	Tê giác hai sừng	EX		Y
9	59	<i>Tragulus napu</i>	Cheo napu	DD		Y
10	86	<i>Lagenodelphis hosel</i>	Cá heo bụng trắng	VU	C1	Y
11	87	<i>Pseudorca crassidens</i>	Cá ông chuông	DD		Y
12	88	<i>Sousa chinensis</i>	Cá heo trắng Trung Hoa	EN	A1c C2a	Y
13	89	<i>Stenella longirostris</i>	Cá heo mõm dài	EN	A1cD1	Y
14	90	<i>Dugong dugon</i>	Bò biển	CR	A1c, d D	Y
II		Birds	Chim			
15	94	<i>Egretta eulophotes</i>	Cò trắng Trung Quốc	VU	A1c,e B2c,d+3a D2	Y
16	122	<i>Lophura diardi</i>	Gà lôi hồng tía	VU	A1a,c C2a	Y
17	126	<i>Lophura nycthemera</i>	Gà lôi trắng	LR	cd	Y
18	127	<i>Pavo muticus imperator</i>	Công	EN	A1 a,c,d+3b,d C2a	Y
19	130	<i>Poluplectron germaini</i>	Gà tiền mặt đỏ	VU	A1 a,c C2a	Y
20	131	<i>Rheinartia ocellata</i>	Trĩ sao	VU	A1 b,c,d	Y
21	140	<i>Columba punicea</i>	Bồ câu nâu	EN	A1 a,c,d C2a	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
22	171	<i>Python reticulatus</i>	Trăn gấm	CR	A1c,d	Y
23	187	<i>Eretmochelys imbricata</i>	Đồi mồi	EN	B2b,e C1	Y
24	199	<i>Amyda cartilaginea</i>	Cua đinh	VU	A1c,d+2cd	Y
25	201	<i>Pelochelys cantorii</i>	Giải khổng lồ	EN	A1d+2d	Y
26	204	<i>Crocodylus siamensis</i>	Cá sấu xiêm	CR	A1c,d	Y
III.2		Amphibian	Lưỡng cư			
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
IV.2		Sea fish	Cá biển			
27	255	<i>Stegostoma fasciatum</i>	Cá nhám nhu mỳ	EN	A1d C2a	Y
28	258	<i>Etmopterus lucifer</i>	Cá nhám nâu	EN	A1a,d D	Y
29	259	<i>Pristis cuspidatus</i>	Cá đao răng nhọn	EN	A1a,d D	Y
30	260	<i>Pristis microdon</i>	Cá đao răng nhỏ	EN	A1a D	Y
31	261	<i>Rhina ancylostoma</i>	Cá giồng mõm tròn	EN	A1a,d C2a	Y
32	265	<i>Megalops cyprinoides</i>	Cá cháo lớn	VU	A1d C1	Y
33	266	<i>Albula vulpes</i>	Cá mòi đường	VU	A1d C1	Y
34	267	<i>Chanos chanos</i>	Cá măng sữa	VU	A2d	Y
35	268	<i>Anodontostoma chacunda</i>	Cá mòi không răng	VU	A1d C1	Y
36	270	<i>Nematolosa nasus</i>	Cá mòi mõm tròn	VU	A1c,d,e C1	Y
37	272	<i>Cyttopsis cypho</i>	Cá dây lưng gù	EN	A1d D	Y
38	275	<i>Aulostomus chinensis</i>	Cá kèn Trung Quốc	EN	A1 B2b+3c	Y
39	276	<i>Solenostomus paradoxus</i>	Cá đao cạo	EN	D	Y
40	277	<i>Doryrhamphus dactylophorus</i>	Cá chia vôi khoang vằn	VU	A1d B2b+3c	Y
41	278	<i>Doryrhamphus exciscus</i>	Cá chia vôi sọc xanh	VU	A1a,d B2b+3c	Y
42	280	<i>Hippocampus japonicus</i>	Cá ngựa nhật	EN	C1	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Khanh Hoa
43	286	<i>Anyperodon leucogrammicus</i>	Cá mú sọc trắng	VU	A1c,d B1+2c	Y
44	289	<i>Plectorhynchus flavomaculatus</i>	Cá kềm chấm vàng	EN	A1c,e B1+2c C2a	Y
45	292	<i>Centropyge bicolor</i>	Cá bướm hai màu	VU	A1d B2b+3c	Y
46	293	<i>Cornadion chrysozonus</i>	Cá bướm bốn vằn	VU	A1d B2b+3c	Y
47	295	<i>Parachaetodon</i>	Cá bướm vằn	VU	A1d B2b+3c	Y
48	296	<i>Pomacanthus imperator</i>	Cá chim hoàng đế	VU	A1d B2b+3c	Y
49	297	<i>Pygoplites diacanthus</i>	Cá chim xanh nắp mang tròn	VU	A1d B2b+3c	Y
50	298	<i>Bodianus axillaris</i>	Cá bàng chài axin	VU	A1d B2b+3c	Y
51	299	<i>Thalassoma lunare</i>	Cá bàng chài đầu đen	VU	A1d B2b+3c	Y
52	301	<i>Satyrichthys rieffeli</i>	Cá chào mào gai	VU	B1 D1	Y
53	302	<i>Anacanthus barbatus</i>	Cá bò râu	EN	A1d D	Y
54	303	<i>Oxymonacanthus longirostris</i>	Cá bò xanh hoa đỏ	VU	A1d B2b,e	Y
55	306	<i>Antennarius Stria tus</i>	Cá lười dong đen	VU	A1d B2b+3c	Y
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crutacean	Giáp xác			
V.1.2		Soft species	Thân mềm			
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
56	329	<i>Acropora aspera</i>	San hô lỗ đỉnh xù xì	VU	A1a,c	Y
57	330	<i>Acropora austera</i>	San hô lỗ đỉnh au-te	VU	A1a,c B2b+3d	Y
V.2.2		Echinoderm	Da gai			
58	341	<i>Actinopyga mauritiana</i>	Đồn đột dứa	VU	A1d B2b,e+3d	Y
59	342	<i>Microthele nobilis</i>	Đồn đột vú	VU	A2d B2e+3d	Y
60	343	<i>Thelenota ananas</i>	Đồn đột lựu	VU	A2d B2b,e+3d	Y
61	344	<i>Heterocentrotus mamillatus</i>	Cầu gai đá	VU	A2d B2b,e+3d	Y
V.2.3		Crutacean	Giáp xác			
62	347	<i>Palinurellus gundlachi wieneckii</i>	Tôm hùm lông đỏ	VU	A1C D1	Y
63	349	<i>Panulirus longipes</i>	Tôm hùm đỏ	EN	A1c,d B2b+3d	Y
V.2.4		Soft species	Thân mềm			
64	357	<i>Haliotis asinina</i>	Bào ngư vành tai	VU	A1C1	Y
65	359	<i>Haliotis ovina</i>	Bào ngư bầu dục	VU	A1C1	Y
66	360	<i>Tectus pyramis</i>	Ốc đụn đực	EN	A1a,c,d	Y
67	361	<i>Tronchus niloticus</i>	Ốc đụn cái	CR	A1a	Y
68	363	<i>Charonia tritonis</i>	Ốc tù và	CR	B1+2a,d D	Y
69	364	<i>Cymatium lotorium</i>	Ốc tù và lótô	VU	A1d B2a,b	Y
70	365	<i>Cypraea testudinaria</i>	Ốc sứ	VU	A1c D2	Y
71	366	<i>Blasicrura chinensis</i>	Ốc sứ Trung Hoa	VU	A1c C1	Y
72	368	<i>Cypraea mappa</i>	Ốc sứ bản đồ	VU	A1a C1	Y
73	369	<i>Cypraea spadicea</i>	Ốc sứ padi	VU	A1a C1	Y
74	373	<i>Epitonium scalare</i>	Ốc xoắn vách	VU	A1 C1	Y
75	374	<i>Pinctada margaritifera</i>	Trai ngọc môi đen	VU	A1d C1	Y
76	375	<i>Pinctada maxima</i>	Trai ngọc môi vàng	VU	A1c,d	Y
77	376	<i>Pteria penguin</i>	Trai ngọc nữ	VU	C1 D2	Y
78	380	<i>Tridacna squamosa</i>	Trai tai tượng nhỏ	VU	A1c,d	Y
79	381	<i>Tridacna gigas</i>	Trai tai tượng khổng lồ	EN	A1d	Y
80	382	<i>Tridacna maxima</i>	Trai tai tượng lớn	VU	A1c,d	Y
81	383	<i>Nautilus pompilius</i>	Ốc anh vũ	CR	A1d C1 D	Y
82	384	<i>Photololigo chinensis</i>	Mực thước	VU	A1d	Y
83	385	<i>Sepia(tigris) pharaonis</i>	Mực nang vằn hổ	VU	A1d	Y
V.3		Insects	Côn trùng			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

2) Flora and Fauna in Ninh Thuan Province

(1) Nui Chua National Park

3.369 Nui Chua National Park is located in Ninh Hai District, established in the Decision No. 134/2003/QĐ-TTg dated 9 July 2003 by the Prime Minister.

(a) Scale, Land Area

3.370 Land area of Nui Chua National Park is 25,013ha, including:

- * Mainland
 - Strictly protected area: 16,087 ha
 - Area for biological recovery: 6,421ha.
 - Administrative and service area: 5 ha
- * Sea:
 - Strictly protected sea: 568 ha.
 - Sea turtle protection area: 99ha
 - Sea weed protection area: 84 ha
 - Sea creature resources preservation: 6,299ha
 - Tourism area: 302
- * Buffer zone: 7.350 ha.

(b) Flora

3.371 Vascular plants include: 1,265 species, 596 branches, 147 families, 85 sectors.

Table 3.1.30 Flora Sectors–Nui Chua National Park

Flora sectors	Species	Branch	Family	Bo
<i>Lycopodiophyta</i>	5	2	2	2
<i>Psicotophyta</i>	1	1	1	1
<i>Polypodiophyta</i>	23	16	10	6
<i>pinophyta</i>	7	4	2	1
<i>Cyadophyta</i>	4	1	1	1
<i>Gnetophyta</i>	2	1	1	1
<i>Magnoliophyta</i>	1.223	570	130	67

Source: Nui Chua National Park

3.372 At Nui Chua National Park, 35 species are categorized in valuable and rare group including: *Diospyros mollis*, *Dalbergia*, *Afleziaxycarpa*, *Sindora Siamensis*, *Xay Dialium Cochinchinensis*, *Manilkara hexandra*, *Pteracarpus macrocarpus*, *Cycar*, *Selaginella tamaristica*.

3.373 80 species of 40 families was named after Phan Rang such as: Thi phan rang (*Diospyros phangrangensis*), De phang rang (*Lithocarpus phangrangensis*), Da phang rang (*Ficus phangrangensis*), Vai phang rang (*Daphniphyllum phangrangensis*), chôi moi phang rang (*Antidesma phangrangensis*),

(c) Fauna

3.374 There are 306 species of wild animals of 89 families, 29 branches, 4

layers, in which 72 species of Manmalia, 181 species of Aves and 17 species of Amphibia.

3.375 Followings are animals which are classified as valuable and rare group:

Table 3.1.31 Fauna group – Nui Chua National Park

Layer	Total	Rare and valuable	Criteria		
			IUCN Red bood (2000)	VN Red book (2000)	Decree 18/HDBT
Animal	72	22	13	4	14
Bird	181	9	5	2	5
Reptile, amphibian	53	16	6	15	1

Source: Nui Chua National Park

3.376 Followings are valuable and rare animals: Cha va chan den (*Pygathrix nigripes*), Gou ngua (*Ursus Thibetanus*), Gau cho (*U.malayanus*), Gai ca long muot (*L.perspicilata*), Cay muc (*Aretictis binturong*), Moo gam (*pardofelis mamorata*), Beo lua (*Catopuma temmincki*), Bao gam (*Neofelis neobulosa*), Mang lon (*Megamuntiacus vuquangensis*), Son duong (*Capricornis Sumatraensis*), Bo nong chan xam (*Pelecanus philipensis*), Ga loi hong tia (*Lophura diardi*), Ga tien mat do (*Polyplectron germaini*), Tri sao (*Rheinartia ocellata*), Cong (*Pavomuticus*), Ken Ken Mang Gan (*gypsbengalensis*), Niec nau (*Ptilolaemus tickelli*), Hong Hoang (*Buceros bicornis*), Chim khach duoi co (*Temnurus temnurrus*), Rong dat (*Physignathus cocincinus*), Ky da van (*Varanus nebulosus*), Tran dat (*Python molurus*), Tran gam (*python reticulatus*), Ran rao thuong (*ptyas korros*), Ran rao trau (*ptyas mucosus*), Ran cap nong (*Bungarus fasciatus*), Ran ho mang (*Naja naja*), ran ho chua (*Ophiophagus hanah*), Rua dat lon (*geoemyda grandis*), Ba ba gai (*Palea stein dachneri*).

(d) Sea Resources

3.377 The sea area at Nui Chua National Park is composed of coastal area in Vinh Hai Commune. It runs from the south of Chong to Vach headland, and is 25km long. The widest area is 4,5km wide. In this area, there is a wide variety of sea resources. Followings are the results of sea resources:

- (i) **Coral:** there are 197 species of 49 genera which are distributed from Vinh Hy to My Tan village, Nhon Hai Commune. Average coverage is 42.6%. 14 species are considered as new ones to Vietnam, including: *Acropora tutuilensis*, *Acropora wallaceae*, *Montipora delicatula*, *Cantharellus noumeae*, *Barabattoia laddi*, *Favites paraflexuosa*, *Platygyra acuta*, *Platygyra contorta*, *Echinopora pacificus*, *Alveopora minuta*, *Porites negrosensis*, *Porites horizontalata*, *Acanthastrea brevis* and *Goniopora burgosi*.
- (ii) **Reef Fish:** there are 147 species of 81 genera, 32 families. The density is about 361-1,984 units/500 m²; the average number is about 564-739 units/500 m².
- (iii) **Mollusc:** there are 45 species, in which there are some big-sized species namely *Trochus*, *Strombidac*, and *Tridacna*.
- (iv) **Polychaeta:** 22 species
- (v) **Crustacea:** 24 species
- (vi) **Echinodermata:** 13 species

(vii) **Seaweed:** 3 species including *Enhalus acoroides*, *Thalassia hemprichu* and *Cymodocea rotundata*.

(viii) **Sea turtle:** 3 species including *Chelonia mydas*, *Lepidochelys olivine*, and *Eret mochelys imbricate*.

(2) Phuoc Binh Natural Reserves

3.378 Phuoc Binh Natural Reserves is located in Bac Ai District, established according to the Decision No. 125/2023/QD-TTg dated 26 September 2002 by the Prime Minister. Total area is 19,814 ha. This is a mixed primeval forest. There is a wide range of fauna and flora:

(a) Flora

3.379 There are many types of forests including many rare plants such as Fokienia, chestnut, etc. Primeval forest covers an land area of 2,000 ha in the reserves with 513 of tracheophyta, 116 families, including the following species:

- Gymnospermae 14 species
- Monocotyledons 85 species
- Magnoliopsida.

3.380 Followings are the valuable and rare species in Phuoc Binh Natural Reserves according to the Decree No. 48/2002/ND-CP dated 22 April 2002 by the Prime Minister:

Table 3.1.32 Floral group in Phuoc Binh Natural Reserves

No	Vietnamese name	Scientific name	Decree 48	VN Red Book
1	Thien tue luoc	<i>Cycas pectinata</i> Griff	IIB	-
2	Thien tue	<i>Cycas rumphii</i> Miq	IIB	-
3	Thong 2 la det (Sri)	<i>Pinus krempqii</i> H.lec	IIB	E
4	Thong 5 la (thong Da Lat)	<i>Pinus dalatensis</i> Ferre	IIB	E
5	Du sam	<i>Keteleeria evelyniana</i> Mesters	IIB	E
6	Bach xanh	<i>Calocedrus marcolepis</i> Kurz	IIB	E
7	Po mu	<i>Fokienia hodginsii</i> Henry et Thom	IIA	V
8	Xa xi (cuu moc)	<i>Cinnamomum verum</i> Presl	IIB	-
9	Cam thi	<i>Diospyros marritima</i> Bl	IIA	-
10	Dang huong	<i>Pterocarpus pedatus</i>	IIA	V
11	Go do	<i>Afzella xylocarpa</i> (Kurz) Craib	IIA	V
12	Go mat	<i>Sindora siamensis</i> teysm ex Miq	IIA	V
13	Cam lai Dong Nai	<i>Dalbergia dongnaiense</i> Pierre	IIA	V
14	Dang huong an	<i>Pterocarpus indicus</i> Willd	IIA	V
15	Gio tram	<i>Aquilaria crasina</i> Pierre ex Lec	IIA	V

Note: IIA: flora restricted from exploitation or use for commercial purposes, IIB: fauna restricted from exploitation or use for commercial purposes, E: Endangered, V: Vulnerable.

Source: Decree No. 48/2002/ND-CP

(b) Fauna

3.381 Followings are the valuable and rare species in Phuoc Binh Natural Reserves according to the Decree No. 48/2002/ND-CP dated 22 April 2002 by the Prime Minister:

Table 3.1.33 Fauna group in Phuoc Binh Natural Reserves

No	Scientific name	Decree 48	VN Red Book
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No	Scientific name	Decree 48	VN Red Book
1	<i>Macacaemestrina</i>	IIB	V
2	<i>Nycticelleus pigmaeus</i>	IB	V
3	<i>Helaretos malayanus</i>	IA	-
4	<i>Selenaretos malayanus</i>	IB	E
5	<i>Petaurita petaurista</i>	IIB	E
6	<i>Meganmuntiacus vuquanensis</i>	IB	V
7	<i>Capriconis sumatraeensis</i>	IB	V
8	<i>Bubalus Bubalis</i>	IA	E
9	<i>Lophura diardi</i>	IA	T
10	<i>Pavo munticus</i>	IA	R
11	<i>Faleo Severus</i>	IIB	-
12	<i>Microhierax coerulescens</i>	IIB	-
13	<i>Psittacula roseate</i>	IIB	-
14	<i>Psittacula alexandri</i>	IIB	-
15	<i>Otus sp</i>	IIB	-
16	<i>Garruslax chinensis</i>	IIB	-
17	<i>Garruslax leucolophus</i>	IIB	-
18	<i>Garruslax moniliger</i>	IIB	-
19	<i>Varanus sp</i>	IIB	V
20	<i>Varanus nebulosus</i>	IIB	V
21	<i>Varanus salvato</i>	IIB	V
22	<i>Python molurus</i>	IIB	V
23	<i>Python reticulates</i>	IIB	V
24	<i>Naja</i>	IIB	V
25	<i>Elaphe radiate</i>	IB	-
26	<i>Ptyas muscosus</i>	IB	V

Note: IA: flora strictly banned from exploitation or use for commercial purposes, IB: fauna strictly banned from exploitation or use for commercial purposes, IIA: flora restricted from exploitation or use for commercial purposes, IIB: fauna restricted from exploitation or use for commercial purposes, E: Endangered, V:Vulnerable.

Source: Decree No. 48/2002/ND-CP

(3) List of Species in Vietnam Red Data Book

3.382 The list of endangered species of Ninh Thuan Province in Vietnam Red Data Book is shown in Table 3.1.34 on flora, and in Table 3.1.35 on fauna. Though it means the existence of these precious species within Ninh Thuan Province, it does not necessarily mean that habitat of these species will be affected by the HSR Projects.

Table 3.1.34 Endangered Species in Ninh Thuan Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	
I		Magnoliophyta	NGANH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
3	6	<i>Pentaspadon Poilanei</i> (Evrard&Tardieu) Phamh	Ngũ liệt Poilane	VU	B1+2e	Y
6	22	<i>Carissa spinarum L.</i>	Xirô Nam	EN	B1+2d,c	Y
12	36	<i>Spirolobium combodianum Baill.</i>	Luân thù	VU	B1+2b,c	Y
19	63	<i>Sarcostemma acidum (Roxb.) Voigt</i>	Tiết căn	EN	B1+2a	Y
23	89	<i>Fernandoa adenophylla (Wall. ex G.Don) Steen</i>	Đỉnh lá tuyến	VU	B1+2a	Y
24	92	<i>Millingtonia hortensis L.f.</i>	Đạt phước	VU	B1+2e	Y
25	94	<i>Argusia argentea (L.f.) Heine</i>	Phong ba	VU	A1a	Y
26	99	<i>Afelia xylogarpa (Kurz) Craib</i>	Gõ đỏ	EN	A1c,d	Y
27	100	<i>Sindora siamensis Teysm.ex</i>	Gụ mật	EN	A1a,c,d	Y

		<i>Miq.</i>				
29	106	<i>Euonymus chinensis Lindl</i>	Đỗ trọng tía	EN	A1b,c,d	Y
31	114	<i>Trichosanthes kirilowii</i>	Qua lâu	VU	A1c,d, B1+2c	Y
32	116	<i>Anisoptera costata Korth.</i>	Vên vên	EN	A1a,b,c+2b,c	Y
33	117	<i>Dipterocarpus dyeri Pierre</i>	Dầu song vàng	VU	A1a,d+2c,d	Y
36	124	<i>Parashorea stellata Kurz</i>	Chò đen	VU	A1,b,c+2b,c, B1+2a,b,c	Y
38	127	<i>Diospyros mollis Griff.</i>	Mặc nửa	EN	A1c,d, B1+2a	Y
39	128	<i>Diospyros mun A. Chev. Ex H. Lecomte</i>	Mun	EN	A1c,d, B1+2a	Y
41	135	<i>Thyrsanthera suborbicularis Pierre ex Gagnep.</i>	Chi hùng	VU	A1c,d	Y
44	139	<i>Dalbergia oliveri Gamble ex Prain</i>	Cắm lai	EN	A1a,c,d	Y
51	157	<i>Lithocarpus harmandii (Hickel & A. Camus)</i>	Dê se	EN	A1c,d	Y
52	161	<i>Bo</i>	Sồi bông nhiều	EN	A1c,d	Y
54	166	<i>Quercus glauca Thunb.</i>	Sồi sim	VU	A1c,d	Y
58	202	<i>Taxillus gracilifolius (Schult.f.) Ban</i>	Mộc vệ rù	VU	A1c,d	Y
68	254	<i>Azima sarmentosa (Blume) Benth.</i>	Thứ mật	EN	A1c,d	Y
70	264	<i>Siphonodon celastrineus Griff.</i>	Xung da	VU	A1c,d	Y
73	274	<i>Schoutenia hypoleuca Pierre</i>	Sơn tần	VU	A1a,b,c,d	Y
74	279	<i>Karomia fragrans Dop</i>	Cà điện	CR	B1+2e	Y
76	281	<i>Viscum indosinense Danser</i>	Ghi đồng dương	EN	A1c	Y
77	282	<i>Tribulus terrestris L.</i>	Tật lê	EN	A1a,c,d, B1+2b,c	Y
78		Liliopsida	LỚP HÀNH			
82	298	<i>Peliosanthes teta Andr.</i>	Sâm cau	VU	A1c,d	Y
88	354	<i>Eria bidupensis (Gagnep.) Seidenf.</i>	Ni lan bì đúp	EN	B1+2b,c	Y
91	368	<i>Paphiopedilum appletonianum (Gower) Rolfe</i>	Hài đài cuốn	VU	B1+2b,c,e	Y
II		Pinophyta	NGÀNH THÔNG			
100	401	<i>Calocedrus macrolepis Kuz</i>	Bách xanh	EN	A1c,d, B1+2b,c	Y
101	408	<i>Cycas elongata (Leandri) D.Y. Wang</i>	Tuế lược thuôn	VU	A2c,d	Y
103	410	<i>Cycas lindstromii S.L. Yang, K. D.hill&N.T.Hiep</i>	Thiên tuế Lindstrom	VU	B1+2b,e	Y
104	414	<i>Cycas pectinata Buch. - Ham.</i>	Tuế lược	VU	A1a,c,d, B1+2b,c,e	Y
III		Polypodiophyta	NGÀNH DƯƠNG XỈ			
IV		Lycopodiophyta	NGÀNH THÔNG			
105	429	<i>Selaginella tamariscina (Beauv.) Spring</i>	Quyển bá trường sinh	VU	A1c,d	Y
V		Rhodophyta	NGÀNH RONG ĐỎ			
106	430	<i>Hydropuntia eucheumoides (Harvey) Gurgel & fredricq</i>	Rong câu chân vịt	EN	A1a,c,d	Y
109	435	<i>Betaphycus gelatinum (Esper) Doty</i>	Rong hồng vân	EN	A1a,c,d	Y
110	436	<i>Eucheuma arnoldii W. v. Bosse</i>	Rong hồng vân thối	EN	A1a,c,d	Y
111	437	<i>Kappaphycus cottonii (W. v. Bosse) Doty</i>	Rong kỳ lân	EN	A1a,c,d, B1+2b,e	Y
VI		Phaeophyta	NGÀNH RONG NÂU			
112	438	<i>Sargassum bicorne J. Agardh</i>	Rong mơ hai sừng	VU	A1c,d+2c	Y
114	441	<i>Sargassum tenerrimum J. Agardh</i>	Rong mơ mềm	EN	A1a,c,d	Y
115	442	<i>Turbinaria decurrens Bory</i>	Rong cùi bắp cạnh	VU	A1a,c,d, B1+2b,e	Y
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

Table 3.1.35 Endangered Species in Ninh Thuan Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Ninh Thuan
I		Animal	Thú			

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Ninh Thuan
1	2	<i>Cynopterus brachyotis</i>	Đơi chó tai ngắn	VU	A1c,d B2a,e	Y
2	13	<i>Macaca fascicularis</i>	Khỉ đuôi dài	LR	Nt	Y
3	39	<i>Arctictis binturong</i>	Cầy mực	EN	A1c,d C1	Y
4	64	<i>Megamuntiacus vuquangensis</i>	Mãng lớn	VU	A1c,d C1	Y
5	89	<i>Stenella longirostris</i>	Cá heo mõm dài	EN	A1cD1	Y
II		Birds	Chim			
6	126	<i>Lophura nycthemera</i>	Gà lôi trắng	LR	cd	Y
7	130	<i>Poluplectron germaini</i>	Gà tiền mặt đỏ	VU	A1 a,c C2a	Y
8	134	<i>Heliopais personata</i>	Chân bơi	EN	B1 C2a D	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
9	182	<i>Ophiophagus hannah</i>	Rắn hổ chúa	CR	A1c,d	Y
III.2		Amphibian	Lưỡng cư			
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
IV.2		Sea fish	Cá biển			
10	268	<i>Anodontostoma chacunda</i>	Cá mèi không răng	VU	A1d C1	Y
11	272	<i>Cyrtopsis cypho</i>	Cá dây lưng gù	EN	A1d D	Y
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crutacean	Giáp xác			
V.1.2		Soft species	Thân mềm			
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
V.2.2		Echinoderm	Da gai			
12	341	<i>Actinopyga mauritiana</i>	Đồn đột dừa	VU	A1d B2b,e+3d	Y
V.2.3		Crutacean	Giáp xác			
13	349	<i>Panulirus longipes</i>	Tôm hùm đỏ	EN	A1c,d B2b+3d	Y
V.2.4		Soft species	Thân mềm			
14	384	<i>Photololigo chinensis</i>	Mực thước	VU	A1d	Y
V.3		Insects	Côn trùng			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
 Source: Vietnam Red Data Book, 2007

3) Flora and Fauna in Binh Thuan Province

(1) Overall Situation of Flora and Fauna

- (a) **Flora:** includes 752 species, classified into 447 branches, 150 families, 59 groups, in which there are 22 species classified into 19 branches and 16 families.
- (b) **Fauna:** Forest animals include 68 species, classified into 26 families and 11 groups, 133 bird species of 42 families - 17 groups, 33 reptiles of 12 families - 3 groups, 15 frog species of 4 families - 1 group and thousands of insects, land animals. 53 species which account for 21.5% of total species, include in the list of rare animals.

(c) Marine Flora and Fauna

3.383 Binh Thuan Sea is the place that has the exchange of North and South flow, the upwelling phenomenon, a rich source of zooplankton volume. These favorable conditions make the potentials of abundant marine resources. A preliminary research shows that:

- (i) The volume of fish is 220,000 tons, in which, floating fish accounts for 60% and 40% of demersal fish. There are more than 60 species of the total 500 small and big species with high economic value such as Thu fish, Hong fish, Mu fish.

- (ii) The volume of shellfish is over 50,000 tons; exploration potential is from 25,000 to 30,000 tons per year. There are a lot of economic value species such as Long shell, Diep shell...
- (iii) The volume of seafood specialty is over 40,000 tons and exploration potential is 8,000 tons per year.

3.384 For example, economic value species: cuttle-fish: 10,000 -15,000 tons, Shrimp: 1,000- 2,000 tons...

3.385 + Floating creatures and plants include 192 floating plant species, 79 floating creature species, and 116 demersal creatures

3.386 Currently, many kinds of rare animals ran out of. There is a severe decrease in the volume and distribution of rare types of wood. Among these kinds, there are a lot of animals and wood those are used for food, medicine, and fur industry, some kinds of animals are hunted to take fur, horns, and tusk such as *Macaca artoides*, *Trachypithecus germain*.

(2) List of Species in Vietnam Red Data Book

3.387 The list of endangered species of Binh Thuan Province in Vietnam Red Data Book is shown in Table 3.1.36 on flora, and in Table 3.1.37 on fauna. Though it means the existence of these precious species within Binh Thuan Province, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 3.1.36 Endangered Species in Binh Thuan Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Binh Thuan
I		Magnoliophyta	NGÀNH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
1	92	<i>Millingtonia hortensis</i> L.f.	Đạt phước	VU	B1+2e	Y
2	94	<i>Argusia argentea</i> (L.f.) Heine	Phong ba	VU	A1a	Y
3	100	<i>Sindora siamensis</i> Teysm.ex Miq.	Gụ mật	EN	A1a,c,d	Y
4	114	<i>Trichosanthes kirilowii</i>	Qua lâu	VU	A1c,d, B1+2c	Y
5	116	<i>Anisoptera costata</i> Korth.	Vên vên	EN	A1a,b,c+2b,c	Y
6	117	<i>Dipterocarpus dyeri</i> Pierre	Dầu song vàng	VU	A1a,d+2c,d	Y
7	139	<i>Dalbergia oliveri</i> Gamble ex Prain	Cắm lai	EN	A1a,c,d	Y
8	254	<i>Azima sarmentosa</i> (Blume) Benth.	Thứ mật	EN	A1c,d	Y
9	271	<i>Aquilaria crassna</i> Pierre ex Lecomte	Trầm hương	EN	A1c,d, B1+2b,c,e	Y
10	282	<i>Tribulus terrestris</i> L.	Tật lê	EN	A1a,c,d, B1+2b,c	Y
II.2		Liliopsida	LỚP HÀNH			
11	295	<i>Iphigenia indica</i> (L.) Kunth	Yến phi	EN	B1+2b,c	Y
12	386	<i>Oryza minuta</i> J. & C. Presl	Lúa ma nhỏ	VU	A2c	Y
II		Pinophyta	NGÀNH THÔNG			
13	410	<i>Cycas lindstromii</i> S.L. Yang, K. D.hill&N.T.Hiep	Thiên tuế Lindstrom	VU	B1+2b,e	Y
III		Polypodiophyta	NGÀNH DƯƠNG XÍ			
IV		Lycopodiophyta	NGÀNH THÔNG			
14	429	<i>Selaginella tamariscina</i> (Beauv.) Spring	Quyển bá trường sinh	VU	A1c,d	Y
V		Rhodophyta	NGÀNH RONG ĐỎ			
VI		Phaeophyta	NGÀNH RONG NẤU			
15	442	<i>Turbinaria decurrens</i> Bory	Rong cùi bắp cạnh	VU	A1a,c,d, B1+2b,e	Y

VII		Mycophyta	NGÀNH NẤM			
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Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable, Y: Yes (existing)
 Source: Vietnam Red Data Book, 2007

Table 3.1.37 Endangered Species in Binh Thuan Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Binh Thuan
I		Animal	Thú			
1	13	<i>Macaca fascicularis</i>	Khi đuôi dài	LR	nt	Y
2	89	<i>Stenella longirostris</i>	Cá heo mõm dài	EN	A1cD1	Y
II		Birds	Chim			
3	126	<i>Lophura nycthemera</i>	Gà lôi trắng	LR	cd	Y
4	130	<i>Poluplectron germaini</i>	Gà tiền mặt đỏ	VU	A1 a,c C2a	Y
5	134	<i>Heliopais personata</i>	Chân bơi	EN	B1 C2a D	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
6	169	<i>Varanus salvator</i>	Kì đà nước	EN	A1c,d	Y
7	184	<i>Dermochelys coriacea</i>	Rùa da	CR	A1d	Y
8	187	<i>Eretmochelys imbricata</i>	Đồi mồi	EN	B2b,e C1	Y
9	192	<i>Cuora amboinensis</i>	Rùa hộp lưng đen	VU	A1d+2d	Y
10	197	<i>Indotestudo elongata</i>	Rùa núi vàng	EN	A1d+2d	Y
11	198	<i>Manouria impressa</i>	Rùa núi viên	VU	A1c,d+2d	Y
12	199	<i>Amyda cartilaginea</i>	Cua đình	VU	A1c,d+2cd	Y
III.2		Amphibian	Lưỡng cư			
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
IV.2		Sea fish	Cá biển			
13	254	<i>Alopias pelagicus</i>	Cá nhám đuôi dài	EN	A1d D	Y
14	257	<i>Cephaloscyllium umbratile</i>	Cá nhám lông nhung	EN	A1a,d C2a	Y
15	258	<i>Etmopterus lucifer</i>	Cá nhám nâu	EN	A1a,d D	Y
16	259	<i>Pristis cuspidatus</i>	Cá đao răng nhọn	EN	A1a,d D	Y
17	260	<i>Pristis microdon</i>	Cá đao răng nhỏ	EN	A1a D	Y
18	261	<i>Rhina ancylostoma</i>	Cá giống mõm tròn	EN	A1a,d C2a	Y
19	266	<i>Albula vulpes</i>	Cá môi đường	VU	A1d C1	Y
20	267	<i>Chanos chanos</i>	Cá măng sữa	VU	A2d	Y
21	268	<i>Anodontostoma chacunda</i>	Cá môi không răng	VU	A1d C1	Y
22	270	<i>Nematolosa nasus</i>	Cá môi mõm tròn	VU	A1c,d,e C1	Y
23	272	<i>Cyttopsis cypho</i>	Cá dây lưng gù	EN	A1d D	Y
24	280	<i>Hippocampus japonicus</i>	Cá ngựa nhật	EN	C1	Y
25	282	<i>Hippocampus trimaculatus</i>	Cá ngựa chấm	EN	A1d C1	Y
26	293	<i>Cornadion chrysozonus</i>	Cá bướm bốn vằn	VU	A1d B2b+3c	Y
27	296	<i>Pomacanthus imperator</i>	Cá chim hoàng đế	VU	A1d B2b+3c	Y
28	301	<i>Satyrichthys rieffeli</i>	Cá chào mào gai	VU	B1 D1	Y
29	302	<i>Anacanthus barbatus</i>	Cá bò râu	EN	A1d D	Y
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crustacean	Giáp xác			
V.1.2		Soft species	Thân mềm			
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
30	329	<i>Acropora aspera</i>	San hô lỗ đỉnh xù xì	VU	A1a,c	Y
31	330	<i>Acropora austera</i>	San hô lỗ đỉnh au-te	VU	A1a,c B2b+3d	Y
V.2.2		Echinoderm	Da gai			
32	341	<i>Actinopyga mauritiana</i>	Đồn đột dứa	VU	A1d B2b,e+3d	Y
33	342	<i>Microthele nobilis</i>	Đồn đột vú	VU	A2d B2e+3d	Y
34	343	<i>Thelenota ananas</i>	Đồn đột lựu	VU	A2d B2b,e+3d	Y
V.2.3		Crustacean	Giáp xác			
35	349	<i>Panulirus longipes</i>	Tôm hùm đỏ	EN	A1c,d B2b+3d	Y
36	352	<i>Ibacus ciliatus</i>	Tôm vỏ biển sâu	VU	A1c,d B2a+3d	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Binh Thuan
37	354	<i>Thenus orientalis</i>	Tôm vỏ đẹp trắng	VU	A1d B2a+3d	Y
V.2.4		Soft species	Thân mềm			
38	374	<i>Pinctada margaritifera</i>	Trai ngọc môi đen	VU	A1d C1	Y
39	375	<i>Pinctada maxima</i>	Trai ngọc môi vàng	VU	A1c,d	Y
40	376	<i>Pteria penguin</i>	Trai ngọc nữ	VU	C1 D2	Y
41	384	<i>Photololigo chinensis</i>	Mực thước	VU	A1d	Y
42	385	<i>Sepia(tigris) pharaonis</i>	Mực nang vân hổ	VU	A1d	Y
V.3		Insects	Côn trùng			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

4) Flora and Fauna in Dong Nai Province

(1) Flora and Fauna in Dong Nai Nature Reserve and Cultural Site

3.388 **Forest Flora:** According to a survey, at present in Dong Nai Nature Reserve, there are 1,401 species, belonging to 623 genus, 156 families, 92 orders, 10 classes and 6 phylum; among which 30 species belonging to 27 genus, 18 families, 16 orders are listed as scarce species in Vietnam Red Book (2007) such as: *Afzelia xylocarpa*, *Pterocarpus macrocarpus*, *Anisoptera costata* Korth, *Dipterocarpus dyeri* Pierre, etc. Woody plants account for a high percentage at 45%, medicinal plants account for 24.8%.

3.389 **Forest Fauna:** Following fauna species are recorded in Dong Nai Nature Reserve.

- (a) **Animals:** 85 species, belonging to 27 families, 10 orders.
- (b) **Birds:** 529 species, belonging to 53 families, 18 orders.
- (c) **Reptiles, amphibian:** 97 species of reptiles and amphibian, including: 64 species of reptiles, belonging to 2 orders and 33 species of amphibian, belonging to 5 families, 1 order.
- (d) **Insects:** 1,189 species of insects, belonging to 112 families and 10 orders.
- (e) **Fishes:** 99 species of fishes, belonging to 29 families and 11 orders.

(2) Biodiversity Resources

3.390 In Dong Nai Province, areas having high and typical biodiversity include Tri An lake, Long Thanh – Nhon Trach mangrove forest and Nam Cat Tien national park. Current biodiversity in those areas are as follows:

(a) Tri An Lake

3.391 Current management of the lake: Fish cage farming is conducted in rivers with the number of cages varying around 700 cages. According to statistics, in 2006 the number of fish cages was 765 cages. Waste water arising from farming and domestic activities (Ngoc Dinh commune, Dinh Quan district) affected water quality in watershed areas. Fishing is strictly managed in terms of fishing methods to ensure sustainable development of aquatic flora and fauna system.

3.392 Biological resources: following flora and fauna are recorded.

- (i) Plant plankton: diversified and includes 131 species, among which *Chlorophyta* takes advantages with 62 species (47.3%) of 38 breeds, *Bacillariophyta* - 38 species (29%): 20 breeds, *Cyanophyta* - 13 species (10%): 10 breeds, *Euglenophyta* - 7 species (5.3%): 3 breeds, *Chrysophyta* - 6

species (4.6%): 2 breeds, *Pyrrophyta* - 3 species (2.3%): 2 breeds, *Xanthophyta* - 2 species (1.5%) 1 breeds;

- (ii) Animals plankton and benthic fauna: diversified, *Protozoa* takes advantages with 12 species, 28 individuals/per l, *Rotifer* - 11 species, 73 individuals/l, *Copepoda* - 10 species, 209 individuals/l, *Cladocera* - 9 species, 205 individuals/l and *larva* - 162 individuals/l;
- (iii) Freshwater fish: 95 species in Tri An and Tan Phu lake, among which there are a few species: *Cyprinus cartio*, *Hypothalmiehthis harmandi*, *Aristichthys nobilis*, *Ctenopharyngodon idella*;
- (iv) *Bivalve molluscs*: in Tri An lake and the Dong Nai river, there are two types of *bivalve molluscs* namely Oyster and mussel. Exploitation output is estimated to be more than 200 ton each year.

(b) Long Thanh–Nhon Trach Mangrove Forest

3.393 Current management of Long Thanh – Nhon Trach mangrove protection forest: mangrove forest in the state forest enterprise Long Thanh is located in administrative boundary of 4 communes including: Phuoc Anh, Long Tho (Nhon Trach district); Phuoc Thai commune, Long Phuoc (Long Thanh district). Total natural area of Long Thanh mangrove forest is 7,952.67ha, of which:

- in Nhon Trach district, there are 7,060ha forest, including 4,036ha land having forest and 3,024ha land not covered with forest;
- in Long Thanh district, there are 1,467ha forest.

3.394 Mangrove protection forest takes part in the process of stabilizing alluvial deposit, preventing erosion due to tidal activities and other activities at river gate. In the forest, there are also other ecological processes like the transmission of alluvium and planktons, creating balance for the development of shrimp larvae and fish. In general, protection of mangrove forest Long Thanh – Nhon Trach has been effectively improved with rather good growth in forest area as well as natural resources

3.395 Biological Resources: following flora and fauna are recorded.

- (i) Plant plankton: in saltwater intrusion areas affected by industrial waste, species are less diversified with 29 species, among which *Bacillariophyta* takes advantages with 17 species, 58.6% belonging to 10 breeds, *Chlorophyta* - 6 species, 20.7% belonging to 6 breeds, *Cyanophyta* - 4 species, 13.8% belonging to 4 breeds, *Chrysophyta* - 1 species and breed, 3.4%, *Euglenophyta*- 1 species and breed, 3.4%. Average density of algae is 19,000 – 45,000 individuals /liter;
- (ii) Animal plankton and benthic animals: in saltwater intrusion areas affected by industrial waste, species are diversified. It is determined that *Copepoda* takes advantages with 11 species, 20 individuals/l, *Rotifer* - 2 species, 8 individuals/l, *Protozoa* - 5 species, 7 individuals/l, *Cladocera* - 11 species, 3 individuals/l and larvae - 38 individuals/l;
- (iii) Crustacean (shrimp, crab): in terms of edible crustacean species, there are about 19 shrimp species, which have exploitation value. *Scylla serrata* of large size is also exploited in large scale in mangrove forests. *Penaeud monodon* is

being exploited at higher frequency.

(c) Cat Tien National Park

3.396 Biological resources: There is a variety of scarce and endemic flora and fauna species, with such dominant species as *Dipterocarpaceae*, *Fabaceae* and *Lythraceae*:

(i) Flora system

3.397 Up to now, there are 1.610 species, 75 orders, 162 families and 724 genus, including:

- Big wood trees: 176 species;
- Small wood trees: 335 species;
- Shrub/Bush trees: 345 species;
- Evergreen carpet: 311 species;
- Creeper: 238 species;
- Parasitic species: 143 species;
- Pteridophyta: 62 species.

3.398 Scarce plants (scarce gene pools): including 38 species of 13 families, like *Azelia Xylocarpa*, *Dalbergia*, *Pterocarpus macrocarpus*, *Sindora siamensis*, *Diospyros maritime*, *Blume*, *Pyinkado*, etc, which are listed in Vietnam red book.

3.399 Endemic gene pools and local endemic plants: including 22 species of 12 families, like Dong Nai nature, *Telectadium edule* *Baill.*

3.400 Among which, Cat Tien national park has 5 main forests as follows:

- Broadleaf evergreen forest: dominant species: Dipterocarpaceae and Fabaceae like *Dipterocarpus alatus* *Roxb. ex G.Don*, *Dipterocarpus baudii*, *Hopea odorata*, *Dalbergia bariensis* *Pierre*, *Azelia Xylocarpa*, *Pterocarpus macrocarpus*.
- Semi-deciduous broadleaf evergreen forest: including wood trees whose leaves fall in dry season like *Lagerstroemia speciosa*, *Tetrameles nudiflora*, *Ligustrum*.
- Mixed forest with wood trees and bamboos: This is a secondary forest type arising from evergreen forest and semi-deciduous forest, which are affected by forest fires, chemicals, therefore, forests have their canopy opened and bamboos can grow. Common plants are *Mesua ferrea*, *Lagerstroemia speciosa*, *Pyinkado*, *Bambusa balcoa* and *Diospyros mun*;
- Pure bamboo forest: This is a secondary forest type, after trees were cut down, bamboos intruded and grew. Two common bamboos are *Bambusa balcoa* and *Diospyros mun*, creating large forests, in wet land, there is only La Nga bamboo species;
- Wet land flora system: swamp area is large, water has yet to be polluted. In rainy season, water level in the Dong Nai river becomes

higher, making 5,360 ha flooded. In dry season, water goes down, leaving many ponds, swamp is narrowed down to 100 – 150 ha. This is also the deepest area of such ponds as: Sau pond, Chim pond, Ca pond, etc. Dominant species are wood plants which can bear water like: *Hydnocarpus althemintica*, *Barringtonia*, *Acutangula Gaertn*, *Hopea ferrea Laness* combined by *Saccharum arundinaceum Rez*, *Saccharum spontaneum*, and *Phragmites australis Cav*. In Cat Tien national park many studies on Bau Sau wet land are being conducted.

(ii) Fauna System

3.401 Dominant fauna species in Cat Tien national park is the hooves with 6 dominant species including: *Sus scrofa*, *Tragulus javanicus*, *Muntiacus muntjak*, *Bos gaurus*, *Bos javanicus* and *Cervus unicolor* and many representative species of *Bovidae* families:

- **Bird:** including 348 species of 64 families, belonging to 18 orders, among which there are 31 scarce species detected and listed in Vietnam Red Book. Scarce birds are: *Ciconia episcopus*, *Pavo muticus*, *Leptoptilos javanicus*, *Pseudibis davisoni*, *Cairina scutulata*, among which, *Arborophila davidi* is the scarce species and endemic in the ASEAN as well as in Vietnam. The number of individuals belonging to this species is increasing during the annual survey on pheasant in the national park;
- **Mammalia:** 105 species of 29 families, 11 orders, among which there are 25 species listed in Vietnam red book like: *Bos javanicus*, *Bos gaurus*, *Panthera tigris*, *Helarctos malayanus*, *Ursus thibetanus*, *Elephas maximus*, *Panthera pardus*, *Catopuma temminckii*, *Cuon alpinus*, *Pygathrix nemaesus*, *Petaurista philippensis*,... In addition, in Cat Tien national park, there is Vietnam rhino population (*Rhinoceros sondaicus annamiticus*), which is sub-type of *Rhinoceros sondaicus*, there are only 2-3 rhinos left, which are in grave danger of extinction.
- **Reptiles:** 80 species of 17 families and sub-families, 4 orders among which there are 23 species listed in Vietnam red book like: *Crocodylus siamensis*, *Python reticulatus*, and *Python reticulatus*.
- **Fish:** diversified with more than 134 species, of 28 families, among which there are about 10 new species discovered in Vietnam; 1 listed in red book of IUCN (arowana or dragon fish); 8 listed in Vietnam red book like: *Bagarius bagarius*, *Leptobarbus hoevenii*, *Mystus wyckioides*, *Channa micropeltes*, and *Scleropages formosus*.
- **Amphibians:** 41 species of 6 families, 2 orders.
- **Insects:** 751 species of 68 families and 9 orders, among which there are 70 species discovered in Vietnam, 15 new species in the southern Vietnam and 2 new sub species for science.

(iii) Natural Landscape

3.402 From Lam Vien highland, the Dong Nai river passes through Cat Tien national park on complex terrain and creates natural boundary surrounding about 1/3 P of the national park with total length of 90km,

which possesses many beautiful natural places of sightseeing like: Sky fall, Dung fall, Ben Cu fall, Mo Vet fall, together with natural ponds like Bau Sau, Bau Ca, Bau Chim, which is attractive to both scientists and tourists.

3.403 According to official data on Cat Tien national park, following species are recorded:

(iv) Terrestrial flora species

- Terrestrial flora species: 1,610 species, 75 orders, 162 families and 724 genus;
- Endemic terrestrial flora species: 23 species of 12 families;
- Scarce terrestrial flora species: 39 species
- The No of species listed in Decree 48 (2002): 10 species;
- No of species listed in Vietnam red book (1992, 2000): 29 species.

(v) Terrestrial Fauna Species

- No of terrestrial fauna species: 1,486 species of 190 families, 50 orders.
- Endemic terrestrial fauna species: details are presented in Table 3.1.38.

Table 3.1.38 List of Endemic Species

No	Common Name	Latin Name
Bird	Orange-necked Partridge	<i>Arborophila davidi</i>
	Silver Pheasant	<i>Polyplectron germaini</i>
Mammalia	Vietnam Java Rhino	<i>Rhinoceros sondaicus nnamiticus</i>
	-	<i>Vivera tainnguensis</i>
Amphibian	-	<i>Cyrtodactylus irregularis</i>
	-	<i>Megophrys intermedius</i>
	-	<i>Microphyla annamensis</i>

Source: 5ECSR 2006-2010, Dong Nai DONRE

3.404 Endemic insect species in the national park have yet to be determined.

(i) No of scarce terrestrial fauna species

- Scarce birds: 42 species;
- Scarce mammalia: 64 species.

(ii) Aquatic resources

- No of aquatic living things : 1,106 species, among which:
- Aquatic flora species : 89 species;
- phyto plankton : 610 species;
- zoo plankton : 126 species;
- zoo benthos : 122 species;
- fish : 159 species;
- Scarce aquatic living things: 8 species.

3.405 At present, there are no updated data on biodiversity in typical eco-system area of Long Thanh – Nhon Trach protection mangrove forest, Tri An lake, natural

conservation area and Vinh Cuu historic places as well as other rivers, lakes, forests, ponds and natural conservation areas.

(3) General Comments on Current Conditions of Forest and Biodiversity

3.406 Matters like deforestation, forest fires, and forest encroachment have decreased. Area of natural forest, protection forest, and important watershed **forest has been stabilized, helping create jobs, improve living standards, ecosystems and promote socio-economic development.**

3.407 The province has boosted biodiversity survey in the province area, especially in Cat Tien national park and Long Thanh – Nhon Trach protection mangrove forest. In these two areas, propaganda and education on environmental protection have been promoted among tourists, students in the buffer zone and local residents. In addition, it is necessary to further improve living standards of ethnic minorities with a view to raising their awareness of forest protection.

(4) List of Species in Vietnam Red Data Book

3.408 The list of endangered species of Dong Nai Province in Vietnam Red Data Book is shown in Table 3.1.39 on flora, and in Table 3.1.40 on fauna. Though it means the existence of these precious species within Dong Nai Province, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 3.1.39 Endangered Species in Dong Nai Province (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Dong Nai
I		Magnoliophyta	NGÀNH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
1	5	<i>Melanorrhoea laccifera</i> Pierre	Sơn tiên	VU	A1a,d+2d, B1+2a	Y
2	8	<i>Anaxagorea luzonensis</i> A. Gray	Quả dầu ngỗng	VU	A1c+2c, B1+3b	Y
3	18	<i>Mitrephora thorelii</i> Pierre	Mạo đài Thorel	VU	A1a,c,d	Y
4	23	<i>Chonemorpha yersinii</i> Spire	Quần hoa yersin	EN	A1c,d	Y
5	37	<i>Strophanthus wallichii</i> A. DC.	Sừng trâu to	EN	B1+2b,c	Y
6	39	<i>Trachelospermum bessonii</i> Pierre ex Pitard	Cổ quạ	EN	B1+2b,c	Y
7	56	<i>Atherolepis pierrei</i> Cost.	Gai lân	CR	B1+2a	Y
8	61	<i>Paphistemma hooperianum</i> (Blume) Decne	Trâm hùng	EN	B1+2a	Y
9	65	<i>Telectadium Dongnaiense</i> Pierre ex Cost.	Vệ tuyến Đồng Nai	CR	B1+2a,b	Y
10	99	<i>Afelia xylogarpa</i> (Kurz) Craib	Gõ đỏ	EN	A1c,d	Y
11	100	<i>Sindora siamensis</i> Teysm.ex Miq.	Gụ mật	EN	A1a,c,d	Y
12	116	<i>Anisoptera costata</i> Korth.	Vên vên	EN	A1a,b,c+2b,c	Y
13	117	<i>Dipterocarpus dyeri</i> Pierre	Dầu song vàng	VU	A1a,d+2c,d	Y
14	118	<i>Dipterocarpus grandiflorus</i> Blanco	Dầu dốt tím	VU	A1c,d+2c,d	Y
15	124	<i>Parashorea stellata</i> Kurz	Chò đen	VU	A1,b,c+2b,c, B1+2a,b,c	Y
16	129	<i>Elaeocarpus hygrophilus</i> Kurz	Cà na	VU	A2c, B1+2a,b	Y
17	138	<i>Dalbergia cochinchinensis</i> Pierre	Trắc	EN	A1a,c,d	Y
18	139	<i>Dalbergia oliveri</i> Gamble ex Prain	Cắm lai	EN	A1a,c,d	Y
19	140	<i>Pterocarpus macrocarpus</i> Kurz	Giáng hương	EN	A1a,c,d	Y
20	195	<i>Strychnos ignatii</i> Berg.	Mã tiền lông	VU	A1a,c	Y
21	212	<i>Aglaia spectabilis</i> (Miq.) Jain &	Gội nếp	VU	A1a,c,d+2d	Y

		<i>Bennet</i>				
22	216	<i>Dysoxylum loureiri</i> (Pierre) Pierre	Huỳnh đường	VU	A1a,c,d+2d	Y
23	230	<i>Melientha suavis</i> Pierre	Rau sắng	VU	B1+2e	Y
24	245	<i>Hydnophytum formicarum</i> Jack	Kỳ nam	EN	A1b,d, B1+2b,e	Y
25	248	<i>Paracoffea Dongnaiensis</i> (Pierre & Pitard) Leroy	Cà phê đồng nai	VU	A1c, B1+2a,c	Y
26	256	<i>Aesandra dongnaiensis</i> Pierre	Xương đào	EN	B1+2b,c,e	Y
27	264	<i>Siphonodon celastrineus</i> Griff.	Xung da	VU	A1c,d	Y
28	274	<i>Schoutenia hypoleuca</i> Pierre	Sơn tần	VU	A1a,b,c,d	Y
29	280	<i>Vitex ajugaeiflora</i> Dop	Bình linh nghệ	VU	B1+2e	Y
II.2		Liliopsida	LỚP HÀNH			
30	289	<i>Homalomena gigantea</i> Engl.	Thiên niên kiện lá to	VU	B1+2b,c	Y
31	338	<i>Dendrobium crepiadatum</i> Lindl. & Paxt	Ngọc vạn sáp	EN	B1+2e+3d	Y
32	366	<i>Nervilia aragoana</i> Gaudich	Chân trâu xanh	VU	B1+2b,c,e	Y
33	386	<i>Oryza minuta</i> J. & C. Presl	Lúa ma nhỏ	VU	A2c	Y
34	392	<i>Stemona cochinchinensis</i> Gagnep.	Bách bộ nam	VU	B1+2b,c	Y
35	394	<i>Stemona pierreii</i> Gagnep.	Bách bộ lá nhỏ	VU	B1+2b,c	Y
36	396	<i>Tacca integrifolia</i> Ker-Gawl.	Ngải rơm	VU	A1a,c,d	Y
II		Pinophyta	NGÀNH THÔNG			
37	409	<i>Cycas inermis</i> Lour.	Tuế sơn trà	VU	A1a,c,d	Y
III		Polypodiophyta	NGÀNH DƯƠNG XỈ			
IV		Lycopodiophyta	NGÀNH THÔNG			
V		Rhodophyta	NGÀNH RONG ĐỎ			
VI		Phaeophyta	NGÀNH RONG NẤU			
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU: Vulnerable. Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

Table 3.1.40 Endangered Species in Dong Nai Province (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Dong Nai
I		Animal	Thú			
1	2	<i>Cynopterus brachyotis</i>	Đơi chó tai ngắn	VU	A1c,d B2a,e	Y
2	4	<i>Rhinolophus thomasi</i>	Đơi lá Tôma	VU	B2a	Y
3	9	<i>Nycticebus pygamaeus</i>	Cu li nhỏ	VU	A1c,d	Y
4	13	<i>Macaca fascicularis</i>	Khi đuôi dài	LR	nt	Y
5	15	<i>Macaca leonina</i>	Khi đuôi lợn	VU	A1c,d	Y
6	17	<i>Pygathrix nemaeus nemaeus</i>	Chà vá chân nâu	EN	A1a,c,d B2b	Y
7	20	<i>Trachypithecus villosus</i>	Voọc bạc	VU	A1c,d	Y
8	27	<i>Nomascus gabriellae</i>	Vượn đen má vàng	EN	A1c,d C2a	Y
9	39	<i>Arctictis binturong</i>	Cây mực	EN	A1c,d C1	Y
10	51	<i>Panthera tigris corbetti</i>	Hồ đồng dương	CR	A1d C1+2a	Y
11	54	<i>Elephas maximus</i>	Voi	CR	A1cB1+2b,c,e C1+2a	Y
12	58	<i>Tragulus Javanicus</i>	Cheo nam dương	VU	A1a,d C1	Y
13	62	<i>Cervus porcinus</i>	Hươu vàng	EN	A1c,d B2a,b,e	Y
14	68	<i>Bos gaurus</i>	Bò tót	EN	A1c,d B1+2a C1+2a	Y
15	69	<i>Bos Javanicus</i>	Bò rừng	EN	A1c,d B2a	Y
16	76	<i>Belomys pearsoni</i>	Sóc bay lông tai	CR	A1+2c,d C1+2a	Y
II		Birds	Chim			
17	98	<i>Ephippiorhynchus asiaticus</i>	Hạc cổ đen	DD		Y
18	100	<i>Leptoptilos javanicus</i>	Già đẫy nhỏ	VU	A1c,e B 2a+3b C 2 a	Y
19	104	<i>Pseudibis davisoni</i>	Quắm cánh xanh	CR	A1a,c,d C2a D	Y
20	108	<i>Cairina scutulata</i>	Ngan cánh trắng	CR	A1a,c,d	Y
21	110	<i>Nettapus coromandelianus</i>	Le khoang cổ	EN	C2a D	Y
22	117	<i>Ichthyophaga humilis</i>	Điều cá bé	VU	B2a C1	Y
23	118	<i>Ichthyophaga ichthyaetus</i>	Điều cá lớn	VU	B2a C1	Y
24	121	<i>Arborophila davidi</i>	Gà so cổ hung	EN	B1+2b, c,d,e C1+2a	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	Dong Nai
25	122	<i>Lophura diardi</i>	Gà lôi hồng tía	VU	A1a,c C2a	Y
26	126	<i>Lophura nycthemera</i>	Gà lôi trắng	LR	cd	Y
27	127	<i>Pavo muticus imperator</i>	Công	EN	A1 a,c,d+3b,d C2a	Y
28	130	<i>Poluplectron germaini</i>	Gà tiền mặt đỏ	VU	A1 a,c C2a	Y
29	142	<i>Bubo nepalensis</i>	Dù di Nê Pan	CR	C2a	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
30	167	<i>Physignathus cocincinus</i>	Rồng đất	VU	A1c,d	Y
31	168	<i>Varanus nebulosus</i>	Kỳ đà vân	EN	A1c,d	Y
32	169	<i>Varanus salvator</i>	Kỳ đà nước	EN	A1c,d	Y
33	171	<i>Python reticulatus</i>	Trăn gấm	CR	A1c,d	Y
34	177	<i>Enhydryis</i>	Rắn bông voi	VU	A1c,d+2cd	Y
35	179	<i>Ptyas mucosus</i>	Rắn ráo trâu	EN	A1c,d	Y
36	182	<i>Ophiophagus hannah</i>	Rắn hổ chúa	CR	A1c,d	Y
37	195	<i>Hieremys annandalii</i>	Rùa rặng	EN	A1c,d+2d	Y
38	196	<i>Malayemys subtrijuga</i>	Rùa ba gờ	VU	A1c,d+2d	Y
39	204	<i>Crocodylus siamensis</i>	Cá sấu xiêm	CR	A1c,d	Y
III.2		Amphibian	Lưỡng cư			
40	210	<i>Bufo galeatus</i>	Cóc rừng	VU	B1+2a,b,c,d	Y
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
41	218	<i>Scleropages formosus</i>	Cá môn	EN	A1c,d	Y
42	219	<i>Chitala ornata</i>	Cá còm	VU	A1a,c,d	Y
43	230	<i>Cirrhinus microlepis</i>	Cá đuông	VU	A1c,d B1+2c,d,e	Y
44	238	<i>Probarbus jullieni</i>	Cá trà sóc	VU	A1c,d B1+2c,d,e	Y
45	245	<i>Ompok miostoma</i>	Cá sơn dài	VU	A1c,d C1	Y
46	251	<i>Coius microlepis</i>	Cá hường	VU	A1c,d	Y
47	252	<i>Coius quadrifasciatus</i>	Cá hường vện	VU	A1a,c,d	Y
48	253	<i>Toxotes chatareus</i>	Cá mang rô	VU	A1a,c,d	Y
IV.2		Sea fish	Cá biển			
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crutacean	Giáp xác			
V.1.2		Soft species	Thân mềm			
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
V.2.2		Echinoderm	Da gai			
V.2.3		Crutacean	Giáp xác			
V.2.4		Soft species	Thân mềm			
V.3		Insects	Côn trùng			
49	400	<i>Kallima albofasciata</i>	Bướm lá vạch trắng	DD		Y

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
 Source: Vietnam Red Data Book, 2007

5) Flora and Fauna in Binh Duong Province

3.409 According to the recent studies and surveys, the preserved and stored vegetation comprises mainly the young forests of which the reserves is small and the greenery-covered rate is mainly with the perennial industrial crops and fruit-trees. The flora and fauna decrease actively in the number and species. The wild fauna is not plentiful. In the forests, there are only the small mammals and birds. The rare and precious animals cover a very few rate and are distributed mainly surrounding Dau Tieng reservoir. According to the statistic data of Tropical Biology Institute, Binh Duong has 23 mammal species, 99 bird species, 19 species of amphibians, 40 species of reptiles, 67 fish species, 1,084 species of vascular plants and many aquatic organisms.

3.410 There have been a few of wild animal remaining in the wild environment left in Dau Tieng protective forest, D strategic was base, Phu Binh forestry farm. They mainly are musk-cat (*Viverricula indica*), long-tailed macaque monkey (*Macaca Fasicularis*), wild-pig (*Sus Scrofa*), Cheo Cheo (*Tragulidae*), hare (*Leporidae*), squirrel (*Sciuridae*), wildcat (*Felis silvestris*), etc. However, the wild animal breeding and conservation situation is being developed quite actively with the participation of many enterprises, households. There have been 218 organizations and individuals who are breeding 85 wild-animal species of which the total quantity is 9,000 animals. The major bred species are malayan-bear (*Helarctos Malayanus*), tibetan-bear (*Ursus Thibetanus*), tiger (*Panthera tigris*), etc. Besides, many households and individuals self-invest to breed the forestry animals with a large-size, such as: porcupine (*Hystrix hodgsoni*), cross-bred forestry pig (*Sus Scrofa*), crocodile (*Crocodylidae*), deer (*Cervus unicolor*), Stag (*Cervus porcinus*), etc. Therefore, the genetic resources of vulnerable rare and specious wild-animals are conserved and bred that will take part in increasing the specie biodiversity of Binh Duong.

3.411 The agricultural flora formation comprises majorly rice, annual crops, fruit-trees. The rice area is 8,028 ha which is distributed in the whole province, but majorly in Tan Uyen and Ben Cat. Binh Duong has a plentiful annual-crop formation which is focally distributed in Tan Uyen, Phu Giao; while the fruit-tree formation is distributed proradically in Thuan An, Ben Cat and Tan Uyen with a total area of 6,620 ha. The majorly planted fruit species are durian (*Duro Zibethinus Murr*), rambutan (*Nephelium lappaceum L.*), mangosteen (*Garcinia mangostana*), mulberry (*Morus alba L.*), To Nu jack-fruit (*Chempedak*), etc. Moreover, there are also the industrial-plant formation which comprises Rubber (*Hevea brasiliensis*), cashew (*Anacardium occiden tablel*), and etc. ; these ones are distributed mainly in Phu Giao, Dau Tieng. Especially, in Ben Cat district, there is Phu An bamboo village which covers in an area of 10 ha, this is reservation zone of bamboo species which include over 1,500 bamboo bushes of 300 species of Vietnam and the world. In Phu An bamboo village, there are over 100 species among which there are many rare and specious species, such as: Tep Nua, Tre Vuong (*Chimonobambusa quadrangularis*), Vang Soc (*Bambusa dolichoclada*), Mai, May Ruoi, Luong (*Dendrocalamus membranaceus Munro*), Vau, Truc Cao Bang, Hop (*Bambusa*), etc.

3.412 With many lakes, ponds, reservoirs and the crisscrossed canal and rivulet networks of Dong Nai river and Saigon one, Binh Duong's aquatic creatures are relatively plentiful.

6) Flora and Fauna in HCMC

3.413 HCMC has 356 flora and fauna species, including 34 animal species, 140 bird species, 41 mammal and reptile species and 141 fish species. 35 rare and precious fauna species are named in Vietnam Red Book (2007), which are comprised of 7 animal species, 5 bird species, 11 mammal and reptile species and 12 fish species. In addition, there are 80 large-size invertebrate fauna species, of which 56 species are valuable.

3.414 HCMC has over 284 flora species, including 7 rare and precious species in Vietnam Red Book (2007) and World Red Book (IUCN, 2010).

Table 3.1.41 Fauna and Flora Species in HCMC (excluding small invertebrate fauna species)

No.	Group	No. of species	Rare and precious species No.	Valuable species No.
1	Animal	34	7	28
2	Bird	140	5	140

3	Mammal and reptile	41	11	41
4	Fish	141	12	112
5	Crustacean	38		29
	Non-crustacean	2		1
6	Shell	40		26
7	Plant	>284	8	N.A

Source: 5ECSR 2005-2009, HCMC DONRE

(1) Biodiversity of Can Gio Mangrove Forest

3.415 The Can Gio Forest was recognized as the first mangrove biosphere reserve in Vietnam by UNESCO in 2000, covering an area of 75,740 ha, including 4,721 ha core zone, 41,139 ha buffer zone and 29,880 ha transition zone. The Can Gio Forests is located in one of rural district of HCMC.

3.416 It is statistically reported that there are 371 species, including 28 animal species, 135 bird species, 41 reptile species 91 fish species, 34 crustacean species, etc.

(a) Animal Species

3.417 There are 28 animal species of 13 families and 7 orders. 3 primates species are also imported to promote ecological tourism on Can Gio Monkey Island, namely *Macaca rhesu*, *Macaca leonine* and *Macaca arctoides*. They are rare and precious species in redbook of Vietnam and the world. *Pteropus lylei* Anderson genus, 1908 is also recorded in Dam Doi, Vam Cat tourism center, Ly Nhon commune.

3.418 Rare and precious animal species: 6 species are named in Vietnam Red Book (2007), including *Cynopterus brachyotis*, *Macaca f. fascicularis*, *Lutra lutra*, *Aonyx cinerea*, *Prionailurus viverrina* and *Manis javanicus*.

(b) Bird Species

3.419 Can Gio biosphere reserve has 135 bird species of 43 families and 16 orders, comprising 54 water bird species and 81 clump species. Vam Sat bird sanctuary in Ly Nhon commune is a bird sanctuary of Can Gio, where many bird species grow up, including rare and precious species of *Anhinga melanogaster*, *Leptoptilos javanicus* and *Anhinga melanogaster*. Two other species are also found, namely *Pycnonotus jorcosus* and *Ixobrychus cinnamomeus*.

3.420 Rare and precious bird species: 5 species are named in Vietnam Red Book (2007), including *Pelacanus philippensis*, *Anhinga melanogaster*, *Nycteria leucocephala*, *Leptoptilos javanicus* and *Tringa guttifer*.

(c) Reptile and Mammal Species

3.421 Can Gio biosphere reserve has 9 frog species of 4 families and 32 mammal species of 15 families and 3 orders, including *Leiolepis belliana* which was misidentified as a new species: *Leiolepis ngovantrii* sp. Nov. Grismer & Grismer, 2010.

3.422 11 rare and precious reptile and mamma species are recorded in Vietnam Red Book (2006), including *Gekko gecko*, *Varanus salvator*, *Python molurus*, *Python reticulatus*, *Ptyas korros*, *Coelognathus radiate*, *Ophiophagus Hannah*, *Bungarus fasciatus*, *Chelonia mydas*, *Crocodylus porosus*, *Eretmochelys*

imbricate.

(d) Fish Species

3.423 Can Gio mangrove forest have 90 fish species of 51 families and 20 orders.

Table 3.1.42 Rare and Precious Fish Species in Can Gio Mangrove Forest

No	Vietnamese name	Scientific name	Note
1	Ca chao bien	<i>Elops sannnu</i> (Ninnaeus, 1976)	VU C1
2	Ca chao vay lon	<i>Megalops cyprinoids</i> (Broussonet, 1782)	VU A1d C1
3	Ca mang sua	<i>Chanos chanos</i> (Forsk., 1775)	VU A1d
4	Ca moi mom tron	<i>Nomainlosa nasus</i> (Bloch, 1795)	VU A1c, d, e C1
5	Ca chinh bong	<i>Anguilla marmorata</i> (Quoy & Gaimard, 1824)	VU A1 d, d, B1+ 2a, b
6	Ca Huong soc xien	<i>Datnioides polota</i> (Hamilton, 1822)	VU A 1a,c,d
7	Ca Chia voi	<i>Proteracanthus sarisshophorus</i> (Cantor, 1849)	NT, 2009 IUCN
8	Ca mang ro	<i>Toxotes chatareus</i> (Hamilton, 1822)	VU A 1a, c, d

Source: 5ECSR 2006-2009, HCMC DONRE

3.424 *Proteracanthus sarisshophorus* (Cantor, 1849) is listed in the IUCN Red Data Book (2009) but is not existed in Vietnam Red Book (2009).

3.425 Valuable fish species: There are 66 medium valuable species, 10 high valuable species and 3 especially high valuable species (*Anguilla marmorata* Quoy & Gaimard, 1824, *Pisoodonophis boro* (Hamilton – Buchanan) and *Proteracanthus sarisshophorus* (Cantor, 1849)).

(i) *Crustacean*: Can Gio mangrove forest has 34 crustacean species of 16 families, including *Penaeus vannamei* (Boone, 1931), of which, 27 species have economic value.

(ii) *Mollusk*: There are 40 shell species of 24 families and 3 branches (Cephalopods, Gastropods and Bivalvae). 24 of 40 species are valuable species.

3.426 Plant Biodiversity: There are 33 plant species of 15 families. In addition, there are 53 forest plant species of 29 families. Moreover, Can Gio mangrove forest also has 126 migrated species of 45 families.

(iii) Aquatic Resources and Aquaculture in Can Gio

3.427 Aquatic Resources in Can Gio submerged zone: Can Gio has densely river and canal system and affected by semi-diurnal tidal regime so this zone has abundant aquatic resources. Organic material degradation of mangrove species are food and habitat of larva species. There are 66 valuable fish species, 10 special valuable species and 3 super valuable species. In addition, Can Gio submerged zone has over 27 valuable crustacean species, especially *Meretrix meretrix* species which was found in sandy bars in Can Thanh and Long Hoa of Can Gio district in August 2009.

3.428 Aquaculture: Aquaculture has been developed rapidly for 15 years, mainly comprising *Penaeus monodon*, shell and *Scylla paramamosain* Estampador.

3.429 *Penaeus monodon*: including industrial breeding (25-20 units/m²). Can Gio district over 5,516 ha shrimp breeding area, of which, *Penaeus monodon*

breeding area is 4,724 ha and *Penaeus vannamei* breeding area is 795 ha with density of 100 units per m².

3.430 *Penaeus vannamei* breeding: HCMC DARD survey identified 3 zones suitably for *Penaeus vannamei* breeding in Can Gio in early 2008, covering 1,300 ha in Tam Thon Hiep commune (114.96 ha), An Thoi Dong commune (563.42 ha) and Ly Nhon commune (616.58 ha).

3.431 *Scylla paramamosain* Estampador, 1949 breeding: *Scylla paramamosain* breeding in Binh Khanh has been stopped due to pollution of Thi Vai River since 1997.

3.432 *Meretrix lyrata* breeding: Can Gio has 634 ha *Meretrix lyrata* breeding area. However, disease occurred in over 500 ha in July 2007, which was estimated at VND 200 billion loss. *Meretrix lyrata* breeds: This activity is conducted in the area along the sea (300m sand bar), mainly concentrated in 600 ha of Sai Goi Sunbay project.

3.433 *Pangasius mekongensis*, Gustiano et al, 2003: *Pangasius mekongensis* has been experimentally in Ly Nhon and An Thoi Dong by Can Gio Aquaculture Promotion Center.

- Impacts on Fauna of Can Gio Submerged Zone

3.434 Industrial pollution in Thi Vai River, especially pollution by wastewater of Vedan Company makes serious degradation of aquatic resources. Many fishing men must change their job for livelihood. Aquaculture in Thanh An and communes of Dong Nai Province has been seriously affected by the river water pollution.

3.435 Industrial shrimp breeding has been expanded in Tam Thon Hiep which encroach habitat of *Lutra lutra* and *Aonyx cinerea* which are rare and precious animal species.

3.436 River's bed fish net used to be developed considerably in Long Tau River but it has been banned for waterway navigation. The site survey result shows that there are many small pots in small tributaries, e.g. Cha La, Thieng Lieng, Vam Sat, etc. Small mesh threatens aquatic resources since mangrove forests are habitat of larva species and young shrimp and fish.

3.437 Fishing by mosquito-net type has been banned but some small mesh net still utilizes to catch fish and shrimp in Can Gio biosphere reserve. Many young fish and shrimp are killed by this net type.

3.438 Unbridled breeding of *Macaca rhesus* and *Macaca leonina* on Monkey Island is unnecessary since they could transmit disease germs to *Macaca f. fascicularis*, contributing to degrading the indigenous animal species in the future.

3.439 Oil spill: Oil spill in Long Tau River in 1995 and recently in Muong Chuoi canal caused great degradation of aquatic resources, affecting seriously on aquaculture. Oil spill may also occur in Can Gio submerged zone.

3.440 Sea encroaching project has adverse impacts on shell breeds in the locality.

(2) Fauna Diversity in HCMC

(a) Animal Species in HCMC

3.441 34 animal species of 15 families and 7 orders have been recorded in HCMC, including 28 species in Can Gio mangrove forest zone and 26 species in Cu Chi forest. For tourism promotion, three Primates species were imported to Can Gio monkey island namely *Macaca leonine*, *Macaca rhesus* and *Macaca arctoides*. They are rare and precious species in Vietnam and World Red Books. *Pteropus lylei* (Anderson 1908) genus has been recorded in Dam Doi, Vam Sat tourism site, Ly Nhon commune.

3.442 Rare and Precious Species: 7 species are listed in Vietnam Red Book (2007)

3.443 7 species are named in Vietnam Red Book (2007), including *Cynopterus brachyotis*, *Macaca f. fascicularis*, *Lutra lutra*, *Aonyx cinerea*, *Prionailurus viverrina*, *Manis javanicus* and *Ratufa bicolor*.

(b) Bird Species

3.444 Bird Species in Can Gio and Cu Chi Forests: 135 bird species of 43 families and 16 orders, comprising 54 water bird species and 81 clump species, including *Aerodramus fuciphagus*, *Leptoptilos javanicus* and *Anhinga melanogaster*, *Pycnonotus jocosus* and *Ixobrychus cinnamomeus*.

3.445 *Bird Species in Thu Thiem Town*: According to Dinh Quang Diep and colleagues (2009), 19 bird species of 12 families were recorded. Some species are adaptive to urban habitat, including sparrow, yellow-vented Bulbul, *Lonchura punctulata*, etc.

3.446 Rare and Precious Species: 5 species are named in Vietnam Red Book (2007), including *Pelacanus philippensis*, *Anhinga melanogaster*, *Nycteria leucocephala*, *Leptoptilos javanicus* and *Tringa guttifer*.

(c) Reptile and Mammal Species

3.447 Reptile and Mammal Species in Can Gio and Cu Chi: 50 species of 21 families and 4 orders are recorded in HCMC, including 40 species in Can Gio mangrove forest and 39 species in Cu Chi forest.

3.448 Rare and Precious Mammal Species: 11 rare and precious reptile and mammal species are recorded in Vietnam Red Book (2006), including *Gekko gecko*, *Varanus salvator*, *Python molurus*, *Python reticulatus*, *Ptyas korros*, *Coelognathus radiata*, *Ophiophagus Hannah*, *Bungarus fasciatus*, *Chelonia mydas*, *Crocodylus porosus*, *Eretmochelys imbricate*.

(d) Fish Species in HCMC

3.449 Total 145 fish species of 61 families and 17 orders are recorded in HCMC, including 89 species of 55 families and 16 orders in Can Gio mangrove forest, including fresh water fish species, e.g. eel, *Oreochromis niloticus*, etc. *Pseudapocryptes borneensis*, *Lutjanus argentimaculus* and *Anguilla*

marc=morata and *Datnioides polota* are also supplemented. In addition, *Periophthalmodon septemradiatus* (Hamilton) was also found and was not recorded for Vietnam science. This is the first time recording the existence of this species in Vietnam.

3.450 Rare and precious species: 12 species are listed in Vietnam Red Book 2007, including 8 fresh water fish species and 8 brackish and salinity water species. In addition, there is *Proteracanthus sarishophorus* (Canto 1849) in the World Red Book *IUCN, 2009).

3.451 Valuable species: 112 fish species are valuable for economic development, including 89 medium valuable species, 19 high valuable species and 4 supper valuable species, e.g. *Anguilla marmorata* (Quoy and Gaimard, 1824), *Pisoodonophis boror* (Hamilton- Buchanan) and *Proteracanthus sarissophorus* (Cantor, 1849), and *Coiusmicrolepis*.

(e) Degradation of Aquatic Resources

3.452 Coastal Fishing: *Larva* species are killed by small-capacity fishing boats and river-bed nets in small canals in Can Gio mangrove forest. In addition, pulse net is also utilized, contributing to extinction of some aquatic resources.

3.453 Butchering Fishing: Electric pulse is applied to catch fish in rivers and canals in Hoc Mon and Cu Chi. Site survey results show that many people applied this method, including in Binh Duong site bank.

3.454 Water Pollution: Surveys of cage fish breeding in Cu Chi district and Ben Cat district in 2009 and early 2010 show that cage fish breeding in these district is a gambling since the breeding could be affected seriously by wastewater of rubber plant, cassava starch processing plant and other plants. The authority could not control the wastewater discharge since wastewater is often discharged at spring tidal period, especially under heavy rain condition.

3.455 Invading Species: *Hypostomus plecostomus* from South America has been imported to Vietnam for ornamental purpose. This species is also found in rivers and canals, especially in Sai Gon river and tributaries with high density.

(f) Crustacean

3.456 Can Gio submerged zone has 38 *crustacean* species of 19 families, including *Penaeus vannamei* (Boone, 1931) and *Caridina acuminata* (Stimpson, 1860), *Siamthelphusa beauvoisi* (Rathbun, 1902), *Harpiosquilla harpax* (de Haan, 1844), *Oratosquilla oratoria* (De Haan, 1844), *Myomenippe hardwickii* (Gray, 1831). Two new species of *Metaplex gocongensi* (Davie and Nguyen, 2003) and *Thalassina Krempfi* (Nguyen and Laurent, 2009) are supplemented. Moreover, two crab species are also recorded in Can Gio. However, *Techypleus gigas* (Muller, 1785) is threatened seriously due to high market demand with high price (150,000 – 200,000 VND/kg) which shall be listed in the Red Book in the coming years. 29 out of 38 species are valuable species, including 8 high valuable species.

(3) List of Species in Vietnam Red Data Book

3.457 The list of endangered species of HCMC in Vietnam Red Data Book is shown

in Table 3.1.43 on flora, and in Table 3.1.44 on fauna. Though it means the existence of these precious species within HCMC, it does not necessarily mean that habitat of these species will be affected by the HSR Projects. It implies that the potential impact to these species should be well avoided, mitigated or compensated through the EIA study to be conducted in the future.

Table 3.1.43 Endangered Species in HCMC (Flora)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	HCMC
I		Magnoliophyta	NGÀNH MỘC LAN			
I.1		Magnoliopsida	LỚP MỘC LAN			
1	5	<i>Melanorrhoea laccifera</i> Pierre	Sơn tiên	VU	A1a,d+2d, B1+2a	Y
2	36	<i>Spirolobium combodianum</i> Baill.	Luân thù	VU	B1+2b,c	Y
3	92	<i>Millingtonia hortensis</i> L.f.	Đạt phước	VU	B1+2e	Y
4	99	<i>Afelia xylogarpa</i> (Kurz) Craib	Gõ đỏ	EN	A1c,d	Y
5	116	<i>Anisoptera costata</i> Korth.	Vên vên	EN	A1a,b,c+2b,c	Y
6	117	<i>Dipterocarpus dyeri</i> Pierre	Dầu song vàng	VU	A1a,d+2c,d	Y
7	118	<i>Dipterocarpus grandiflorus</i> Blanco	Dầu đọt tím	VU	A1c,d+2c,d	Y
8	123	<i>Hopea pierrei</i> Hance	Kiên kiên phú quốc	EN	A1c,d	Y
9	157	<i>Lithocarpus harmandii</i> (Hickel & A. Camus)	Dẻ se	EN	A1c,d	Y
10	216	<i>Dysoxylum loureiri</i> (Pierre) Pierre	Huỳnh đường	VU	A1a,c,d+2d	Y
11	274	<i>Schoutenia hypoleuca</i> Pierre	Sơn tằm	VU	A1a,b,c,d	Y
II.2		Liliopsida	LỚP HÀNH			
12	394	<i>Stemona pierrei</i> Gagnep.	Bách bộ lá nhỏ	VU	B1+2b,c	Y
II		Pinophyta	NGÀNH THÔNG			
III		Polypodiophyta	NGÀNH DƯƠNG XỈ			
IV		Lycopodiophyta	NGÀNH THÔNG			
V		Rhodophyta	NGÀNH RONG ĐỎ			
VI		Phaeophyta	NGÀNH RONG NẤU			
VII		Mycophyta	NGÀNH NẤM			

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
Source: Vietnam Red Data Book, 2007

Table 3.1.44 Endangered Species in HCMC (Fauna)

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	HCMC
I		Animal	Thú			
1	9	<i>Nycticebus pygmaeus</i>	Cu li nhỏ	VU	A1c,d	Y
2	13	<i>Macaca fascicularis</i>	Khỉ đuôi dài	LR	nt	Y
3	15	<i>Macaca leonina</i>	Khỉ đuôi lợn	VU	A1c,d	Y
4	45	<i>Viverra megaspila</i>	Cầy giông sọc	VU	A1c,d C1	Y
5	49	<i>Prionailurus viverrinus</i>	Mèo cá	EN	A1c,d C1+2a	Y
II		Birds	Chim			
6	91	<i>Pelecanus philippensis</i>	Bồ lông chân xám	EN	A1c,d B2 b, c,e+3b,d	Y
7	113	<i>Aquila clanga</i>	Đại bàng đen	EN	C2a D	Y
8	126	<i>Lophura nycthemera</i>	Gà lôi trắng	LR	cd	Y
III		Reptile -amphibian	Bò sát -lưỡng cư			
III.1		Reptile	Bò sát			
9	171	<i>Python reticulatus</i>	Trăn gấm	CR	A1c,d	Y
10	177	<i>Enhydris</i>	Rắn bông voi	VU	A1c,d+2cd	Y
11	179	<i>Ptyas mucosus</i>	Rắn ráo trâu	EN	A1c,d	Y
III.2		Amphibian	Lưỡng cư			
12	207	<i>Ichthyophis bannanicus</i>	Ếch giun	VU	B1+2a,b,c	Y
IV		Fishies	Cá			
IV.1		Freshwater fish	Cá nước ngọt			
13	219	<i>Chitala ornata</i>	Cá còm	VU	A1a,c,d	Y

Number		Name		Status		Distribution
Serial No	No in Redbook	Scientific name	Vietnamese name	Red List Category	Criteria and Sub-criteria	HCMC
14	230	<i>Cirrhinus microlepis</i>	Cá đuông	VU	A1c,d B1+2c,d,e	Y
15	238	<i>Probarbus jullieni</i>	Cá trà sóc	VU	A1c,d B1+2c,d,e	Y
16	245	<i>Ompok miostoma</i>	Cá sơn đài	VU	A1c,d C1	Y
17	251	<i>Coius microlepis</i>	Cá hương	VU	A1c,d	Y
18	252	<i>Coius quadrifasciatus</i>	Cá hương vện	VU	A1a,c,d	Y
19	253	<i>Toxotes chatareus</i>	Cá mang rô	VU	A1a,c,d	Y
IV.2		Sea fish	Cá biển			
V		Spiniless	Động vật không xương sống			
V.1		Freshwater Spiniless	Động vật không xương sống nước ngọt			
V.1.1		Crutacean	Giáp xác			
V.1.2		Soft species	Thân mềm			
V.2		Sea Spiniless	Động vật không xương sống ở biển			
V.2.1		Coral	San hô			
V.2.2		Echinoderm	Da gai			
V.2.3		Crutacean	Giáp xác			
V.2.4		Soft species	Thân mềm			
V.3		Insects	Côn trùng			
20	387	<i>Lethocerus indicus</i>	Cà cuống	VU	A1 c,d,e C2b,c,e	Y

Note: EW: Extinct in the wild, CR: Critically Endangered, EN: Endangered, VU:Vulnerable.Y: Yes (existing)
 Source: Vietnam Red Data Book, 2007

3.1.9 Natural Hazards

3.458 Characteristics of natural hazards at each province are outlined in Table 3.1.45.

Table 3.1.45 Characteristics of Natural Hazards at Each Province

No	Province/ City	Available documents	Description
7	Khanh Hoa	DOT's Summary Report for the meeting with JST. See heading 1.8 and 1.9 for further detail below.	In Khanh Hoa Province, the period from August to December suffers from the highest number of rains and floods.
8	Ninh Thuan	5ECSR, chapter 8, heading 8.1. Pp.132-144.	Ninh Thuan is located in South Central province of the country, so the province faces significant impacts caused by natural hazards such as typhoons, flash flood, draught, salinity etc.
9	Binh Thuan	Information and monitoring data on landslide and soil erosion can be seen at Chapter IX (page 103 to page 111) of 5ECSR in Binh Thuan Province" in 2005 - 2009 period". Research document: "Natural disasters in Binh Thuan Province and prevention methods". (conducted by Center for hydro-meteorological forecasting of Binh Thuan). Yearly Reports on situation of and response to storms and floods control as well as natural disasters mitigation in Binh Thuan Province (1996, 1997, and every year from 1999 to 2010)	Since in the rainy season of 2009, the rainy-water volume of some locations was lower than the average one of years; in addition, by the end of the year 2009 rainy-season, some zones had no rain or had with an insufficient water volume; so the situation of droughts and insufficient water-volume happened in the dry season which was considered to be relatively seriously
10	Dong Nai	Document prepared by DARD as the follow-up after the meeting with JST. Periodic report of the first six-month of 2011 on the implementation of laws on storms and floods control in Dong Nai Province. Annual report on storms and floods control in 2010 as well as solutions to cope with draught in 2010-2011. See the paragraph below for further information.	Season transitioning period of 2010 started in April, 30th and ended in May, 20th. Rainy season of 2010 lasted 6 months from the end of May to the end of November.
11	Binh Duong	A report prepared by DARD on information including landslide, flood, typhoon, flooding discharge of the national reservoir period 2006-2010, hazard status, production forest and protection forest.	The province has the relatively safe conditions of topography, geology and climate. Thus, there have not been any natural disasters which affect seriously to the local people's life.
12	HCMC	Letter No. 166/CCTL dated Dec.15, 2011 by S-Department on Flood and Storm Control in response of JICA official request letter	Geology, topography, hydrological regime, stream pressure are increasingly complicated. The water level of rivers, canal, and channel is rising up and especially characterized by eastern sea tides

Source: DONRE, compiled by JICA Study Team

1) Natural Hazards in Khanh Hoa Province

3.459 In addition to the central regulations on flood and hurricane, annually, the province issued such document as: Instruction on flood and hurricane prevention and protection; Decision on the establishment and consolidation of the department of flood and storm prevention and protection, directive documents during the inspection of flood and storm prevention and protection, instruction, monitoring in case of floods and storms.

3.460 Rain and flood monitoring in the charge of the Southern Central hydro-meteorological station, it is suggested that the team contact this office for information.

3.461 In Khanh Hoa Province, the period from August to December suffers from the highest number of rains and floods.

3.462 According discussion report for the meeting with JST prepared by DONRE: Natural incidents impacting Khanh Hoa Province include: hurricane, flood; oil spill; land erosion, and soil salinity, etc. In addition, impacts of global climate change are also a

factor causing natural disasters and environmental incidents in Khanh Hoa Province.

3.463 In the Cai river (Nha Trang) and the Dinh river (Ninh Hoa), over the last few years, serious land erosion and slide in the river bank has become an local urgent matter.

3.464 The Cai river (Nha Trang) originates from Chu Giao, Dak Lak Province flows into the East Sea at Nha Trang Gulf. The Cai river is the main source of domestic and production water supply in Khanh Hoa Province. In recent years, river banks have to face with serious land slide and collapse. From 2007 to now large area of residential land, production land of households living along the river has been washed away in every rainy season. Many residential areas, gardens and crop cultivation land in Vinh Thanh, Vinh Ngoc commune (Nha Trang) and Dien Tho commune, and etc. were intruded, adversely affecting the lives of many households.

3.465 In the Dinh river (Ninh Hoa), land erosion in two river banks is also extremely serious, especially in sections which have yet to be protected by embankments in Ninh Xuan, Ninh Phu commune, etc.

2) Natural Hazards in Ninh Thuan Province

(1) Types of Natural Disasters in Ninh Thuan

(a) Drought

3.466 Due to Ninh Thuan Province has the lowest rainfall throughout the country; every year in the dry season, water shortages often occur, seriously affecting agricultural production and daily life activities. The drought has developed in more complicated manner in recent years, due to the abnormal changes of the global climate.

3.467 Drought is always a serious disaster in Ninh Thuan, followed by storms and flooding. Drought is the main reason for declining soil quality; combined with saline the lands of many areas become unusable for agricultural production. The dry season lasts for 7-9 months of the year, and Jan, Feb, March and April of the year are often in severe drought.

(b) Floods

3.468 Ninh Thuan is a coastal province with a coastline of 105 km, so when heavy rains occur in conjunction with high tides, storms and tropical depressions, making flooding worse. In addition, there are a number of other factors affecting the possibility of major flooding as river basins, the density of the forest cover.

3.469 However, most of the storms were not directly influencing to the weather of Ninh Thuan Province or influencing at a weak level. Particularly in 2006, Typhoon No. 9 (December, 2006), Typhoon No. 10 was hitting Ninh Thuan and Khanh Hoa Province in 2008 and Typhoon No. 11 was hitting Khanh Hoa, Phu Yen Province with heavy rain, winds.

(c) Climate Change

3.470 The climate change is a problem that faces the global and Ninh Thuan Province is part of that. The climate change reveals in the rise in Earth's surface temperature, unpredictable storms, extreme drought, sea level rise, resulting in flooding in many areas.

(d) Sea Level Rise

3.471 Ninh Thuan topography is lower from the Northwest to the Southeast, because this is the land at the end of the Truong Son Mountains crashing into the sea. In the long term, sea level rise will affect low areas, especially in the coastal lowland area with an elevation of less than 20m (relatively flat), altering their ecosystem properties. Sea level rise will inundate salt and reduce the area of Thuong Diem salt field, indirectly affecting the lives of salt workers here.

(e) Coastal Erosion-Deposition

3.472 Coastal erosion is natural disaster formed by sea waves in combination with other factors (the increase of storms, rising sea levels, river flow, solidity of the rock shore, human activities, etc.), contributing to the increase or decrease in their intensity. The coastal erosion results in land erosion, loss of housing, environmental destruction and coastal erosion often associates with storms. In Ninh Thuan, Binh Thuan region, coastal erosion tends to become stronger and the erode sections will also increase.

(2) The Damage caused by Natural Hazards in Ninh Thuan Province.

3.473 The damages caused by natural hazards in the period 2006-2010 as summarized in the table below:

Table 3.1.46 Statistics on the Damage caused by Natural Disasters in Ninh Thuan Province in the Period from 2006–2010

Indicator \ Year	2006	2007	2008	2009	2010
Economic welfare					
- The death	1 people	-	5 people	1 people	7 people
- The injured	7 people	-	6 people	1 people	3 people
- The collapsed/unroofed	168 houses	128 houses	377 houses	248 houses	1,947 houses
- The flooded houses	-	1,985 houses	73 houses	563 houses	13,369 houses
On agricultural production	318 million	5,228 million	4.850 million	6.500 million	200 billion
- The area of crops were flooded, damaged	230,70ha	1,781.63ha	3.378,20ha	4,639.05ha	14,011.10
- Livestock, poultry death	-	705 livestock	6,833 livestock	1,376 livestock	138,715 livestock
For irrigation	176 million	2,543 million	7,000 million	26,000 million	200 billion
- Channel erosion and sedimentation	With a volume of 3.336m ³ embanked soils, 2.770m ³ excavated soils, 30m ³ stones and 20.56m ³ concretes by all types.	With a volume of 21,225m ³ embanked and excavated soil, 1.288 m ³ stones, 335 m ³ concrete by types.	With a volume of 28,898 m ³ embanked soils, 85 m ³ stones, 365m ³ concrete by types; 1.670m in length.	With 48,560 m ³ stones, soils va concrete by types; 3,795m in length.	With a volume of 140,130 m ³ stones and concrete by types.
- Embankment erosion	With a volume of 3,336 m ³ embanked soil and 2,770m ³ excavated soil, 30 m ³ stones and 20.56 m ³ concrete by types.	-	1000m (Quao river)	-	390m
- Riverside avalanche	85m	400m (Cai River)			250m
1000m					
On traffic	1,447 million	4,645 million	3,500 million	16,600 million	280 billion
- Road erosion	With a volume of 1,965.5m ³ soil	With a volume of 10,321.97 m ³ soil	With a length of 12,065m and landslide in Ngoan Muc slope at km	With a length of 8.380m and 2,920m ³ roadbed	With a volume of 141,159m ³

Indicator \ Year	2006	2007	2008	2009	2010
			207 + 700		
Aquaculture	117 million	120 million	2,611 million	2,100 million	310 billion
- Eroded shirmp hatching pond	0.8 ha	-	63 ha	13,42ha	-
- Sinking boats/ships		-	2 boats	5 boats	22 boats
- Damaged cartilage	7 tons	-	-		(with an 538.3 ha of aquaculture damaged)
- Sweet snail damage	148ha	-	-		
- Eroded embankment, wall	2.5 tons	-	-		
- Damaged fishy pond	564 ha	-	-		
	0.6ha	1.2 ha	20.7 ha	24ha	
On salt					
- Salt fields were flooded and landslides occurred	-	-	96 ha	63,115 m ³ soils by all types and 1,000 tons crude salt	450.5 ha and 776 tons of crude salt
Other works	1,216 million	78 million	556 million	1,500 million	102 billion
- Broken concrete column	17 pillars	-	-	-	-
- Sketched electricity pillar	-	4 columns	12 columns	2 columns	142 columns
- Damaged, unroofed schools	18 rooms	3 rooms	2 schools, 2 classrooms	2 schools	33 schools
- Unroofed office building	1 rooms	-	1 building	2 buildings	-
The total value of damage (billion VND)	3.38	13,222	20.54	60.25	1,122

Source: Flood and Storm Control Committee of Ninh Thuan Province (2005 - 2010)

3.474 As can be seen from the above table, the level of damage caused by floods was largest in 2010 (1,122 billion), the extent of damage on the economy, agriculture, irrigation, transportation, fisheries and other works was also higher than the previous years.

(3) Change and Damage Caused by Drought

3.475 During the drought of 2005, the total rainfall in the first eight months was 120-160mm, lower the multi-years average from 80-100mm. It led droughts in rivers and streams, ponds and lakes in the province and unable to serve for agricultural irrigation (33,116.66 ha). Therefore, agricultural production in the province faced many difficulties, cattle lacked of food and water.

3.476 In the first eight months of 2006, the drought situation in Ninh Thuan took place on a small local scale, not in serious water shortages as in previous years, little rainfall but steadily over the months. In the dry season (January to August), most parts of the province had higher total rainfall compared the same period of multi-years' average, rainfall in the first eight months of the year in most areas was from 250 - 550mm, with 20-40 days of rain.

3.477 Rainfall in the first eight months of 2007 in most areas of the province from was 350-700mm and unevenly distributed among months. Though the drought of 2007 occurred locally, it caused significant impacts on agricultural production. 12.148 billion VND was spent to dig ponds, wells, dredging and repair of irrigation works, the same as the support for the summer-autumn 2007. In addition, the province had 12.6 tons of rice famine relief to farmers affected by drought.

3.478 During the dry season of 2008 and 2009, there were waves of moderate rains, heavy rain, so there was no drought or lack of water.

3.479 The dry season of 2010 came early, while the hot weather, high temperatures made a large evaporation of water in rivers and streams, ponds and lakes, causing depletion. Damage caused by the drought as follows:

- Agricultural production: 100% total area (940.4 ha) affected by drought (of which: wheat 60.2 ha; chickpeas 152.4 ha; sesame 35ha; Wheat 206.1 ha and Corn 486.7 ha).
- Husbandry: 76 cattle died due to lack of food, drinking water, malnutrition.

3.480 Water levels in rivers and streams hardly change and remain at low level; the monthly average water levels are at approximately higher than the multi-years 'average.

3.481 Vulnerability due to drought in Ninh Thuan may increase further due to the lack of surface water as well as the decline in the capacity of the irrigation system. This is a huge limitation to address the relationship between supply and demand of water resources to serve agricultural production in the province. The capacity of the irrigation system can only satisfy 33% of demand for irrigation.

3) Natural Hazards in Binh Thuan Province

(1) Overall Situation

3.482 In 2010, Vietnam had not only to face to the greatly serious consequences of the climate change but also to be affected directly with two typhoons and two tropical depressions (in this year, there are 8 typhoons and tropical depressions impacts directly to Vietnam). Hence, it can be said that the hydro-meteorological situation of Binh Thuan was so complexly in 2010.

3.483 Since November 2009 to May of 2010, it was the dry season in Binh Thuan. Since in the rainy season of 2009, the rainy-water volume of some locations was lower than the average one of years; in addition, by the end of the year 2009 rainy-season, some zones had no rain or had with an insufficient water volume; so the situation of droughts and insufficient water-volume happened in the dry season which was considered to be relatively seriously. Most of rivers and springs were dried up; in addition, the salinization at riversides seemed to be increased more and more that affected negatively to the production and living activities of many zones of Binh Thuan, especially the northern districts and the provincial central zone, such as: Tuy Phong, Bac Binh, Ham Thuan Bac, Phan Thiet City and Ham Thuan Nam.

3.484 Typhoons and tropical depressions: there are 6 typhoons and 5 tropical depressions which developed on East Sea, especially the tropical depression happened at the middle of Jan 2010. This one caused of 3 dead people and 86 sunk and damaged ships. The total damaged value was estimated to be 32 billion VND.

3.485 The 2010 rainy season of Binh Thuan lasted from the late of May (since May 25th year 2010. This one occurred 15 to 20 days later than the average one of years) and finished by the end of November (at the same finished time of the average one of years).

3.486 The rain volume was distributed unevenly. The total rainy volume of northern area in 2010 was higher than the average one of years; while the one of coastal area and the central zone were medium or small than the average one of years. In addition,

the one of the southwest area was smaller than the average one of years.

3.487 In the early period of the rainy season, there were three rainy times; the rainy volume was distributed unequally in June, July, August (each rainy time lasted 5 to 8 days) and mainly in the central zone and the northern area of the province. This situation made up disadvantages for the crop cultivation.

3.488 The thunderbolts, tornadoes, thunderstorms, locally heavy rains caused of the inundation in many zones in March, May and June. As the consequence, there were 3 dead people, 1 injured person. Many houses, facilities, rice and crop fields, infrastructural facilities were damaged seriously. The damage value was about 12 billion VND in estimation.

3.489 In the flooding season of 2010: in the provincial rivers, there are 2 to 3 major floods, the flood-peaks were in conformity with level II and level III of warned flood water. Particularly, the highest flood-peak on Luy river was higher than level III (be 0.80m higher than the one of level III - occurring in October).

(2) Damages Caused by Natural Disasters

- Indicators of the damages reported in 2010 are as follows.
 - Casualty: 7 people
 - Injured: 1 people
 - Damaged houses: 1,804 houses
 - Killed Cattle and Poultry: 3,287
 - Public works and livestock farms to be blown: 12
 - Total agricultural area of damage: 25,713 ha
 - Area of rice: 7,810 ha
 - Area of cereal crop: 17,903 ha
 - Damaged and sunk vessels: 87
 - Damaged irrigational works: 12HM
 - Total value for damage: 87,748.0 mill VND

4) Natural Hazards in Dong Nai Province

3.490 Rain: Season transitioning period of 2010 started in April 30 and ended in May 20. Rainy season of 2010 lasted 6 months from the end of May to the end of November. Total amount of rainfall from beginning of the year to September 31, 2010, was on average equal to 89% of the whole year's precipitation and 90% rainfall over the same period in 2009. Long Khanh experienced the highest amount of rainfall (122% accumulated average annual rainfall)

3.491 Typhoon and tropical low pressure: In 2010, there were 6 typhoons and 8 tropical low pressures in the East Sea, however, they had little impact on Dong Nai weather.

3.492 Flooding: Water level of the Dong Nai river (in Ta Lai), La Nga river (Phu Hiep) remained low. In Ta Lai, the highest water level in the year was 111.63 m; 0.87 m lower than alarming level 1. This is the year having the lowest water level of all the years from 1980 to present. In Phu Hiep, the highest water level was 104.58 m, 0.08 m higher than alarming level 1. Amount of water from the Dong Nai river flowing to Tri An lake consecutively becomes smaller than average amount of many years. In July and August,

the water amount was only 30% of average amount of many years.

3.493 Tornado: There were 15 tornadoes happening in 7 districts including: Xuan Loc (Xuan Thanh, Xuan Bac, Xuan Tho, Suoi Cat, Xuan Phu commune); Thong Nhat (Bau Ham 2 commune); Dinh Quan (Thanh Son, Phu Loi, Gia Canh commune); Tan Phu (Thanh Son, Phu Dien commune); Long Thanh (Long Duc, Loc An commune); Trang Bom (Bac Son commune); Long Khanh town (Xuan Tan, Xuan An, Xuan Hoa, Xuan Thanh, Bau Tram, Bao Vinh).

5) Natural Hazards in Ho Chi Minh City

3.494 Land erosion: Geology, topography, hydrological regime, stream pressure are increasingly complicated. The water level of rivers, canal, and channel is rising up and especially characterized by eastern sea tides. The change of hydrological regime and hydraulic pressure results in whirlpools that give effects to the areas where the earth ground is soft and provoke landslide.

3.495 Flood: In recent years due to climate change, natural disasters occur erratically and in a complex manner. The natural disasters such as unseasonal rain comes frequent, increased rainfall intensity and rainfall is not similar across regions and time, number of days with rainfall exceeding 100 mm increased.

3.496 Typhoon: Property: The total damage was estimated at 86.36 billion, including damage to residential housing: 40,324 billion VND, schools and health: 8.68 billion; offices: 1,889 billion VND; telecommunications and electricity: 2,511 billion VND; urban transport projects and public works: 1,651 billion VND; irrigation and rural roads: 1,235 billion VND, production establishments: 21.07 billion VND, business services: 9 billion VND.

3.497 People: 1 missing person and 4 people died, plus 2 corpses founded on shore of Long Hoa commune was identified, one belonged to Quy Nhon City, Binh Dinh Province and another from Mo Duc district, Quang Ngai Province.

(1) Flood

3.498 Characteristics of flood in the south section are summarized in Table 3.1.47.

Table 3.1.47 Characteristics of Flood at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	Report No 1971/BC-GTVT-GT regarding to summary of reports prepared by concerned department for the meeting with JICA Study team ISR. 5ECSR 2006-2010.	The period from 2006 to 2009 experiences extraordinary features of rain and flood with early months of each year having to suffer from many waves of rains.
8	Ninh Thuan	Annual reports prepared by the Steering Committee for Storms and Floods Control (from 2005 – 2009).	Flood level on river and stream starts from middle of September to beginning of December. Number of flood is 4-8 at alarm rate I-III.
9	Binh Thuan	"Natural disasters in Binh Thuan Province and prevention methods". (Conducted by Center for hydro-meteorological forecasting of Binh Thuan "Yearly statistic report on specific features of climate and hydro-meteorology in Binh Thuan Province (every year from 1995 to 2010", respectively, as shown in detail below	Comparing with the average one of years, the no. of floods on Luy River and the one on Ca Ty River were more than the average one of years; while the ones of the left rivers were less than the average one of years.
10	Dong Nai	Periodic report of the first six-months of 2011 on the implementation of laws on storms and	Flood: often happens in low-lying area around the Dong Nai river, La Nga River in

No	Province/City	Available documents	Description
		floods control in Dong Nai Province. Annual report on storms and floods control in 2010 as well as solutions to cope with draught in 2010-2011.	such districts as: Tan Phu, Dinh Quan, Vinh Cuu, and Bien Hoa City.
11	Binh Duong	A report prepared by DARD on information including landslide, flood, typhoon, flooding discharge of the national reservoir period 2006-2010, hazard status, production forest and protection forest	In 2010, due to impacts of tropical pressure, there were heavy rains in Southern region; national reservoirs were to discharge flood that provoked flooding in communes locating near the riverbank of the Saigon River, Dong Nai River and Be River.
12	HCMC	Letter No. 166/CCTL dated Dec.15, 2011 by S-Department on Flood and Storm Control in response of JICA official request letter	Factor that cause flooding is a dense network of rivers and canals in the city and lower topography of riparian zone. The total length of rivers and canals is around 3.114km and these rivers and canals are influenced by irregular tide regime.

Source: DONRE, compiled by JICA Study Team

(a) Flood in Khanh Hoa Province

3.499 According to data of department of agriculture and rural development (DARD), regulations on flood are in accordance with the central general regulations. For alarm levels of flood in rivers of Khanh Hoa Province, the PM adjusted regulations pursuant to Decision No 632/QĐ-TTg dated 10/5/2010 as is in the table below.

Table 3.1.48 Alarm Level of Flood in Khanh Hoa Province

River	Alarm levels of flood (m)					
	Alarm Level I		Alarm Level II		Alarm Level III	
	Previous level	Decision No 632/QĐ-TTg	Previous level	Decision No 632/QĐ-TTg	Previous level	Decision No 632/QĐ-TTg
1. The Dinh river, Ninh Hoa	4	4	4,5	4,8	5	5,5
2. The Cai river, Nha Trang	8	8	9	9,5	10	11

Source: DONRE, compiled by JICA Study Team

3.500 These two main rivers are installed with flood monitoring system, managed by the Southern Central hydro-meteorological station. The team is suggested to directly contact monitoring offices for information on monitoring data.

3.501 The period from 2006 to 2009 experiences extraordinary features of rain and flood with early months of each year having to suffer from many waves of rains. Hurricane No.9 in 2006 (Durian) directly affected the southern central provinces, including Khanh Hoa. In 2007, Khanh Hoa was influenced by two hurricanes (No.6 and No.7). High rainfall caused the river water level to rise beyond alarm level II, III. Especially in hurricane No.7, high precipitation combined by flood drainage at the reservoir Ea Krong Rou, Da Ban, water level in the Cairiver (Ninh Hoa) reached and exceeded the alarm level III. Khanh Hoa province in 2008 was directly affected by Typhoon No.10 (Noul). Although the extent of influence was not large, the typhoon caused high rainfall, continuous rain and waves of rains and floods next, which resulted in significant damages to the Khanh Hoa Province. Especially in early November 2009, typhoon No 11 (Mirinae) directly affected Khanh Hoa Province with historically heavy rain and flood, which caused loss of people and property across the province.

3.502 Flood prone areas by communes: Vinh Hiep, Vinh Trung, Dien Toan, Suoi Hiep, Suoi Cat, Suoi, Cam Hiep Bac, Cam Hiep Nam, Cam Phuoc Tay, Cam An Bac, Cam Phuoc Dong, Cam Thinh Dong, Cam Thinh Tay, P. Ba Ngoi (14 communes)

(b) Flood in Ninh Thuan Province

- Current Situation

3.503 Flood season: Flood level on river and stream starts from middle of September to beginning of December. Number of flood is 4-8 at alarm rate I-III (2 floods above alarm rate III).

3.504 The highest flood peak in the year is as follows.

- i. On Cai river Phan Rang in Tan My station, flood peak reaches 39.41m, which is 1.41m higher than alarm rate III at 16:00 01st November; In Phan Rang station, it reaches 5.38m, which is 0.79m higher than alarm rate III at 16:00 01st November.
- ii. On Lu River in Phuoc Huu station, it reaches 14.6m, which is 2.3m higher than alarm rate II at 9:00 in 1 November.

3.505 Flood prone area by communes: Do Vinh, Dao Long, Tan Tai, My Dong, Dong Hai, Phuoc Thanh, My Son, Nhon Son, An Hai, Phuoc Thuan, Phuoc Son, Phuoc Vinh, Phuoc Vinh, Phuoc Dan, Cong Hai, Bac Phong Loi Hai, Xuan Hai, Ho Hai, Tan Hai, Phuong Hai, Phuoc Hoa, Phuoc Chinh, Phuoc Trung, Phuoc Binh(25 communes).

- Damages caused by flood

3.506 With happening of flood, provincial area is waterlogged impacting agriculture production activities and damage of state and citizens' property.

- People's livelihood and economy
- People: Fatality: 7 people and Injured: 3 people
- Housing: Collapsed, damaged, roof-blow up house: 1,974, and waterlogged houses: 13,369.

3.507 Damage on agriculture production is as follows:

- Total area of damaged crop: 14,011.1 ha (rice: 8,002.9 ha, onion and garlic: 128.5 ha, wheat: 333.5 ha, corn: 1,276.4 ha, cane: 27.7 ha, grape and apple: 1,087.1 ha, subsidiary crop: 2,575.9 ha, others: 579 ha).
- Dead and washed over poultry, cattle: 138,715 (cow and buffalo: 461; goat and sheep: 1,928; pig: 2,616; chicken and duck: 133,710)
- Agriculture production land is collapsed, embanked 236.7 ha.

3.508 Damage on irrigation system is as follows:

- Section of 30m length and 14m depth with about 30,000m³ in Phuoc Trung Lake under construction is broken.
- Channel and ditches are collapsed and embanked with length of 93,261km and quantity of 140,130 m³ concrete and stone.
- Girdle shaped dyke is 130m collapsed, collapsed stone embankment is 390 collapsed and river, streamside is 250m collapsed.

3.509 Damage on transportation is as follows:

- Provincial road from 701 to 710, Kien Kien- My Tan route, Binh Tien- vinh Hy route is side eroded, stone is washed out from road bed, erosion overflow 117,339m³; especially Kien Kien- My Tan, Binh Tien- Vinh Hy, Ninh Binh- Phuoc Binh route is divided due to collapse of mountain.
- Inter-commune, interior field road, etc. were collapsed seriously of about 211.156km with quantity of 23,720m³ and 35,080 m² causing traffic interruption in many days.
- Hoa Son hanging bridge of Ninh Son district is collapsed, Ba Tinh bridge of Tan Hai commune is washed out and the railway is 100m³ collapsed.

3.510 Damage on marine transport and production is as follows:

- Drowned and washed out ship and boat: 22
- Damaged aquaculture area: 538.3 ha.

3.511 Others:

- Flooded salt area: 450.5ha, damaged salt: 776 tons; collapsed mountain : 50m; Project for construction and enhancement of water drainage system of Phan Rang- Thap Cham is 4,714 m² collapsed, 4,541m³ embanked; 20,000m³ gradation is overflown, 7,044m fence is fallen, 20 schools are damaged, 13 schools are roof blown up, teaching equipment, toys of 40 schools are damaged, chair and table in 37 schools are lost; 3 hospitals are damaged, medical aid station is damaged; rural living activities water with total length of 6,530m is damaged; 110 telephone poles are fallen, 142 electric poles are fallen etc.,

3.512 Total damage is estimated about 1,122 billion VND.

3.513 In which:

- - Economy livelihood: 30 billion VND
- - Agriculture production: 200 billion VND
- - Irrigation: 200 billion VND
- - Transport: 280 billion VND
- - Aquatic product: 102 billion VND
- - Others: 102 billion VND

(c) Flood in Binh Thuan Province

- Flood status

3.514 The quantity of floods which were monitored along the provincial rivers was 58 in 2010. Comparing with the average one of years, the no. of floods on Luy River and the one on Ca Ty River were more than the average one of years; while the ones of the left rivers were less than the average one of years. The no. of floods on rivers in the year 2010 rainy season was mainly in Jun, Jul, Aug, Oct and Nov.

3.515 The floods occurred on these rivers mainly in Jun, Jul, Aug, Oct, and Nov.

3.516 On Ca Ty river – Muong Man hydrologic station: there were 6 floods

(while in 2009, there were 15 floods and the average quantity of years was 4 floods). For the flood height (H): 1 flood H = 100 cm, 4 floods H = 100 to 200 cm, 1 flood H = 300 to 400 cm, For the warned water level of the flood peak, 6 floods of which the peaks were lower than the level 1.

3.517 On Phan river – Cau 37 station: there were 7 floods (while in 2009, there were 8 floods). For the flood amplitude, 3 floods: H = 100 cm, 2 floods H = 100 to 150 cm, 2 floods H = 150 to 200 cm. For the warned water level of the flood peak, 1 flood of which the peak was higher than the level 1, 1 flood of which the peak was lower than level 1 and 5 floods of which the peaks were higher than level 2.

- On Dinh river – Z30D station: there were 23 floods (in 2009, there were 19 floods). For the flood scale, 3 floods: height (H) = 100 cm, 11 floods: H = 100 to 150 cm, 2 floods: H = 150 to 200 cm, 3 floods: H > 200 cm. For the warned water level of the flood peak, 12 floods of which the flood peaks were higher than the level 1, 4 floods of which the peaks were lower than the level 1, 3 floods of which the peaks were lower than the level 2.
- On La Nga River – at the northwest of the province: the floods on this river mainly occurred in Nov. There were totally 2 floods (in 2009, there were 6 floods, the average quantity of years was 7 floods). For the flood scale, 1 flood: H = 200 to 300 cm, 1 flood: H = 300 to 400 cm. For the warned water level of the flood peak, 1 flood of which the peak was higher than the level 1, 1 flood of which the peak was higher than the level 2.

3.518 The flood was happening in 24 hours from October 22 to 23 for communes and towns along the Luy River. It caused to congestion in 20km in NHIA in area of Song Luy commune and Luong Son town (Km 1635).

- In later October, the flood became over the warning level in basins of Mao River, Da Gia River, Truong An River, Dong River in Bac Binh district and Tuy Phong district. In addition, it was to outlet the flood in order to secure works, housing and agricultural production, aquaculture for Vinh Hao commune, Vinh Tam commune. The heavy rain also caused flood in Ham Thuan Bac district and Ham Thuan Nam district and damaged areas of agricultural cultivation.
- In Duc Linh district, the heavy rain resulted in a widespread flooding in Dong Ha commune, Tra Tan commune, Tan Ha commune, one child was killed by the flood and 188.65 ha of rice and cereal crop was in water.

3.519 Flood prone area by communes: Bac Binh town, Song Luy, Song Binh, Phan Tien, Phan Son, Luong Son, Phan Lam, Hong Thai, Phan Thanh, Cho Lau, Lien Huong town, Phong Phu, Duc Phu, Nghi Duc, Duc Tan, Mang To, Bac Ruong, Dong kho, Me Pu (25 communes).

(d) Flood in Dong Nai Province

- Current situation

3.520 Flood: often happens in low-lying area around the Dong Nai river, La Nga River in such districts as: Tan Phu, Dinh Quan, Vinh Cuu, and Bien Hoa City.

3.521 Flash flood: due to characteristics of rivers and streams in the

province which are steep and have narrow spring beds, flash floods often happen in mid-land area whose terrain is gradually lower like: Long Khanh, Trang Bom, Thong Nhat, Long Thanh, Cam My, Dinh Quan.

3.522 Local flood: often happens in residential areas along NH 20 (in such communes as: Gia Tan, Gia Kiem, Thong Nhat district). Reasons are low quality of drainage system along the road, small culvert openings.

3.523 Water level of the Dong Nai river (in Ta Lai), the La Nga river (in Phu Hiep) remained low; in Ta Lai, the highest water level of the year was 11.63 m, lower than warning level I: 0.87 m. This is the year having the lowest water level since 1980. In Phu Hiep, the highest water level of the year was 104.58, higher than warning level I: 0.08m. Volumetric flow of the Dong Nai river flowing into Tri An lake was continuously lower than average level of many years. Water level in July and August was only equal to 30% of average level of many years.

- Damages caused by flood

3.524 There were 4 floods, among which 1 flood happened in a wide area due to heavy rains from 10th to 14th, October in such districts as: Xuan Loc, Long Khanh, Dinh Quan, Long Thanh, Bien Hoa. Total damages: 1 person dead (lived in Xuan Tho commune, Xuan Loc district), who was swept away by flood when passing through spring in Xuan Bac commune, flooded house: 1,231 houses, people evacuated: 250 people, people engaged in aids and rescue: 242 people, 763 ha rice and second crops were flooded, 43 ha lake ponds were flooded, 200 poultry were swept away, several road sections were flooded and broken (detailed statistics were attached).

3.525 As soon as receiving information on flooding, all local resources and forces: military command, public security, communal militia deployed on the site to support people, and minimized damages. DARD – Standing office of the steering committee for flood and storm control of province and districts, communes timely instruct the tackling of natural disasters and making good of damages.

(e) Flood in Binh Duong City

3.526 In 2010, due to impacts of tropical pressure, there were heavy rains in Southern region; national reservoirs were to discharge flood that provoked flooding in communes locating near the riverbank of the Saigon River, Dong Nai River and Be River.

3.527 Be River: In general, the water level in Phuoc Hoa station in the peak months (August, September and October) was approximate or higher than the alert level. Particularly in October 2006, the hydropower reservoir discharged flood due to heavy rain, the highest water level was at 30.26 m on October 5, 2006, 0.26 m above the warning level II. This has been the highest flood peak for the past 5 years, but still 3.58 m lower than the flood peak in 2000.

3.528 Saigon River: For the past 5 years, the tidal peak is higher the warning level II, III. In Thu Dau Mot, the tidal peak was 1.39m on November 7, 2010 and it was 0.09 m higher than the alert III.

3.529 Dong Nai River: For the past five years, the tidal peak was on the alert I, II. In Bien Hoa, the highest water level caused by hydroelectric flood discharge was 2.06 m on September 2 and it was 0.06 m higher the alert III.

3.530 Dau Tieng Irrigation Reservoir in the Saigon River: In 2006-2009, 15 floods were discharged at the reservoir from 50-400m³/s and in the dry season, it was maintained at 20-50m³/s down to the Saigon River in tidal days in a month to push salt and serve production and people's life at the downstream of the reservoir.

3.531 Tri An Hydropower Reservoir on Dong Nai River: in 3 years from 2006 to 2007 and 2009, there were several flood discharges through the overflow, in which the highest discharging is 2502 m³/s on 30 September 2006. That drifted many shoals of small fish in Dong Nai river, affecting agricultural production and people's life at the downstream. In 2008, 2010 the reservoir discharged no flood through the overflow.

3.532 The three hydropower reservoirs on the Be river (Thac Mo, Can Don, Ho Srok Phu Mieng): in three years from 2006 to 2007 and 2009, the reservoirs discharged several floods over the overflow. The maximum discharge volume of Thac Mo is 700m³/s (September 29, 2007), Can Don reservoir was 1280m³/s (September 10, 2009), Srok Phu Mieng Lake was 1,200 m³/s (September 30, 2006). In 2008, 2010, there were no flood discharge in these reservoirs.

(f) Flood in Ho Chi Minh City

3.533 Latest Municipal Regulations is the Decision No.2440/QD-UBND dated on 17/5/2011 of the Chairman of the PC issuing the prevention plan for active response to inundation due to heavy rains and high tides on the city. Flood monitoring is conducted by the Southern Meteorological Station.

3.534 Flooding Type: Factor that cause flooding is a dense network of rivers and canals in the city and lower topography of riparian zone. The total length of rivers and canals is around 3.114km and these rivers and canals are influenced by irregular tide regime.

3.535 Flooding Areas: Mainly are Thu Du Dist, Tan Binh Dist, Go Vap Dist, Binh Thanh Dist, Binh Chanh Rural Dist, Hoc Mon Rural Dist, Cu Chi Rural Dist, Can Gio Rural Dist, Dist 2, Dist 8, Dist 9 and Dist 12.

3.536 External causes: In recent years due to climate change, natural disasters occur erratically and in a complex manner. The natural disasters such as unseasonal rain comes frequent, increased rainfall intensity and rainfall is not similar across regions and time, number of days with rainfall exceeding 100 mm increased.

3.537 As reported by the Executive Center for Anti-Flood Programs at Document No. 36/TTCN-QLTN 01 dated 12 January 2011, rainfall over the years detailed as below:

3.538 In 2008: there were 152 rains during the middle April to late November. Of which, 66 rains provoked flooding (40mm/1hour), one with the highest rainfall (140mm) and two others with rainfall of 800mm.

3.539 In 2009: Rain occurred early in February and there were totally 150 rains in 2009. Of which, 50 rains provoked flooding and 10 rains with rainfall of 80mm – 120mm (4 rains >100 mm, 3 rains >90 mm and 3 rains >80 mm).

3.540 In 2010: Rain came late in May and high rainfall intensity on a large scale from July to November. In 2010, there were 168 rains, of which 82 rains provoked flooding (up 74.5% compared to 2009).

3.541 Due to the impact of rising sea levels: According to the study of Marine Hydro-meteorological Center, climate change has been affecting the sea level.

3.542 The effect of the tide is more increasing and tide reached a record peak, the later was higher than the former year: Tidal peak was at Phu An (Saigon River) from 1999 to now is moving from 1.40m to 1.58m. Especially in 3 recent years, the tidal peak has always exceeded the warning level III: in 2009 the tidal peak was 1.56m, in 2010, it was 1.55m and in October 2011, it reached 1.58m.

3.543 In November 2008, high tides occurred at the time the storm moved into the continent of South Central region, a prolonged northeast monsoon rose up the sea level, heavy rains at upstream, Dau Tieng Reservoir had to discharge flood with an amount of 400m³/s in 2 hours and it caused flooding in some areas in HCMC.

3.544 To deal with the problem to reduce the discharge of flood damage to downstream areas of Dau Tieng Reservoir, Dau Tieng Irrigation Exploitation One-Member Ltd has developed the emergency response plan Dau Tieng lake (this plan is being completed to submit the MARD).

3.545 Internal causes (for outskirts areas): The planning of tourism - ecological, residential areas along rivers and canals in a number of districts delayed to implement. It leads to embankments in several projects, the planning have not been concerned to strengthen (Ward 28, Binh Thanh Dist, Thu Duc Dist.)

3.546 The construction of a number of drainage projects in urban area is obstructing natural drainage. Funding for routine maintenance of flood control works, irrigation systems, anti-tidal embankments is limited. Neither deploys full potential in the people involved in the management and protection of dyke system. Accessing to scientific and technological applications in operational management, facilities investment towards industrialization and modernization is still restricted, affecting the management and exploitation. Therefore, the operation is still not very effective.

3.547 At present, due to the urbanization of the city seems fast, the extraction of groundwater issues in recent years has affected the land subsidence in some places. The people are not aware to protect the bank protection. Some abuse rivers, channels and canal for aquaculture and discharge garbage and wastes into the water causing obstruction of water drainage.

(2) Landslide

3.548 The characteristics of the landslide in the south section are summarized in Table 3.1.49..

Table 3.1.49 Characteristics of Landslide at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	Report No 1971/BC-GTVT-GT regarding to Summary of reports prepared by concerned Department for the meeting with JICA Study team of HSR. 5ECSR 2006-2010 Report	In the Cai river (Nha Trang) and the Dinh river (Ninh Hoa), over the last few years, the situation of river bank landslide and erosion has become serious one of the most urgent problems in the locality.
8	Ninh Thuan	Annual reports prepared by the Steering Committee for Storms and Floods Control (from 2005 – 2009)	Landslide prone areas by communes: Phuoc Nam, Phuoc Dien, Phuoc Thuan, Phuoc Son, Phuoc Vinh, Phuoc Chien, Phuoc Binh, Phuoc Tan, Bac Phong, Binh Phu, Lam Son, Luong Son. (12 communes)
9	Binh Thuan	5ECSR, chapter XI, heading IX.1, pp. 108-111.	Landslide prone areas by communes: Duc Long ward (Phan Thiet City, Tien Thanh commune, Phuong Loc commune (La Gi town)(4 communes)
10	Dong Nai	Official letter No 1012/2008/SNN&PTNT-TL from Dong Nai DARD to MARD regarding to landslide situation along rivers in the province. Report No 49/2007/BC-PKT prepared by the Economics Division of Vinh Cuu District regarding to landslide situation in Tan An, Hieu Lien and Phu Ly communes as well as resettlement works.	Landslide prone areas by communes: Phu Ly, Tan An, Hieu Lien, Nam Cat Tien, Binh Loi, Tan Hanh, Hoa An, Quyet Thang Ward, Hiep Hoa, Long Binh Tan Ward, Huong Long commune.
11	Binh Duong	A report prepared by DARD on information including landslide, flood, typhoon, flooding discharge of the national reservoir period 2006-2010, hazard status, production forest and protection forest.	Binh Duong Province has no occurrence of landslide but along Saigon River and Dong Nai River.
12	HCMC	Letter No. 166/CCTL dated Dec.15, 2011 by S-Department on Flood and Storm Control in response of JICA official request letter	There are 62 points in risk of landslide such as in District 2 (2 points), District 8 (1 point), District 9 (1 point), District 12 (2 points), Binh Thanh Dist (8 points), Thu Duc Dist (7 points), Cu Chi District (3 points), Nha Be District (19 points), Binh Chanh Dist (4 points) and Can Gio Dist (12 points)

Source: DONRE compiled by JICA Study Team

(a) Landslide in Khanh Hoa Province

3.549 In the Cai river (Nha Trang) and the Dinh river (Ninh Hoa), over the last few years, the situation of river bank landslide and erosion has become serious one of the most urgent problems in the locality.

3.550 The Cai river (Nha Trang) originates from Chu Giao mountain, Dak Lak Province and flows out to the east seain Nha Trang bay, the Cai river is the source supplying domestic waster, production water in Khanh Hoa Province. Over the last few years, many parts of production and housing land have been washed away in rainy season. Large area of housing land and crop fields in such communes as Vinh Thanh, Vinh Ngoc (Nha Trang City) and Dien Tho, and etc. has been intruded, causing negative impacts on residential life. Reason for landslide and erosion is the unplanned exploitation of sand, which commonly happens in the Cai river in Dien Khanh district and Nha Trang City.

3.551 In the Dinh river (Ninh Hoa), landslide along two sides of river banks is happening seriously, especially in rivers sections where dykes have yet to be constructed like in Ninh Xuan, Ninh Phu etc.

(b) Landslide in Ninh Thuan Province

3.552 Little information on landslide found in Ninh Thuan Province except coastal erosion as mentioned in soil erosion part and some landslide prone areas described in the table 3.1.35.

(c) Landslide in Ninh Thuan Province

• Situation

3.553 Red-sand erosion and sediment flood mainly occur in communes as Tien Thanh, Phan Thiet City.

3.554 As the surveyed data, the soil erosion in the studied area is mainly the red-sand erosion combined with the sediment flood.

3.555 The landslide situation of the studied area is summarized with the available documents (to refer the below table)

Table 3.1.50 Some Typical Locations of Red-land Erosion and Sediment Flood in Phan Thiet City and Suburban Areas

No.	Name of locations	Geographical locations	Time	Size of the eroded location (length x breath x depth) – Vm ³	Major causes	Damaged rate
1	Bien Cat (red-sand erosion)	Cat beach, Rom island, Mui Ne ward, Phan Thiet City	before 2005	$V = 400 \times 10 \times 35 \text{ m} = 40,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion ditches, – The saturation of red-sand and water – Degraded vegetation.	Destroyed the ground structure of terrain; Damaged the gardens.
2	Thien Bong Lai (red-sand erosion, sediment flood)	Rang Dong tourism zone, Mui Ne ward, Phan Thiet City	Before 2006	$V = 400 \times 15 \times 30 \text{ m} = 80,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion ditches, – The saturation of red-sand and water Degraded vegetation.	Destroyed the ground structure of terrain; Damaged the gardens; caused of sediment flood.
3	Tien Phu 2 (red-sand erosion, sediment flood)	Tien Phu village, Tien Thanh commune, Phan Thiet City	since 2004 up to present	$V = 50,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion ditches, – The saturation of red-sand and water Degraded vegetation.	Destroyed the ground structure of terrain; Buried houses and roads.
4	Tien Phu 1 (red-sand erosion, sediment flood)	Tien Phu village, Tien Thanh commune, Phan Thiet City	since 2004 up to present	$V = 40 \times 50 \times 25 \text{ m} = 50,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion ditches, – The saturation of red-sand and water Degraded vegetation.	Destroyed the ground structure of terrain; Buried houses and roads.
5	Tien Phu 3 (red-sand erosion, sediment flood)	Tien Phu village, Tien Thanh commune, Phan Thiet City	since 2004 up to present	$V = 30 \times 30 \times 40 \text{ m} = 36,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion ditches, – The saturation of red-sand and water Degraded vegetation.	Destroyed the ground structure of terrain; Buried houses and roads.
6	Tien Phu 4 (red-sand erosion, sediment flood)	Tien Phu village, Tien Thanh commune, Phan Thiet City	since 2004 up to present	$V = 300 \times 5 \times 60 \text{ m} = 90,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion ditches, – The saturation of red-sand and water Degraded vegetation.	Destroyed the ground structure of terrain; Buried houses and roads.
7	Tien Phu 5 (red-sand erosion, sediment flood)	Tien Phu village, Tien Thanh commune, Phan Thiet City	a sinkhole occurring since 1968 up to present	$V = 1,000 \times 450 \times 65 \text{ m} = 29,250,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion ditches, – The saturation of red-sand and water – Degraded vegetation.	Destroyed the ground structure of terrain; Buried houses and roads.
8	Phan Thiet 1 old airport (red-sand)	Tien Duc village, Tien Thanh	before 1990 up	$V = 350 \times 50 \times 30 \text{ m} = 1,400,000 \text{ m}^3$	– Heavy rain, – Slope, the rise of erosion	Damaged Phan Thiet old airport;

	erosion, sediment flood)	commune, Phan Thiet City	to present		ditches, – The saturation of red-sand and water – Degraded vegetation.	Landslide poured down the residential zones which located at the low terrain; Formed a sediment flood which killed 3 people.
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Source: 5ECSR (2005-2009)-DONRE

- Causes

3.556 Major causes of the landslide are summarized as follows.

Table 3.1.51 Some Major Causes of Landslide along Shoreline of Southern Central Region

No.	Causes
I	The reason of geological environment
1	Topographic slope angle and the height of the slope are great
2	Loose sedimentary soil
3	Abrupt changed humidity reduces the cohesive capacity of the soil
II	Internal causes
4	The hoisting movement of layers within the earth for the newly recent tectonics
III	External causes (exogenous causes)
5	Heavy rains, long-period lasting rains
6	Erosion at the slope roots because of the flow
7	Degraded vegetation
IV	Human causes
8	The excavation effects to the slopes
9	Put the additional charge on slopes
10	Deforestation

Source: 5ECSR (2005-2009)-DONRE

3.557 Depending on each specific location or condition, the erosion, landslide and sandy flow, which cause of sediment flood catastrophe, are developed with a group of many reasons which together impact on the studied area, specifically as:

- The external causes are the main causes,
- Geological environment is the potential cause,
- Human activities increase the size and the serious rate of the red-sand erosion and sediment floods.

(d) Landslide in Dong Nai Province

- Landslide Situation

3.558 The inspection and field survey indicated a number of areas of the Dong Nai River having the occurrence of landslides. They are Nam Cat Tien (Tan Phu Dist); Tan Binh, Binh Loi, Tan An (Vinh Cuu Dist), Long Hung (Long Thanh dist); Communes: Tan Hanh, Hoa An, Hiep Hoa and Wards: Hoa Binh, Quyet Thang, Long Binh Tan, Thong Nhat, Tan Mai, Tam Hiep (Bien Hoa City).

3.559 Landslide is found in areas from the Dong Nai River to the junction Hieu Liem - Vinh Cuu district (to the downstream of Tri An hydropower plant) to Long Hung commune (Long Thanh). The most serious case was detected in the area of Bien Hoa City and many communes that have constituted a major of impacts on the lives and activities of people living in riverside areas.

- Causes

3.560 External factors: In recent years, the weather has been becoming more volatile and unpredictable. Rainfall was with a great intensity, concentrated in a narrow area in a short time, resulting in rapid flash flooding, so that it was difficult to prevent local flooding occurred in many parts of the province.

3.561 Overexploitation of forests, especially watershed flood has increased the frequency of flood and its speed

3.562 On the management: There is no management body to be responsible for river protection, management and exploitation. Some rivers are co-managed and exploited by different with many sectors such as agriculture, transportation, construction, industry and local authorities.

3.563 Excessive exploitation activities over coastal area and river include sand mining, shipping, construction

3.564 Construction activities in the upstream pay no attention to the interests of the downstream

3.565 Partial awareness of river protection and exploitation of people and localities where the river goes through

(e) Landslide in Binh Duong Province

3.566 Binh Duong Province has no occurrence of landslide but along Saigon River and Dong Nai River, specific:

- Landslide in the River Saigon

3.567 The Saigon River is passing through 4 districts, namely Dau Tieng, Ben Cat, Thu Dau Mot and Thuan An in Binh Duong Province. The river has a total length of 112 km and there is a national reservoir Dau Tieng. When heavy rain prolongs, the reservoir requires discharging flood to secure safe but provoking the flood in lower areas and riverbank areas. After survey, the riverbank landslide was concluded as follows:

3.568 Thuan An town and Thu Dau Mot town: No landslide

3.569 Ben Cat district: 10 Points of landslide were found in Phu An commune and An Tay commune with a total length of 3,200 m. The length of each landslide section varied from 50-500 m. The depth of landslide was from 2-10 m. The landslide areas were agricultural land and riverbank land and no case of landslide for housing area and protective dyke.

3.570 Dau Tieng district: 45 points of landslide were found in Thanh Tuyen commune, Thanh An commune, Dinh Thanh commune and Dau Tieng town. The total length of landslide was 6,330m and the length of each landslide section ranged from 15-1,000 m. The depth of landslide was from 2-20 m. The landslide areas were agricultural land, riverbank land and no case of landslide for housing or construction works.

3.571 Causes: There are several causes to riverbank erosion (tide, flood, discharge of reservoir.) but the main cause comes from exploitation of riverbed sand and rain. In 2005, the PPC imposed an embargo on exploitation of riverbed sand in Dau Tieng district, Ben Cat district. As a result, the riverbank landslide

became less frequent. Illegal sand exploitation still continued in HCMC and Tay Ninh and often appeared at night alongside the river in Ben Cat district and Dau Tieng district. Since 2009, the illegal sand exploitation has been controlled thanks to patrol and check of functional agencies; however it has not been totally under control.

- Landslide in the River Dong Nai

3.572 The Dong Nai River is passing through Tan Uyen district, Binh Duong Province and the river has a length of 56 km, belonging to the branch of the Be river and there are five reservoirs such as Tri An, Thac Mo, Can Don, Srok Phu Mieng and Phuoc Hoa. When heavy rain prolongs, the reservoir requires discharging flood to secure safe but provoking the flood in lower areas and riverbank areas. Through inspection, there were 350 positions to be found with landslide and 69 households were to relocate. In 2010, there were some points in risk of landslide arising: 15 households (in Lac An commune and Thai Hoa commune) and in 2011, there was 3 more households (in Thanh Hoi and Thanh Phuoc commune) in risky area to be relocated.

3.573 Causes: There are several causes to riverbank erosion (tide, flood, discharge of reservoir) but the main cause comes from exploitation of riverbed sand and rain. The landslide started to occur in 2005 and the severe landslide was in 2 years in 2003 and 2004. In 2005, the PPC imposed an embargo on exploitation of riverbed sand in Tan Uyen district. As a result, the riverbank landslide became less frequent. Illegal sand exploitation still continued and often appeared at night alongside the river in Thanh Hoi commune, Bach Dang commune, in Tan Uyen district. Since 2009, the illegal sand exploitation has been controlled thanks to patrol and check of functional agencies; however it has not been totally under control.

(f) Landslide in Ho Chi Minh City

- Landslide categories

- Riverbank and coastal landslide occurs during March to September when the water level is measured lowest during the year. At this time, tides increase the risk of landslide from 29h PM to 02h AM.
- As reported by the Transport Department and summarized by the Flood Control Committee, there are 62 points in risk of landslide such as in District 2 (2 points), District 8 (1 point), District 9 (1 point), District 12 (2 points), Binh Thanh Dist (8 points), Thu Duc Dist (7 points), Cu Chi District (3 points), Nha Be District (19 points), Binh Chanh Dist (4 points) and Can Gio Dist (12 points)

- Damage by Landslide: Refer to the following list of Damage by Landslide in HCMC from 2006 to 2011.

Table 3.1.52 List of Landslide Damage in HCMC from 2006-2011

Year	Damage				Affected Areas
	People	Property	Agriculture	Land and Structures	
2006	-	<ul style="list-style-type: none"> Housing of collapse and heavy damage: 1 Housing of partial damage: 1 	7.5 ha	<ul style="list-style-type: none"> Eroded embankment: 57m 	District: 12 and Nha Be
2007	-	<ul style="list-style-type: none"> Housing of partial damage: 59 	2.3 ha	<ul style="list-style-type: none"> Eroded embankment: 110m 	District: 12, 8, 2 and Nha Be and Binh Chanh
2008	Injured: 4 people	<ul style="list-style-type: none"> Housing of heavy damage: 5 Housing of partial damage: 12 	-	<ul style="list-style-type: none"> Pool: 385m Landslide: 610 m² 	Dist: Nha Be, Can Gio and Thu Duc
2009	-	<ul style="list-style-type: none"> Housing of total damage: 2 Housing of partial damage: 3 	-	<ul style="list-style-type: none"> Landslide: 4,4048 m² 	Dist: Nha Be, Binh Chanh, Cu Chi, Thu Duc, Binh Thanh
2010	-	<ul style="list-style-type: none"> Housing of total damage: 1 Housing of partial damage: 10 2 scooters, 4 fridges, 3 tivi, 3 speaker, 1 air conditioner, 2 washing machine, 2 sewing machines and other things 	-	<ul style="list-style-type: none"> Area of landslide: 2,802 m² 	Dist: Nha Be, Chu Chi, Thu Duc, and Binh Thanh
2011	Dead: 1	<ul style="list-style-type: none"> Housing of total damage: 10 Housing of partial damage: 3 	-	<ul style="list-style-type: none"> Area of landslide: 4,406 m² 	Dist: Nha Be, Binh Chanh, Cu Chi, Thu Duc, and Binh Thanh
Total Damage by Type of Natural Disaster	Dead: 1 Injured: 4	<ul style="list-style-type: none"> Housing of collapse and heavy damage: 19 Housing of partial damage: 88 2 scooters, 4 fridges, 3 tivi, 3 speaker, 1 air conditioner, 2 washing machine, 2 sewing machines and other things 	9.8 ha	<ul style="list-style-type: none"> -Eroded embankment: 552 m² -Landslide: 11,886 m² 	Dist: 12, 8, 2, Nha Be, Binh Chanh, Cu Chi, Can Gio, Thu Duc, and Binh Thanh

Source: Sub-Department for Flood and Storm Control, HCMC DARD/2011

- **Causes**
 - Geology, topography, hydrological regime, stream pressure are increasingly complicated. The water level of rivers, canal, and channel is rising up and especially characterized by eastern sea tides. The change of hydrological regime and hydraulic pressure results in whirlpools that give effects to the areas where the earth ground is soft and provoke landslide.
 - Such activities as building houses, warehouse, architectural structures and terminal at the edge of embankments, put more load on the soft ground. Subsidence is easy to occur and it destabilizes the slope of riverbanks.
 - Illegal exploitation of sand in the river is also a cause to landslide.
 - Bridge abutments and supports are built to change and prevent the streams.
 - Effect from dredging of riverbed, channel bed and canal bed has damaged breakwater trees along the riverbanks.
 - Navigation of a number of inland waterway means and shipping vessels creates waves and illegal anchorage of vessels and barges damaged the riverbank and breakwater trees.
 - Trees growing along the riverbanks function as breakwater strip but they were destroyed and killed by various reasons.

(3) Typhoon

3.574 The damage by Typhoon in Vietnam is reported mostly in the southern part of the country. Though not so frequent, typhoon damage is reported in all of the city/provinces in the south section, and some large size typhoons are included, such as Thphoon Durian in 2006.

Table 3.1.53 Characteristics of Typhoon at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	DOT's Summary Report for the meeting with JST – heading 1.8 and 1.9. Five-Year Environmental Status Report 2006-2010 Report., Chapter 8, pp. 160-161.	There have been some tropical storms which visited Khanh Hoa during 2006-2010 such as: Storm No 9 (Durian) in 2006, Storms No & No 7 in 2007, Storm No.10 (Noul) in 2008 and Storm No 11 (Mirinea) in 2009.
8	Ninh Thuan	Annual reports on storm-flood control and mitigation of natural disasters (from 1998 to 2010).	Number of storm and tropical depression directly impacts on country is 7-8, number of storm and tropical depression directly impact on Ninh Thuan is 2-4
9	Binh Thuan	Information and monitoring data on landslide and soil erosion can be seen at Chapter IX (page 103 to page 111) of "Report on "Current situation of environment in Binh Thuan Province" in 2005 – 2009 periods". Research document: "Natural disasters in Binh Thuan Province and prevention methods". (conducted by Center for hdro-meteorological forecasting of Binh Thuan).	Typhoons occurred mainly in July, August, October, November and November (averagely there were two typhoons and tropical depressions per month)
10	Dong Nai	Document prepared by DARD as the follow-up after the meeting with JST. Periodic report of the first six-moth of 2011 on the implementation of laws on storms and floods control in Dong Nai Province. Annual report on storms and floods control in 2010 as well as solutions to cope with draught in 2010-2011.	Typhoon and tropical low pressure: In 2010, there were 6 typhoons and 8 tropical low pressures in the East Sea, however, they had little impact on Dong Nai weather.
11	Binh Duong	A report prepared by DARD on information including landslide, flood, typhoon, flooding discharge of the national reservoir period 2006-2010, hazard status, production forest and protection forest.	For the past 20 years, Binh Duong Province has not been influenced directly by tropical pressures and typhoons.
12	HCMC	Letter No. 166/CCTL dated Dec.15, 2011 by S-Department on Flood and Storm Control in response of JICA official request letter	On December 5, 2006, the city was affected by Typhoon No. 9 (typhoon Durian) which caused damage to people and property in the Can Gio district

Source: DONRE, compiled by JICA Study Team

(a) Typhoon in Khanh Hoa Province

3.575 There have been some tropical storms which visited Khanh Hoa during 2006-2010 such as: Storm No 9 (Durian) in 2006, Storms No & No 7 in 2007, Storm No.10 (Noul) in 2008 and Storm No 11 (Mirinea) in 2009.

3.576 In 2006, the storm No 9 (Durian) affected directly provinces in the Southern Central including Khanh Hoa, in 2007, Khanh Hoa was affected by 2 storms (storm 6 and storm 7), high rainfall made river water level raise more than alarming level II, III, especially in the storm No 7, heavy rainfall together with water falling from EaKrôngRou, Da Ban, water level in the Cai Ninh Hoa river exceeded alarming level 3. In 2008, Ninh Hoa was directly affected by storm No10(Noul), although degree of impact was not high but continuing rain impacted Khanh Hoa to some extent. At the beginning of 11/2009 storm no 11(Mirinae) directly affected

Khanh Hoa Province, causing heavy rain in the whole province.

3.577 Storm and heavy rains have caused great damage in terms of people and houses:

Table 3.1.54 Damage Caused by Storms and Rains in the Period 2006–2009

No.	Affected Entities	Unit	2006	2007	2008	2009
1	Human beings:	Person				
	-Death			12	19	14
	-Injured		1	1	1	
	-Lost			1	20	9
2	Housing(Collapsed and broken house)	House	185	336	514	1,279
3	Agriculture:	Ha				
	-Damaged rice		350	1,592	2,769	3,913
	-Damaged Second crop	Poultry/cattle	1,714	3,165	3,240	4,880
	-Dead poultry and cattle				16,236	13,795
4	Aquaculture:					
	- Sinking boats	Piece	3	33	123	100
	- Broken ponds	ha	200	254	780	800
5	Transport:	m ³				
	- Amount of land slided and washed away		500	56,000	92,000	248,000
	- Broken culverts and bridges			41	52	31
6	Irrigation:	m ³				
	- Amount of rocks and soil in irrigation projects, dykes collapsed and deposited.		1,000	49,000	40,000	
	- Small irrigation works broken			29	37	30
Total Damages		Bil VND	22	56	100	450

Source: Sub-Department of Irrigation, Khanh Hoa DARD/2009

(b) Typhoon in Ninh Thuan

3.578 In 2010, there are about 7-10 cold air spells and 6 storms on East sea. These storms and tropical depression do not affect Ninh Thuan weather.

3.579 Forecasting: Number of storm and tropical depression directly impacts on country are 7-8, number of storm and tropical depression directly impact on Ninh Thuan is 2-4.

3.580 From January to August, it is possible to occur 1-2 storms or tropical depression. From September to December, there is 3-4 tropical depression or storm impacting on weather of the province.

(c) Typhoon in Binh Thuan Province

3.581 In 2010, there were 6 typhoons and 5 tropical depressions developed on East Sea (while the average quantity of typhoons and tropical depressions of years was 10 and the one of 2009 was 8). Among, 3 typhoons and 5 tropical depressions affected directly to Vietnam (while the average one of years was 6 and the one of 2009 was 7). The typhoons and tropical depressions landed into Vietnam greater and greater (compared with the previous years). Some of them were strong or very strong ones which was assessed to be the super-storms.

3.582 In 2010, Binh Thuan was affected directly with the tropical depressions which occurred in 18th to 20th of January 2010. The impacted size of this one lasted from Binh Thuan to Soc Trang. Since being affected with this tropical

depression, it rained in many locations of Binh Thuan, among the most heavy rainy volume occurred in Phu Quy island (130,4 mm – on Jan 19th, 2010).

3.583 Excluding the tropical depression happened in the middle of the first week of January, 2010 (the same situation had not happened before), all typhoons developed in East Sea since July (2010) – It was later than the average one of years as well as the one occurring in the southeast provinces and southern ones. The typhoons and tropical depressions finished in December. They occurred mainly in July, August, October, November and November (averagely there were two typhoons and tropical depressions per month); while typhoons or tropical depressions occurred only one time in January, September and December. During period February to June, there were no typhoons and tropical depressions (Table 3.1.46).

3.584 Among 11 above mentioned typhoons and tropical depressions, 4 ones were developed at the west of Pacific Ocean and moved into East Sea, 2 typhoons and 5 tropical depressions were developed directly on East Sea (among, 1 tropical depression occurred directly on the sea lasting from Binh Dinh to Ninh Thuan on November 3, 2010 (Table 3.1.46).

Table 3.1.55 The Quantity of Typhoons and Tropical Depressions Developing on East Sea in 2010

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Tropical depression	1	-	-	-	-	-	-	-	-	1	2	1	5
Storm, typhoons (magnitude 8to 11)	-	-	-	-	-	-	-	2	1	-	-	-	3
Strong storms/ typhoons (magnitude 12 of stronger)	-	-	-	-	-	-	2	-	-	1	-	-	3
Total quantity of typhoons/ storms and tropical depressions	1	-	-	-	-	-	2	2	1	2	2	1	11
Rate (%)	9.1	0.0	0.0	0.0	0.0	0.0	18.2	18.2	9.1	18.2	18.2	9.1	100.0

Source: DONRE

3.585 Among the typhoons and tropical depressions which landed and affected directly to Vietnam in 2010 (3 typhoons and 5 tropical depressions), 3 typhoons developed at the eastern sea of Luzon island of Philippine, 1 typhoon and 5 tropical depressions developed on East Sea.

3.586 These typhoons were strong ones (wind magnitude 9 to 10, and gust 11 to 12) or very strong ones (wind magnitude 12, gust 13 to 14); among, Typhoon 6 (MEGI) was assessed to be the super-storm (wind magnitude 17 and gust 17) which moved fast with 15 to 20km/h of the average speed. Most of the typhoons lasted for 6 to 7 days. Excluding Typhoon 3 and Typhoon 5, these ones lasted for 3 to 4 days. Most of typhoons mainly moved to the direction of west or west-northwest; excluding Typhoon 4 (LIONROCK) which had a complex direction.

3.587 The development progress of some typhoons and tropical depressions which landed into Vietnam in 2010:

3.588 Tropical depression 1: At 13:00 of Jan 18 of 2010, a low pressure developed at the south of East Sea; to the late afternoon of the same date, this low pressure developed to become to a tropical depression. The wind speed at

the core location of the tropical depression was level 6 and hurricane 7 or 8. At 1 pm of Jan 19th, 2010 the coordinate of the tropical depression's core location was 7.8 to 8.1 of the northern latitude and 110.4 to 111.4 of the eastern longitude (at the north of Truong Sa islands). This one moved mainly to the west and northwestern- west direction, its speed was 10 km/h which was faster and faster (15 to 20 km) with the moved direction of northwestern-west and northwest. By the afternoon of Jan 20, 2010, the tropical depression landed into the area of provinces from Binh Thuan to Soc Trang; then it was weaker and weaker to return to a low pressure which continuously moved into the mainland, weakened and disappeared then.

3.589 Being affected directly with the tropical depression, in Binh Thuan, there was rain in some locations on January 19 to 20, 2010. In addition, there was heavy rain in some locations, especially, it rained so heavy in Phu Quy island. The rainy volume was distributed mainly in the central zone and northern one of the province. The wind direction changed since the late afternoon of January 19; the wind magnitude 5 or 6 and the gust 7.

3.590 Typhoon 1 (CONSON): this one developed at the west of Pacific Ocean on July 12, 2010. After damaging the central region of Philippine, the typhoon continuously moved into the East Sea. The core location of CONSON was 14.8 of northern latitude and 119.8 of eastern longitude. At the core of the typhoon, the strongest magnitude was 9 to 10 and the gust was 11 to 12. The typhoon moved to the direction of west – northwest and northwest with 20 to 25 km/h of the wind speed. After landing in Bac Bo bay, its magnitude was 10 to 11 with 12 to 13 of gust; however, CONSON moved slower and slower with 15 to 20 km/h of the wind speed then to the northeast direction. Typhoon 1 landed into Hai Phong – Thai Binh in the evening of July 17th and weakened to be as a low pressure which continuously moved into the mainland and disappeared in the morning of July 18th.

3.591 Typhoon 3 (MINDULLE): The typhoon developed from a low pressure, which started at the eastern area on East Sea on August 21. The moving direction of the typhoon was west – northwest with 15 to 20 km/h of the speed. At the core location of the typhoon, the magnitude was 10 to 11 and the gust was 12 to 13. MINDULLE landed into Nghe An – Thanh Hoa. It weakened and disappeared on August 25. Typhoon 3 caused a great deal of damage to people and houses, crops of Central Region's provinces.

- (d) Tropical depression 4: this one developed from a low pressure at the north of Truong Sa islands on November 12, 2010. At 7 a.m of November 12, 2010, the core location of the tropical depression was 13.0 to 14.0 of northern latitude and 112.0 to 113.5 of eastern longitude which was 410 km far from Quang Ngai – Khanh Hoa beach to the east. The strongest magnitude at the core location of the tropical depression was 6 and the gust was 7 to 8. This one moved slowly to the direction between west and west – northwest with 10 km/h of speed. By the late afternoon of November 14, 2010, the tropical depression landed into Quang Ngai – Binh Dinh and weakened as a low pressure. At 19 pm of November 14, 2010, the core location of the tropical depression was in Kon Tum, Quang Nam and Quang Ngai. The strongest wind magnitude at the core location was 6. Tropical depression 4 continuously moved into the mainland, weakened and disappeared

then.

(e) Typhoon in Binh Duong Province

3.592 For the past 20 years, Binh Duong Province has not been influenced directly by tropical pressures and typhoons.

3.593 In 5 years (2006-2010) 44 hurricanes and 16 tropical pressures attacked on the East Coast, including 17 hurricanes, 9 tropical pressures hit ashore in Vietnam, a direct effect to our country. Such storms as Typhoon No. 9 in 2005 and Typhoon No. 10 in 2008 affected South Vietnam. In general, rainfall in Binh Duong Province for 5 recent years has reached approximately the popular level and higher than the average of many years.

(f) Typhoon in HCMC

- Latest Municipal Regulations

3.594 Decision No.2439/QD-UBND dated May 17, 2011 of the chairperson of the city people's committee on issuing the responding plan to direct typhoons hitting the city.

3.595 Decision No.2441/QD-UBND dated May 17, 2011 of the chairperson of the city people's committee on issuing the safety-guaranteeing plan for people and vessels of aquaculture operation in the city.

- Typhoon Monitoring and Data

3.596 The Southern Meteorological Station conducts the typhoon monitoring for HCMC.

- Typhoon Records for Over 20 Years

3.597 On December 5, 2006, the city was affected by Typhoon No. 9 (typhoon Durian) which caused damage to people and property in the Can Gio district, specifically. The total damage of property was estimated at 86.36 billion, including damage to residential housing: 40,324 billion VND, schools and health: 8.68 billion; offices: 1,889 billion VND; telecommunications and electricity: 2,511 billion VND; urban transport projects and public works: 1,651 billion VND; irrigation and rural roads: 1,235 billion VND, production establishments: 21.07 billion VND, business services: 9 billion VND. Damage of people was: 1 missing person and 4 people died, plus 2 corpses founded on shore of Long Hoa commune were identified, one belonged to Quy Nhon City, Binh Dinh Province and another from Mo Duc district, Quang Ngai Province.

3.598 Remedial work was conducted as follows: 49 people were rescued, in which: 25 people from Can Gio Dist, 24 people from other provinces. The failed power system, fallen trees, damaged schools were repaired and clean. 28 damaged buildings were recovered right in 2006. Of total 3,547 destroyed houses, 2,940 houses were repaired (accounted for 82%) in 2006, the remainders were also repaired in the early 2007. The relocation of the People: 8,329 people were moved to safe shelter from storm.

3.599 Support and aids was provided as follows: By the end of 2006, the Fatherland Front Committee of Can Gio district received more than 9.7 billion

and a food staple of the individual units (the National Front supported 4,179 billion VND). City People's Committee approved to extract 8,666 billion VND from the city budget for Can Gio District, allocated 13.45 billion VND as additional investment fund for Can Gio District in 2007; The city's flood control fund supported 600 million VND).

(4) Other Hazards

3.600 As other hazards, oil spill in Khanh Hoa province, Dong Nai province and HCMC, drought in Ninh Thuan province, sand movement in Binh Thuan province, and others are reported in the provincial reports by DONRE.

Table 3.1.56 Other Hazards at Each Province

No	Province/ City	Available documents	Description
7	Khanh Hoa	DOT's Summary Report for the meeting with JST, heading 1.8 and 1.9. See the paragraph below	In a three year period from 2006 to 2009, in Khanh Hoa, there was no oil spills. However, in April, 2007, an oil streak was discovered to be spilled to the shore in Hon Gon peninsular and clotted oil in beaches in Nha Trang, Doc Let, Bai Dai
8	Ninh Thuan	Partial Information has been found in Report on summary of flood prevention and natural disaster mitigation.	Dry months in 2010 in Ninh Thuan area, the weather is hot, temperature is high, great evaporation dried out water in ponds and lakes. Damage situation of drought is shown below.
9	Binh Thuan	Research document: "Natural disasters in Binh Thuan Province and prevention methods". (conducted by Center for hydro-meteorological forecasting of Binh Thuan).	Other hazards in Binh Thuan Province include oil spill, the red tide, sandy wind, coastal erosion, riverbank erosion.
10	Dong Nai	Five-year environmental status report of Dong Nai Province (2006-2010), chapter 8, pp.138-143.	Apart from the natural disasters hit Dong Nai Province every year, tornados and oil spill are also regarded as typical other hazards. Since boat operation is relatively intensive here, the risk of oil spill on rivers is very high in Dong Nai Province.
11	Binh Duong	Environmental Status Report in the period 2005-2010 of Binh Duong Province.	Owing to proactively conduct well the pollution prevention, Binh Duong has few environmental incidents.
12	HCMC	Five-year Environmental Current Status Report of HCMC (2005-2009), chapter VIII, heading 8.2, pp. 142-144.	Other hazards has been recorded fire incidents, explosion threat and oil spill.

Source: DONRE, compiled by JICA Study Team

(a) Other hazard in Khanh Hoa Province

- Oil spill

3.601 In a three year period from 2006 to 2009, in Khanh Hoa, there was no oil spills. However, in April, 2007, an oil streak was discovered to be spilled to the shore in Hon Gon peninsular and clotted oil in beaches in Nha Trang, Doc Let, Bai Dai. In Bai Ngang, Hon Gam, oil streak density is sparse; pollution scale is not high, covering on a 1 km long sandy beach. On beaches, oil lump is small, with the size from 1 – 2 cm to 3 – 8 cm, appearing in a sparse density, lying on the edge of the water, and concentrating in such locations as:

- Nha Trang beach: clotted oil concentrates in the section from the southern Tran Phu bridge to the Da bridge, and with the density smaller than the northern Nha Trang.
- Doc Let tourism place: clotted oil concentrates on the beach in front of Doc Let tourism place, covering a length of 800 m, inclusive of part of beach in front of Cat Trang tourism place.
- Bai Dai Cam Ranh: clotted oil concentrates on the beach at 2 km north of

Cam Ranh airport.

3.602 As soon as oil was found drifting to the coast, local competent authority mobilized residents, officials, military forces to collect all spilled oil. Tourism enterprises also quickly arranged people at the place of oil collection on beaches under their management right upon oil being found drifting into the coast. Collection was implemented quickly, thoroughly, and safely. As a result, damages from oil spill are not serious.

- Salinity Intrusion

3.603 Salinity intruding deep into inland areas has a negative influence on people's life and production. Along the Cai river (Nha Trang) from Vinh Phuong commune to the river mouth in Xom Bong, Ha Ra bridge, salinity greatly exceed the permitted level. Results of model1D (experimental calculation of salinity intrusion) in the Cai river (Nha Trang) shows that when water level in the river mouth experiences the maximum fluctuation of 0,67 m, salinity in the river mouth shall be 33‰, at the Sat bridge 24.23‰, Go bridge (Vinh Ngoc) 19.23‰ and Vinh Phuong bridge 3.01‰. In case of minimum fluctuation in the river mouth (-0.65 m) salinity decreases but is still high, in the river gate 30.96‰, at Sat bridge là 14.73‰, Go bridge (Vinh Ngoc) 9.71‰ and at Vinh Phuong bridge 0.98‰. According to Model 2D, when water level in river mouth reaches the maximum level, flow to the upstream shall be stronger. Looking at the flow vector chart, it can be found out that there is a change in the flow near Vinh Phuong Bridge. Contour line with salinity of more than 10‰ already intruded further into the Vinh Phuong bridge, contour line with salinity of 14‰ already intruded further into the Sat bridge. When water level reaches the bottom level, contour with salinity of 4, 6, 8, 10 still exists in Vinh Phuong bridge.

3.604 At present, the Cai river is the sole water supply for Nha Trang City with 2 clean water treatment factories namely Vo Canh and Xuan Phong. Vinh Phuong Bridge aimed at preventing salinity intrusion, which has a negative influence on domestic water supply for Nha Trang City.

3.605 In Cam Ranh, almost every river mouth in the area has to face with salinity intrusion of surface water. In rainy season, salinity boundary line is only 1-2 km away from the river mouth; however, in dry season, salinity intrusion boundary line is pushed 5-7 m deep into inland areas. Total mineralization is rather high (3 – 30 g/l), therefore, in many places, cultivation land cannot be used for agricultural purposes. On the other hand, most of deposits making up plains are young ones, good water absorption and severe climate are great obstacles to desalination, creating premise for the salinity intrusion of underground water.

(b) Other hazard in Ninh Thuan Province

3.606 Rainy season in 2009 ended soon (middle November 2009). Rainfall of rainy season in 2009 is from 400-800 mm, which is 100-399 mm lower than average rate in many years and dry season comes soon (end of November 2009). Dry months in 2010 in Ninh Thuan area, popular rainfall is lower than average rate in many years of same period. The weather is hot, temperature is high, great evaporation dried out water in ponds and lakes. Damage situation of drought is as follows:

3.607 Regarding agriculture production: total 100% damaged area of 940.4 ha is caused by drought (rice: 60.2ha, green pea: 152.4ha, cycad: 35ha, wheat: 206.1ha, corn: 486.7 ha).

3.608 Regarding husbandry: there are 76 cows and buffalos died due to lack of food and drink, malnutrition.

(c) Other hazard in Binh Thuan Province

- Oil spill

3.609 The oil exploitation in BinhThuan in the recent years not only make up the national economic values, among including the socio-economic development of BinhThuan, but also have potential risks of marine environmental degradation and pollution.

3.610 The oil spill risks at the southeastern oil exploiting locations in Vietnam sea do not affected to BinhThuan coastal area during the northeastern monsoon period. However, in the end of the northeastern monsoon period (March), since the seasonal-transferring month (Apr) to Southwest monsoon season (May to Sep). The incident of oil spill can affect to BinhThuan's coastal zones and PhuQuyisland as follows:

- If the oil spill occurs at the location of oil drilling flat-forms. The polluted oil following waves will move into the beaches in Mar, Apr, May and last for 5 to 20 days after the date beginning the incident. The remained oil content will be 30 to 60%;
- If the oil spill occurs at the location of oil drilling flat-forms.The polluted oil following waves will move into PhuQuy island in Apr, May, Jun, Jul, Aug, Sep and last for 2 to20 days after the date beginning the incident. The remained oil content will be 40 to 70%;
- If the oil spill occurs along the maritime routes.The polluted oil following waves will move into the beaches in Feb, Mar, Apr, May and last for 5to 20 days after the date beginning the incident. The remained oil content will be 20 to 60%;
- If the oil spill occurs along the maritime routes.The polluted oil following waves will move into PhuQuyisland in Mar, Apr, May, Jun, Jul and last for 2 to 20 days after the date beginning the incident. The remained oil content will be 20 to 60%.

- The red tide

3.611 According to the report of Environmental Protection Branch of Central Region, the maritime water suddenly turned into the red which would be

returned into the dark-blue and turned again into the dark black as the color of sewage-water. The crab, fish, shrimp were dead; the coral reef was also dead with a white performance; the seaweeds and sea-grass were dead, either. Thus, most of aquatic creatures were destroyed. A few days after, this zone was affected with a very terrible bad smell. "the red tide" caused of the above situation which occurred in Binh Thuan's sea for some years ago.

3.612 "Red tide" or "the algal blooms" is named for the surge increase of the maritime alga quantity. "The algal bloom" causes of the colors of the seawater (red, dark blue, gray or sometime "rice bran" color, etc.). The situation "algal bloom" often leads to the decrease of the oxygen within the maritime water that causes the death of many aquatic creatures. "The algal seed is available in the sea-water, so it can "bloom" at any locations where there are advantageous conditions for this situation, such as: the rise of temperature, the poor water-exchange, the increase of environmental nutritional conditions, the marine environment pollution, etc.", said by Dr. Nguyen Ngoc Lam (of Nha Trang Oceanography Institute).

3.613 As the studied result of Nha Trang Oceanography Institute, along Vietnam's inshore areas there are 70 algae which are potentially damaged for the natural environment. It should be focus on the "bloom" of *Phaeocystis Globosa* which often occurs in the sea of Binh Thuan and lasts for over or almost one month.

3.614 The red tide incident starting in the middle of July 2001 covered in a area of 40 km². This situation destroyed 90% of this area's aquatic creatures (including shrimps, fish are feeding in cages along the beach), polluted seriously the environment which had to overcome for months then. This red tide also caused of 82 hospitalized patients who had swum in this area (they were itched and their sensitive skin parts were blistered, because the blue algae "bloomed" and discharged their toxins into the sea-water). It should be focused that the "blooming" of this blue algae (cyanobacteria) also occurs in many fresh-water reservoirs that threatens the people who uses this water sources.

3.615 In the recent years, the red tide has occurred again in Binh Thuan sea (area from Tien Thanh to Mui Ne of Phan Thiet City) and often lasted for 15 days/time; especially, the time in the middle of August 2009.

3.616 With the increase of the tourists as well as the rise water volume discharged into the environment and the rapid development of factories, enterprises, the red tide will occur more frequently and the period of each occurring time will last longer.

3.617 The red tide is considered as a disaster for the coastal biological system as well as for the tourism which have been developing greater and greater in BinhThuan.

- Sandy Wind (moved sand)

3.618 Sandy wind occurs generally in the districts as Tuy Phong (Binh Thanh commune, etc.), Bac Binh (Hoa Thang commune, etc.), Ham Thuan Bac (Ham Duc commune, Hong Son commune, etc.), Mui Ne Phan Thiet.

3.619 This situation happens mainly on the sandy dunes which are located at the height of 15 to 100m. The vegetation is the forests for human livelihood purposes; however, at some location people have deforested for cultivating watermelon and some other annual crops. Hence, the sandy winds can occur greatly in the hot months and drought conditions.

3.620 The moved sand narrows gradually the cultivation area of this zone since the desertification. The moved sand also affects to the traffic activities. The consequences of the moved sand are as follows:

- The local grassroots lose their cultivation area this means that they have no livelihoods, so they will migrate uncontrollably;
 - The water quality;
 - The sedimentation in lakes, ponds, rivers, springs, rivulets;
 - The food production, land productivity and the soil's natural restoring capability will be minimized;
 - The health of the local people.
- Coastal Erosion

3.621 Some only locations in Binh Thuan are impacted with the coastal erosion which affected relatively greatly to the local people's living daily activities as well as to the economic development; specifically such as: the residential zone in Phuoc Hoi ward – Lagi provincial town, the residential zone in Hung Long ward, Doi Duong, Ham Tien – Mui Ne in Phan Thiet City, Phan Ri Cua district town, the erosion zone in Vinh Than commune – TuyPhong district, etc.

3.622 Ham Tien–Mui Ne (in PhanThiet): The beach of Ham Tien–Mui Ne has 10 km of length. In this location, the coastal erosion has begun since 1980, yearly it occurs in July to October (when the wind of which the main direction of southwest and west operates). The eroded coastal section is 4,800 m; the breath of the eroded section (from the sea to the mainland) is 50 to 100 m; the average eroding rate is 4 to 6.5 m/year. The coastal erosion affects to the local people; hundreds of houses have been collapsed and hundreds of households have been removed to another place. In addition, tourism and tourist facilities (hotels, restaurants locating at the coastal range) are also affected with the coastal erosion. Up to present, the province has constructed 1,910 m of embankments which have reduced the coastal erosion which, however, continuously occurs at the locations of embankments.

3.623 Doi Duong (in PhanThiet City): This one locates in PhanThiet bay in which there are a beautiful beach and many important tourist facilities, such as: restaurants, hotels and golf-course. Since 1980, the beach have been eroded greatly that have been serious more and more. The eroded section is 2,000 m of which the breath is 50 to 100 m (from the sea to the mainland). The average eroding rate is 5 m/year. Especially, in Jan to Feb of 2003, the erosion happened with an intense rate that destroyed a series of facilities of the coastal residential zones in Hung Long ward. At present, the sandbags are utilized to be stacked for the coastal erosion prevention; however, this solution is not affective. Hence, the project constructing protective embankments for

Doi Duong has not been finished as well as performed its effect.

3.624 For the morphology, BinhThuan beach has many concave curve sections of which the popularly extended direction is the semi-latitude. For the structure, most of the coastal line is sandy sections, the left one which covers such as small rate is the eruption native-rock coast. The coast is not shielded with the islands badly. With these above mentioned features of the coastal morphology and structure, the coastal erosion occurs relatively greatly. The major features of coastal erosion in BinhThuan are as follows:

- The eroded coast which is divided into many sections is quite long and covers 10 % of total coastal length,
- The coastal erosion is mainly intensive with 5to 6.5m/year of the yearly average eroding rate.
- The average eroded section's breath (from the sea to the mainland) is 50 to 100 m,
- The eroding time is yearly in Sep, Oct, Nov (the serious one is in period 1983 to 1999).
- For the damaged rate: Both Central government and the local government have used a great fund for the embankment construction. The area which has been encroached since the coastal erosion is relatively large. The coastal erosion has collapsed many houses and destroyed many constructional works (traffic and tourist facilities, other embankments). Up to present, the coastal erosion has been threatening the life of people as well as the important infrastructural facilities of the eroded zones (Ham Tien-Mui Ne, Doi Duong).

- Riverbank erosion

3.625 The riverbank erosion occurs mainly along 3 major rivers as La Nga (in Tanh Linh district, Duc Linh), Ca Ty river (the section running through Phan Thiet City), Luy river (in Bac Binh).

3.626 The riverbank erosion along Ca Ty river (in PhanThiet): The river basin's area is 753 km², the length of the major tributary is 56 km. The average breath of the flow is 26.7 m; the river has trend to be expanded to the river-estuary, it is 100 to 200 m at the location of PhanThiet estuary.

3.627 The downstream section of Ca Ty river which runs through Ham My, Phan Thiet City to discharge to the sea via Phan Thiet estuary has 7.2 km of length. The total length of the eroded sections along this river is 2,600 m. The average length of each eroded section is 100 to 300 m, while the width of the eroded section is 10 to 35 m and the depth of the eroded cliff is 1.5 to 1.6m. The average erosion rate is 1.8 to 7 m/year. The erosion degree is from the small one to the moderate one.

3.628 Hung Long section: The eroded cliffs have 1,050 m of length, 1.5 to 1.6 m of depth and 10 to 35 m of width. The erosion coefficient is 36.1 to 38.1 and the average erosion rate is 2to 7m/year.

3.629 The major damages: the riverbank erosion along Ca Ty river, Luy river and La Nga river has destroyed many facilities, roads, houses, the coastal

cultivation areas as well as threaten the life of the coastal population, socio-economic activities in Phan Thiet City.

(d) Other Hazards in Dong Nai Province

- Risks of oil spills

3.630 The regions at which oil spills are likely to occur contain: (1) Ship movements along the routes of Dong Nai include: Dong Nai River, ThiVai River, Nha Be River, Long Tau River; (2) The area of oil, petro and chemical ports: Phuoc Khanh oil port, SCTGAS-VN port and VTGAS port, Superphosphate Long Thanh, Unique Gas factory port. (3) Oil importing facilities, ports and oil stores in Dong Nai; and (4) Oil exploiting activities.

3.631 In Dong Nai, boat operation is relatively intensive. Thus, the risk of oil spill on rivers is very high. At the moment, the level of boat operation in Dong Nai is high while the narrow passages system and maritime safety signal equipment are limited, and then cannot satisfy the demand thus the ability of collision is still high. Besides that, the personal boat operation is still disordered; captains, ship drivers are not formally trained and licensed. Collision and oil spills have the same reasons which are the irresponsibility of ship drivers and lack of skill of ship drivers and captains. The rate of incidents, sinking by collision contributes nearly 100 % among maritime incidents in recent years.

- The current condition of Oil Spill prevention facilities at Dong Nai Ports

3.632 At the present, those ports along Dong Nai River are mostly not equipped with oil spill prevention facilities. Thus, when there is oil spill in Dong Nai area, the recovering activities are slow and less effective due to the shortage of special-used equipment to rescue).

3.633 Some centers participate in oil spill emergency

- In Dong Nai river and Long Tau river: NASOS and Dai Minh Private Enterprise;
- In Thi Vai river: NASOS and Oil – Sea Technical service Co., Ltd (PVD)
- Those facilities are well equipped with special-used equipment to response oil spill incidents. However, those facilities are not located in Dong Nai Province thus from the oil spill starts expanding till they present, oil expands widely and is hard to control, which causes serious damage. Therefore, Dong Nai provincial authority should plan to equip those companies for responding oil spill incidents, chemical incidents; fees and methods for training and professional drill in responding those incidents

- Statistics on oil spills, toxic chemicals and waterway accidents in Dong Nai Province.

3.634 According to the statistics from Ministry of Transportation, the number of maritime accidents in the nationwide decreased in two consecutive years (in 2006: 59 cases, decreased 9 incidents; in 2007: 47 incidents, decreased 12 incidents), in the first period of 2008, the number of maritime accidents increased 6 incidents compared to the same period of 2007, about 27 incidents. The main reason of those incidents, according to the investigation of

maritime incidents, is due to the human factor (shippers are careless, subjective, lack of experience thus they are unable to react immediately in sudden and complicated cases.). Other reasons should be mentioned are old transportation means which are not repair and checked frequently as in regulation; as well as in bad infrastructure; moreover the port bridge is overused with unsuitable capacity, the usual length of the bridges are used up therefore it cannot ensure the essential distance among ships as regulated; supporting facilities do not suit supported ships.

3.635 Besides those reasons, there is another reason which is not highly mentioned but quite essentially. That is the weakness and irregulation in reporting and investigating of maritime incidents.

3.636 Particularly in Dong Nai Province, according to the statistics of Dong Nai Port office, the number of maritime incidents in the period of 2007 to 2008 is 8.

3.637 Among indicated reasons causing oil spills and maritime incidents in Dong Nai Province, the main reason is resulted in the ship incidents (cutting the mooring rolls, ships or ship anchors collisions). Several serious maritime incidents cause oil spill in rivers within Dong Nai River; the damage statistics and solution's results are illustrated below:

3.638 Khanh Hoi 7 ship sank in Dong Nai port bridge after loading goods

3.639 Khanh Hoi 7 ship (belongs to Nha Rong Maritime Transportation and Trade Co., Ltd, No. 42 Hoang Dieu, District 4) with 1,181-ton load suddenly capsized at K3 port bridge in Dong Nai port, Long Binh Tan ward, Bien Hoa City, Dong Nai Province at 23h on 28th June in 2007.

3.640 Mr. Huynh Tien Dung was the ship-owner; the ship reached Dong Nai port for loading 900m³ of timber and kept waiting to 29th June to leave for QuyNhon. Most of the timber after being capsized were expanded into Dong Nai River and impacted the movement flow of other maritime means along this river.

3.641 (Four ships of Dai Minh Oil Spill Rescuing Company was floating to cover oil spill from Khanh Hoi 7)

3.642 Right after the incident, Dong Nai Port JSC (the port manager) and Dong Nai Port Office assigned Dai Minh Oil Spill Rescuing Company to solve the problem of oil spill.

3.643 According to Dai Minh Company, the accident had released about 15,000 liter of DO oil and 200 liter of petro from Khanh Hoi 7 ship. The four ships of Dai Minh Company with 15 rescuers did float 300m of floating fin, oil permeating fin and bump those oil onto the water, prevent it from expanding on Dong Nai River. Simultaneously, a diver group of Dai Minh Company started to investigate the sunken ship.

3.644 Those divers sealed the oil and petrol pipe within the ship's motor in time in order to prevent oil from expanding to the outside environment. Salvaging the ship was very difficult because it capsized at sideways.

3.645 It was estimated that this accident damaged more than 2 billion VND. Besides that, the ship capsized at the port bridge thus it impacted seriously other uploading and loading activities of Dong Nai Port JSC. One more threat was that at tidal period, the water-flow could push Khanh Hoi 7 ship to flow close to Dong Nai piers (50m far from it to the upper direction) which was very easy to cause collision.

3.646 Ship-owner and good-owner had managed, hired a professional team to plan the salvage of good and ship. According to some experts, it was likely that Khanh Hoi 7 ship had overloaded, therefore when the tide receded the ship's hips touched the river bank then the ship was out of balance and capsized.

3.647 The incident of DO oil spill in river of Tan Mai Group JSC

3.648 When pumping FO oil into the fuel tank of Tan Mai Group JSC (Tan Mai ward, near Dong Nai River, at Bien Hoa area), the oil pipe on Dang Giang Transportation Co., Ltd barge was suddenly broken and caused oil spill in the river.

3.649 Upon the detection of the incident at 13:00 on November 15, 2006; the barge was stopped pumping and carried out the suction of the spilled oil in the river.

3.650 Although the amount of spilled oil was not much, that incident made the local people nervous because near the scene of oil spill there were about 100 fish cages of 32 households at Tan Mai ward with tons of fish. This oil spill could lead to water pollution in rivers, impacting those fish cages and brought a huge damage of the local economy. In recent years, factories in Bien Hoa 1 Industrial Zone had not treated the wastewater well, caused the chemical leakage into Dong Nai River and affected the fish cages seriously as well as polluted the Dong Nai water sources at Bien Hoa area.

- Oil spill at Bien Hoa Sugar Company

3.651 On January 20, 2006, when an oil ship was pumping oil into the tank of Bien Hoa Sugar Company in Bien Hoa 1 Industrial Zone (Dong Nai), an oil pipeline was leaked, causing oil spill to flowing along water canal into Dong Nai river.

3.652 Many people near the canal did collect about 2,000 l of oil; however, there is still a large amount of oil inside the exhaust expanding to Dong Nai River. This is the first oil spill to Dong Nai River in the province.

3.653 According to the inspector from Dong Nai Department of Natural Resources and Environment, the oil spill occurs because of the pressure during oil bumping from Oil ship while the oil pipes of Bien Hoa Sugar Company are too old, and are not usually maintained thus broke.

3.654 Though the pollution existing surrounding Bien Hoa Sugar Company has not been defined and so are the sources of Dong Nai River, some carps raised in fish cages at Tan Mai ward, Bien Hoa City died.

3.655 Tornado: There were 15 tornadoes happening in 7 districts including: Xuan Loc (Xuan Thanh, Xuan Bac, Xuan Tho, Suoi Cat, Xuan Phu commune); Thong Nhat (Bau Ham 2 commune); Dinh Quan (Thanh Son, Phu Loi, Gia Canh commune); Tan Phu (Thanh Son, Phu Dien commune); Long Thanh (Long Duc, Loc An commune); Trang Bom (Bac Son commune); Long Khanh town (Xuan Tan, Xuan An, Xuan Hoa, Xuan Thanh, Bau Tram, Bao Vinh).

(e) Other Hazards in Binh Duong Province

3.656 Owing to proactively conduct well the pollution prevention, Binh Duong has few environmental incidents. During period 2005 – 2010, there was only one which was the broken embankment of the biological waste-water treatment reservoir of Vietnam Sanmiquel Foods Company. The major cause is that the co. had not cared of the waste water treatment system; while the rainfall volume in July of 2009 was huge. The water level rose highly that led to the broken embankment of the biological reservoir on July 25th, 2009. Therefore, over 230,000 m³ of waste water overflowed to Ben Van Spring and polluted the water environment, damaged and affected to the aquaculture and crops of some farmer households in the zone. After the incident, Binh Duong People's Committee directed the provincial departments, sectors to coordinate with Vietnam San Miguel Foods Company in overcoming promptly this situation; so the environmental and property damages caused by the incident were minimized.

(f) Other hazards in Ho Chi Minh City

- Fire Incident

3.657 Fire incident could occur in production environment where gaseous substances are accumulated. Explosive gases are characterized by combustible temperature and concentration of combustible gas. The minimum concentration, where combustion and explosion could occur, is lower bound while the maximum concentration where combustion and explosion could occur, is upper bound. The concentration between lower and upper bounds are fire and explosion distance.

- Oil Spill

3.658 Oil spill means oil dispersion to environment unexpectedly. Oil spill is classified to three levels as follows:

- Small-scale: the spilled volume is <7 tons
- Medium-scale: the spilled volume is 7 tons to 700 tons
- Large-scale: the spilled volume is over 700 tons
- Heat Pollution: Some measures are applied to identify heat pollution risks, including Hazard and Operability Study (HAZOP), Structure What If (SWIFT) which are detailed in environmental incident documents.
- Pollution Dispersion Threat: Pollutants dispersion is process where pollutants are diluted to environment. Pollutants affecting to ambient environment depends on space and temporal.

3.659 The dispersion flow is as follows: molecules are moved freely in a small space and could be separated from that space. If the space is small the separated molecules will move to other space and vice-versa. Number of separated molecules will be higher if their density is higher and vice versa. Low-density molecules spaces will receive more molecules.

- Oil Spills in HCMC

3.660 Sai Gon – Nha Be Rivers are primary waterway routes of HCMC, playing significant roles in the city economic and tourism development, promoting freight and fuel transport between HCMC and Southeast region provinces (Dong Nai, Vung Tau, Binh Duong, etc.) as well as between HCMC and Mekong River Delta. Various waterway accidents were recorded, including ship crash due to complex current flow, uncontrolled fuel pumping, fuel scrap discharging, etc. Oil spill incidents have been occurred in Sai Gon – Nha Be Rivers in 205-2009 as follows:

Table 3.1.57 Oil Spills in HCMC, 2005-2009

No.	Oil spill incident	Date	Time	Spilled volume	Location
1	Crash between Kasco Oil Tank (30,000 tons DO) with the wharf	Jan. 21, 2005	-	100 tons	The wharf of Sai Gon Petro oil refine plant (Thanh My Loi ward, District 12)
2	Crash between Ho Tay ship with HamLuong ship	Apr. 6, 2005	-	Oil tank broken, 40 m ² DO	Long Tau river, Thieng Lieng area, Can Gio district
3	Hoang Dat ship crash and shipwreck	May 15, 2007	-	2 tons	Lotus port
4	Duc Tri shipwreck	Mar. 8, 2008	-	1,700 tons FO oil	Lagi Binh Thuan flowing to Vugn Tau
5	QC Vision ship and Vietransimex 5 ship crash	Apr. 9, 2008	2:00	Oil leakage	Shipmarin port, Phu Thuan ward, district 7
6	Gia Dinh oil tank ship and Inmextran 16 ship crash	Nov. 26, 2008	21:30	12 m3 spilled oil	Thieng Lieng village, Thanh An, Can Gio
7	Lady Belinda ship wreck	Sept. 21, 2009	14:00	17 m3	Buoy No. 8, Soai Rap River
8	Long Phu Ship I	Nov. 26, 2009	22:00	750 tons gasoline ship fire (50,000 liter fire and leakage)	Tac Roi river, Tam Thon Hlep commune, Can Gio
9	MSC KiWi ship	Feb. 16, 2010	-	Broken of oil storage tank	Cat Lai port

Source: 5ECSR 2005-2009, HCMC DONRE

3.2 Living Environment

3.2.1 Air Quality

3.661 The provincial/city regulation on air quality monitoring does not exist. The QCVN 05, 06:2009/BTNMT is applied instead to identify the air pollution in their provinces/cities. For comprehensive view, the monitoring system is summarized as shown in Table 3.2.1. It depends on the requirement of each province; a number of parameters, locations and frequencies are also differentiated accordingly.

Table 3.2.1 Monitoring System of Air Quality at Each province

No	Prov/City	Location	Frequency	Method	Equip.	Description
7	Khanh Hoa	Ancient citadel Dien Khanh, areas in Binh Tan, Dong De (Nha Trang), Vinh Hoa residential area, Dac Loc IZ, Van Gia town Van Phong International transit-economic zone, Ninh Hoa town, My Giang residential area, T-junction in Dien Khanh, Khanh Vinh, To Hap, Cam Ranh, Dien Phu IZ, Cam Lam DPC, Suoi Dau IZ, Ru Ri, Luong Hoa, Van Ninh, Cam Ranh, Ninh Ich landfills,	Four times per year	Samples are surveyed, measured and collected at target sites, then analyzed at laboratory of Environmental Monitoring Center under Khanh Hoa DONRE	Specialized equipments	6 main parameters (Dust, SO ₂ , NO ₂ , HC, CO and NH ₃) are analyzed in conformity with QCVN 05: 2009/BTNMT to identify the pollution of air quality.
8	Ninh Thuan	Industrial zones and industrial clusters such as Thanh Hai, Thap Cham, Du Long. Urban areas including Tan Son, Phuoc Dan, Khanh Hai, Loi Hai, Phuoc Nam, Phuoc Dai, Thanh Hai and Ca Na and some main roads inside the city Phan Rang-Thap Chap.	Four times per year	Samples are surveyed, measured and collected at target sites, then analyzed at laboratory of science, technology and environmental management institute- HCMC University of Industry.	Special equipments	5 main parameters (Dust, SO ₂ , NO _x , CO and THC) are analyzed in line with QCVN 05: 2009/BTNMT to identify the pollution of air quality.
9	Binh Thuan	Air pollution is originated mainly from three sources; Industrial zones/clusters (old and new IZs, craft villages etc), transportation, activities of urban and infrastructure construction and residential areas.	For times per year	Samples are collected periodically and analyzed at the laboratory of the Environmental Monitoring Center under Binh Thuan DONRE.	Specialized equipments	5 main parameters (Dust, CO, SO ₂ , NO ₂ , H ₂ S) are collected at each location and analyzed pursuant to QCVN 05: 2009/BTNMT to identify the pollution.
10	Dong Nai	Monitoring activities are conducted mostly in main three locations; industrial zones/clusters, transportation sites and residential areas including Bien Hoa City, Long Khanh, Vinh Cuu, Tan Phu, Dinh Quan, Xuan Loc, Trang Bom, Thong Nhat, Long Thanh, Nhon Trach Cam My.	Four times per year	Samples are collected at the target sites and analyzed at the laboratory.	Specialized equipment	4 parameters were analyzed; dust, CO, NO ₂ and SO ₂ in accordance with QCVN 05: 2009/BTNMT to identify the air pollution in the province.
11	Binh Duong	Vulnerable locations: traffic sites, densely residential areas, industrial zones/clusters and craft villages	Four times per year	Sample are collected and analyzed at the laboratory.	Specialized equipments	5 parameters (Dust, SO ₂ , NO _x , CO and CO ₂) are analyzed in line with QCVN 05: 2009/BTNMT.
12	HCMC	Monitoring activities are conducted automatically in 9	Four times per year	Collecting samples periodically at the	Specialized equipments	5 main parameters are analyzed: dust, Pb, CO,

No	Prov/City	Location	Frequency	Method	Equip.	Description
		locations: Tan Son Hoa, 56 Truong Quoc Dung str., Thu Duc, DPC No.2, Quang Trung Soft park, Thao Cam Vien (Zoo), DOST (244 Dien Bien Phu), Hong Bang High school (Dist.5), Thong Nhat hospital (Tan Binh Dist.), DOET Binh Chanh Dist. And 6 other semi-automatic stations; Hang Xanh crossroad, Dinh Tien Hoang intersection (DBP), Phu Lam, An Suong rotation points, Go Vap crossroad and Nguyen Van Linh intersection (Huynh Tan Phat).		target sites and to be analyzed at the Laboratory of HEPA (HCMC Environmental Protection Agency under HCMC DONRE.		NO ₂ , SO ₂ , O ₃ in conformity with QCVN 05: 2009/BTNMT to identify the air pollution in the city

Source: DONRE, compiled by JICA Study Team

3.662 Due to the rapid urbanization and industrialization, air pollution is regarded as one of the pressing problems of the environment in Vietnam now. Air pollution concentrates mostly on densely populated areas, roadsides, industrial zones, craft villages etc. Since the huge parameters were analyzed, only main parameters are displayed in Table 3.2.2 as typical cases.

Table 3.2.2 Typical Result of Air Quality

No.	Province/city	Dust (mg/m ³)	Temp. °C	Humid (%)	CO (mg/m ³)	NO ₂ (mg/m ³)	SO ₂ (mg/m ³)	Source/ year
	QCVN 05, 06:2009/BTNMT	0.30	-	-	30.0	0.20	0.35	
7	Khanh Hoa	0.36-1.35	-	below	below	0.003-0.006	0.060-0.085	ECSR/2006
8	Ninh Thuan	0.18-0.80	-	-	5.0-14	0.10-0.26	0.2-0.41	5ECSR
9	Binh Thuan	0.02-0.24	-	-	below	below	below	5ECSR
10	Dong Nai	0.07-1.63	-	-	2.0-29	0.007-0.043	0.015-0.15	SR/2009
11	Binh Duong	0.18-0.62	-	-	below	below	below	5ECSR
12	HCMC	0.39-0.91	-	-	14-19	0.21-0.31	-	5ECSR

Note: "-"not specified, "5ECSR":Five-Year Current Status Report

Source: DONRE, compiled by JICA Study Team

3.2.2 Surface Water Quality

3.663 Similarly, the provincial regulation on surface water quality does not exist, either. As shown in table 3.2.2, QCVN 08:2008/BTNMT issued by national level are used instead to identify the pollution of surface water. It depends on each province/city, locations, frequencies, methods and a number of parameters are required differently.

Table 3.2.3 Monitoring System of Surface Water Quality at Each Province

No	Prov/ City	Locations	Frequency	Method	Equip.	Description
7	Khanh Hoa	Stations at Rivers, streams, lakes, ponds, industrial zones/clusters including Thanh Minh, Binh Tan and Duc My bridges, Nha Trang and Ninh Hoa steel bridges, Nha Trang garment and textile, Bay Xa, Dong Trang dams, Ong Cua drainage, Suoi Dau near Vo Canh water treatment plant, Ta Ruc, Hoa Son, Da Ban and Cam Ranh	12 times per year	21 samples are collected periodically at the targets and analyzed at the laboratory of environmental monitoring center under Khanh Hoa DONRE	N/A	16 main parameters are analyzed in accordance with QCVN 08:2008/BTNMT to identify the pollution in the province.
8	Ninh Thuan	26 locations in Cai river Nam, Bac canals and fishing port; Ca Na, Dong Hai, Ninh Chu, Minh Tan.	12 times per year	N/A	N/A	9 main parameters are analyzed based on QCVN 08:2008/BTNMT to identify the pollution in the province.
9	Binh Thuan	Monitoring locations; mostly in Luy, La Nga, Cai Phan Thiet, Song Long Song, Ca Ty, Phan Dinh rivers and other lakes/ponds in the province.	Four times per year	Samples are collected periodically and analyzed at the Laboratory Binh Thuan environmental monitoring and analysis center under DONRE	N/A	6 main parameters (pH, BOD ₅ , TSS, NO ₂ , NH ₃ , and coliform) are analyzed and based on QCVN 08:2008/BTNMT to identify the pollution in the province.
10	Dong Nai	Monitoring locations: mostly in rivers, streams, lakes/ponds including Dong Nai, Thi Vai, Dong Mon, Buong, La Nga, Go Gia, Dong Tranh, Long Tau rivers and Tri An, Long An, Suoi Vong, Cau Moi Suoi Tre, Gia Ui, Nui Le, Da Ton Thanh Nien Song My lakes/reservoirs and Linh, Chua, San Mau, Ba Lua, Siep, Nuoc Trong Gia Mang streams	Four times per year	Samples are collected periodically and analyzed at the Laboratory Dong Nai environmental monitoring and analysis center under DONRE	N/A	6 main parameters: DO, BOD ₅ , COD, TSS, NH ₃ , NO ₂ and Fe are analyzed and based on 08:2008/BTNMT to identify the pollution in the province.
11	Binh Duong	Monitoring locations: mostly in rivers, streams, lakes/ponds and reservoirs including Sai Gon river (SG1, SG2 and SG3), Dong Nai river (DN1, DN2 and DN3), Be river, Cat, Siep streams, Cau Ong Co, Suoi Cat, Ong Danh Suoi Sip canals.	Four times per year	N/A	Specialized equipments	3 main parameters are analyzed and based on 08:2008/BTNMT to identify the pollution in the province.
12	HCMC	30 locations: Mostly in Sai Gon and Dong Nai rivers consisting of Phu Cuong, Binh Phuoc, Phu An, Hoa An, Cat Lai, Binh Dien, Nha Be, Ly Nhon, Tam Thon Hiep, Vam Co, Ben Cui, Ben Suc, Thi Tinh, Rach Tra, Thay Cai, An Ha, Canh Dong WTP, Dong Tranh, Nga Bay and Cai Mep estuaries and canal system in urban areas.	Four times per year	Samples are collected periodically and analyzed at the Laboratory HCMC environmental protection agency under HCMC DONRE	Specialized equipments	8 main parameters (pH, salinity, DO, COD, BOD ₅ , oil, coliform and Mn are analyzed in conformity with 08:2008/BTNMT to identify the pollution in the province.

Note: "N/A": No information available in the reference document

Source: DONRE, compiled by JICA Study Team

Table 3.2.4 Typical Result of Surface Water Quality

No	Province/city	pH	DO (mg/l)	TSS (mg/l)	BOD ₅ (mg/l)	COD (mg/l)	NH ₄ ⁺ (mg/l)	NO ₂ ⁻ (mg/l)	NO ₃ ⁻ (mg/l)	Coli (MPN/100ml)	Source/year
QCVN 08:2008/BTNMT		5.5-9	≥ 4	50	15	30	50	0.04	10	7500	
7	Khanh Hoa	6.9-7.3	5.8-7.2	32.3-45.3	2.4-8.1	12.1	34.3	0.011	0.210	7225-46868	5ECSR/2009
8	Ninh Thuan	7.2-7.4	6.3-7.2	1.2-4.0	1.0-1.8	-	0.07-0.50	0.007-0.014	0.12-0.13	14000-55000	SR/10
9	Binh Thuan	6.25-8.45	≥ 4	<50	<15	<30	<50	<0.04	<10	<7500	5ECSR/2009
10	Dong Nai	-	2.3-4.9	19-134	4.0-9.0	66-204	-	0.086-0.118	-	-	5ECSR/2010
11	Binh Duong	-	2.9-4.2	-	-	11-15	-	-	-	-	5ECSR/2009
12	HCMC	6.2-7.0	2.2-5.1	-	2.6-3.5	5.9-6.2	-	-	-	1324-183124	5ECSR/2009

Note: "-"not specified, "5ECSR": Five- year environmental status report, "SR" Summary Report
Source: DONRE, compiled by JICA Study Team

3.2.3 Groundwater Quality

3.664 Table 3.2.5 shows monitoring system of groundwater quality at each province.

Table 3.2.5 Monitoring System of Groundwater Quality at Each Province

No	Prov/City	Locations	Frequency	Method	Equip.	Description
7	Khanh Hoa	Monitoring locations are conducted mostly in two areas; surrounding areas near Huyndai Vinashin ship building (Nix waste store) and My Giang residential area (digging and drilling wells).	Four times per year	Samples are collected periodically from wells and analyzed at the laboratory of environmental monitoring center under DONRE	Specialized equipments	13 main parameters are analyzed in line with QCVN 09:2008/BTNMT to identify the pollution in the province.
8	Ninh Thuan	Households in Phuoc Huu, Thanh Hai, Phuong Minh, Phuoc Son, Phuoc Thuan, Van Hai communes, residential area An Dat,	Four times per year	Samples are collected periodically from households' wells and analyzed at the laboratory of science, technology and environmental management institute- HCMC University of Industry.	Specialized equipments	6 main parameters (pH, NO ₂ , CaCO ₃ , Cl ⁻ , Coliform) are analyzed in accordance with QCVN 09:2008/BTNMT to identify the pollution in the province.
9	Binh Thuan	Monitoring locations; mostly in coastal tourism sites and some wells in rural areas of the province.	N/A	N/A	Specialized equipments	8 main parameters (pH, NaCl, NO ₃ , SO ₂ , As, Hg, Fe and coliform) are analyzed in line with QCVN 09:2008/BTNMT to identify the pollution in the province.
10	Dong Nai	6 Monitoring locations and 13 drilling holes: mostly in Nhon Trach, Long Khanh, Dinh Quan, Long Thanh, Thong Nhat and Trang Bom).	Four times per year	32 samples are collected in rainy and dry seasons and then analyzed at the laboratory of environmentally technical center under DONRE	Specialized equipments	12 main parameters; are analyzed in conformity with QCVN 09:2008/BTNMT to identify the pollution in the province.
11	Binh Duong	N/A	N/A	N/A	N/A	8 parameters are analyzed and based on QCVN 09:2008/BTNMT to identify the pollution of ground water in the province.
12	HCMC	16 monitoring stations; mostly in landfills, factories, parks, racing schools including Dong Thanh, Go Cat, Linh Xuan, Truong Tho, Dong Hung Thuan, Go Vap, Tan Son Nhat, Bau Cat, Phu Tho, Tan Tao, Binh Hung, Tan Phu Trung, Thoi Tam Thon, Tan Chanh Hiep, Long Thanh My and Thanh My Loi.	Four times per year	Samples are collected periodically and analyzed at the laboratory of HEPA under DONRE	Specialized equipments including logger	8 parameters (pH, TDS, Hd, NO ₃ , TOC, Fe, Coliform and Fecal coliform) are analyzed based on QCVN 09:2008/BTNMT to identify the pollution of ground water in the province.

Note: "N/I": Not implemented yet, "N/A": No information available in the reference document

Source: DONRE, compiled by JICA Study Team

Table 3.2.6 Typical Result of Ground Water Quality at Each Province

No	Province/city	pH	Fe (mg/l)	Cl ⁻ (mg/l)	As (mg/l)	Cd (mg/l)	NO ₃ ⁻ (mg/l)	Pb (mg/l)	CaCO ₃ (mg/l)	Coli (MPN/100ml)	Source /year
	QCVN 09:2008/ BTNMT	5.5-8.5	5	250	0.05	0.005	15	0.01	500	3	
7	Khanh Hoa	7.3-7.8	0.105-0.522	81.0-110	0.034-0.004	0.002-0.007	0.62-0.63	0.002-0.002	-	399-37750	5ECSR/2009
8	Ninh Thuan	6.6-7.9	0.04-1.77	28.0-19809	-	-	-I	-	132-5960	450-70000	5ECSR/2010
9	Binh Thuan	5.7-8.2	<5	<250	<0.05	-	15.0-26.4	-	-	<3	5ECSR/2009
10	Dong Nai	4.5-8.1	0.1-27.2	1.6-196	0.001-0.04	<0.005	0.3-148.4	-	2.3-737	43000	5ECSR/2009
11	Binh Duong	3.06-6.9	-	<250	-	-	-	-	-	>3	5ECSR/2009
12	HCMC	4.3-7.7	0.2-70.4	-	-	-	0.03-78.5	-	7.1-1.692	26	5ECSR/2009

Note: "-"not specified, "5ECSR": Five-year environmental status report
Source: DONRE, compiled by JICA Study Team

3.2.4 Soil

3.665 Table 3.2.7 shows monitoring system of soil at each province, and Table 3.2.8 shows soil quality at each province.

Table 3.2.7 Monitoring System

No	Prov/City	Locations	Frequency	Method	Equip.	Description
7	Khanh Hoa	N/I	N/I	N/I	N/I	N/I
8	Ninh Thuan	Agricultural land such as paddy field, orchard. Industrial zones/clusters, landfills.	Once per year	Samples are collected from target areas and analyzed at the laboratory of science, technology and environmental management institute.	Specialized equipment	5 parameters are analyzed in conformity with QCVN 03/15:2008/BTNMT to identify soil contamination in the province.
9	Binh Thuan	N/A	N/A	N/A	N/A	N/A
10	Dong Nai	locations; mostly in industrial zones, agricultural areas, urban areas, Nam Cat Tien National Park, Vinh Cuu nature reserve and heritage, and residential areas.	Twice per year	76 samples are collected and analyzed at the laboratory of monitoring center of DONRE	Specialized equipments	76 parameters: analyzed in line with QCVN 03/15:2008/BTNMT to identify soil contamination in the province.
11	Binh Duong	N/I	N/I	N/I	N/I	N/I
12	HCMC	N/I	N/I	N/I	N/I	N/I

Note: "N/I": Not implemented yet, "N/A": No information available in the reference document
Source: DONRE, compiled by JICA Study Team

Table 3.2.8 Typical Result of Soil Quality at Each Province

No	Prov/City	pH	Humid (%)	Lindan (mg/kg)	Cu (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Zn (mg/kg)	As (mg/kg)	Source/year
	QCVN 03/15:2008/BTNMT	-	-	-	50	70	2	200	12	
7	Khanh Hoa	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
8	Ninh Thuan	5.76-7.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5ECSR/2010
9	Binh Thuan	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	Dong Nai	5.6	N/A	N/A	0.79-66.5	1.8-26.8	0.016-0.113	3.33-146	0.09-20.6	SR/2010
11	Binh Duong	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I
12	HCMC	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I	N/I

Note: "N/I"- Not implemented yet, "N/A"- No information available in the reference documents, 5ECSR-Five-year environmental status report, and SR-Summary report.
Source: DONRE, compiled by JICA Study Team,

3.2.5 Noise

3.666 Table 3.2.9 shows monitoring system of noise at each province.

Table 3.2.9 Monitoring System of Noise at Each Province

No	Prov/City	Location	Frequency	Method	Equip.	Description
7	Khanh Hoa	Dien Khanh ancient citadel, Binh Tan, Dong De (Nha Trang), Vinh Hoa residential area (Nha Trang Northern city, Dac Loc-Vinh Phuong IZ, Van Gia township (Van Ninh), Van Phong international transit station, Ninh Hoa township, My Giang residential area (Ninh Hoa), T-junction (Dien Khanh), Can Lam DPC, Suoi Dau IZ, Ru Ri, Luong Hoa, Van Ninh, Cam Ranh, Ninh Ich landfills.	Four times per year	Noise is surveyed, measured and collected at target sites, then analyzed at laboratory of Environmental Monitoring Center under Khanh Hoa DONRE	Specialized equipments	Noise is usually monitored together with air monitoring in line with QCVN 26:2010/BTNMT to identify the noise permitted level.
8	Ninh Thuan	Residential areas, markets and main roads in total of 13 locations.	Three times per year	Noise is monitored together air quality parameter and compared with the standard level.	Specialized equipments	Noise is usually monitored together with air monitoring in accordance with QCVN 26:2010/BTNMT to identify the permitted level.
9	Binh Thuan	Target locations: transportation activities, infrastructure construction, residential areas.	Four times per year	Noise is surveyed, measured and collected at target sites together with air quality monitoring activities	Specialized equipments	Noise is usually monitored together with air monitoring in accordance with QCVN 26:2010/BTNMT to identify the permitted level.
10	Dong Nai	Target locations: industrial zones, transportation activities, urban areas.	For times per year	Noise is surveyed, measured and collected at target sites together with air quality monitoring activities	Specialized equipments	Noise is usually monitored together with air monitoring in accordance with QCVN 26:2010/BTNMT to identify the permitted level.
11	Binh Duong	6 vulnerable locations: IZs, residential areas, pottery production plants, urban areas and rural areas.	Four times per year	N/A	Specialized equipments	Noise is usually monitored together with air monitoring associated with QCVN 26:2010/BTNMT to identify the permitted level.
12	HCMC	6 locations: crossroad An Suong, Hang Xanh, Go Vap, Nguyen Van Linh, Huynh Tan Phat, Phu Lam	Four times per year	Noise are surveyed and monitored together with air quality at hotpots.	Specialized equipment	Noise is usually monitored together with air monitoring in line with QCVN 26:2010/BTNMT to identify the permitted level.

Source: DONRE, compiled by JICA Study Team

Table 3.2.10 Typical Result of Noise Monitoring

No	Province/city	dB(A)	Source/year
QCVN No. 26: 2010/ BTNMT (TCVN 5949-1998)		75	
7	Khanh Hoa	63-73	5ECSR/2010
8	Ninh Thuan	80-85	5ECSR/2010
9	Binh Thuan	54-78	5ECSR/2009
10	Dong Nai	62-75	5ECSR/2010
11	Binh Duong	49-77	5ECSR/2006
12	HCMC	70-88	5ECSR/2009

Note: "5ESR": Five-year environmental status report
Source: DONRE, compiled by JICA Study Team

3.2.6 Vibration

3.667 In spite of fact that the vibration is stipulated in the regulation No. 27: 2010/BTNMT, most of tentative provinces/cities have not conducted monitoring activities for vibration yet.

3.2.7 Solid Waste

3.668 Final disposal sites at each province are shown in Table 3.2.11.

Table 3.2.11 Final Disposal Sites at Each Province

No	Prov./City	Location	Capacity	Life	Type	Status
7	Khanh Hoa	Ninh Ich landfill	6 ha	-	Sanitary	Constructing
		Luong Hoa landfill	20 ha	-	Sanitary	Constructing
		Cam Thinh Dong landfill	10 ha	Since 1980	Unsanitary	Operating
		Ninh An landfill	5 ha	-	Unsanitary	Operating
		Vinh Trung landfill	1 ha	7 years	Unsanitary	Operating
		Dien Lam landfill	3 ha	20 years	Unsanitary	Operating
		Doc Ke landfill	1.5 ha	Since 2000	Unsanitary	Operating
		Khanh Son landfill	0.51 ha	15 years	Open	Operating
8	Ninh Thuan	Khanh Vinh landfill	0.5 ha	10 years	Unsanitary	Closed
		Kien Kien disposal site	5 ha	-	-	Operating
9	Binh Thuan	Ninh Son disposal site	4.5 ha	-	-	Operating
		Tan Lap landfill	50,000 m ²	Since 2004	Unsanitary	Operating
10	Dong Nai	43 spontaneous landfills	15.9 ha	-	Unsanitary	Operating
		Bien Hoa Landfill	15 ha	-	Sanitary	Constructing
		3 Landfills in Long Khanh Dist.	7,000 m ²	-	Temporary	Operating
		2 landfills in Long Thanh Dist.	3.5 ha	-	Temporary	Operating
		1 landfill in Long Thanh Dist.	30 ha	-	Sanitary	Pending
		1 landfill in Vinh Cuu Dist.	2,000 m ²	-	Open	Operating
		1 landfill in Thong Nhat Dist.	10 ha	-	Sanitary	Operating
		1 Tay Hoa landfill in Trang Bom	-	-	-	To be open
1 landfill in Dinh Quan Dist.	1 ha	-	-	Operating		
11	Binh Duong	Nam Binh Duong Solid Waste Treatment complex	75 ha	-	Sanitary	Operating
12	HCMC	Go Cat landfill	25 ha	6 years	-	Closed
		Phuoc Hiep 1 landfill	45 ha	3 years	-	Closed
		Da Phuoc landfill	128 ha	Since 2007	Sanitary	Operating
		1A landfill	9.7 ha	1 year	-	Closed
		Landfill No.2	19.7 ha	Since 2008	-	Operating
		Dong Thanh landfill	43 ha	12 years	-	Closed

Note: "-": Not specified
Source: DONRE, compiled by JICA Study Team

3.3 Social Environment

3.3.1 Land Use and Demography

3.669 Land use and demography at each province is presented in Table 3.3.1.

Table 3.3.1 Land Use and Demography at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	Related regulations on official rate on land/structure: the documents below are taken from the report prepared by DOT of Khanh Hoa for the meeting with JST. Heading 2.3 regarding to land-use. 5ECSR, chapter 1, pp.11-13. (see detailed information below)	Khanh Hoa Province has a total area of 5,217,6 km ² . Natural land is divided into different land use purposes and land types.
8	Ninh Thuan	Report No 40/2011/BC-UBND issued by the PPC of Ninh Thuan regarding to Report on the results of land statistics of Ninh Thuan Province.	Land area by land users is 255,549.84 ha (accounting for 76.1% natural land of the entire province)
9	Binh Thuan	Land-use planning map up to 2010. 5ECSR chapter I, heading I.4, pp.12-13.	According to the land statistics in 2008, Binh Thuan province has 781.043 ha of natural land; the average of land using areas is 152people/km ² .
10	Dong Nai	5ECSR chapter 1, heading 1.3, pp. 1-11.	Total natural land of Dong Nai Province as of 1st, January, 2010 is 590.723,62 ha (of which 3.475,60 ha are located in islet Go Gia – Phuoc An commune – Nhon Trach district).
11	Binh Duong	5ECSR chapter 1, heading 1.2, pp. 21-22. As show below.	As a whole, the land-use situation of Binh Duong in period 2005 to 2010 changed; a large area of agricultural land has been transferred into the non-agricultural one (for housing area, specialized area and public purposes)
12	HCMC	5ECSR chapter V, heading 5.3, pp.95-100. As show below.	Agricultural land conversion to non-agricultural land meets 40% of the plan. As of the end of 2009, 8,150 ha has not been converted to non-agricultural land as plan.

Source: DONRE, compiled by JICA Study Team

1) Land-use in Khanh Hoa Province

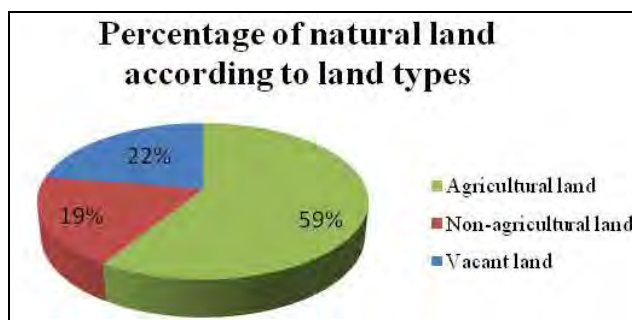
(1) Natural Land Divided according to Land Use Purposes and Land Types

3.670 According to data of Khanh Hoa DONRE, Khanh Hoa Province has a total area of 5,217.6 km². Natural land is divided into different land use purposes and land types as is in Table 3.3.2.

Table 3.3.2 Natural Land Divided according to Land Use Purposes and Land Types in Khanh Hoa Province

Land types	Area (km ²)	Region	
		Rural residential area	Urban land
Natural land	5,217.6	1,030.2	271.1
-Agricultural land	3,069.0	732.0	73.8
-Agricultural land	885.9	422.2	48.3
-Forestry land	2,114.2	284.8	16.7
-Aquaculture land	56.3	17.7	6.7
-Land for salt production	10.3	6.0	1.8
-Other agricultural land	2.1	1.3	0.1
-Non-agricultural land	977.4	154.1	156.5
-Housing land	61.8	38.4	21.8
-Specialized land	828.3	83.9	128.0
-Religious and cemetery land	14.2	5.9	1.7
-Specialized river, spring, water surface land	73.2	25.9	5.1
-Vacant land	1,171.2	144.1	40.9

Source: Khanh Hoa Annual Statistics Yearbook, 6/2009



Source: Khanh Hoa Annual Statistics Yearbook, 6/2009

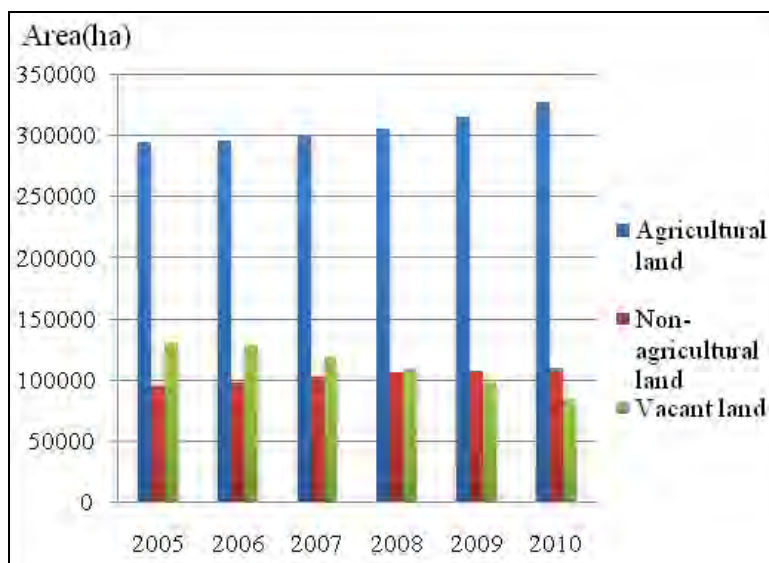
Figure 3.3.1 Percentage of Natural Land according to Land Types

3.671 According to statistics of land fund of organizations in 2008 (Source: Khanh Hoa DONRE) total number of organizations using land in Khanh Hoa Province is 1,131 organizations with 3,943 land lots and total usable land area of 11,347.5 ha.

(2) Changes in Land Use Structure and Purposes from 2006 Up to Now

3.672 On 15/8/2007, the Government issued Resolution 46/2007/NQ-CP adjusting land use planning to 2010 and 5 year land use plan (2006-2010) in Khanh Hoa Province.

3.673 According to above resolution, total natural land of the province in 2005 was 520,542 ha, of which agricultural land accounted for 56.6%, non-agricultural land accounted for 18.3%, vacant land 25.1%. The province shall push changes in land use structure in the direction of increasing agricultural and non-agricultural land, specifically, to 2010 agricultural land shall be increased to 21.1%, accounting for about 109,772 ha; agricultural land shall increase to 62.9%, making up 327,332 ha.

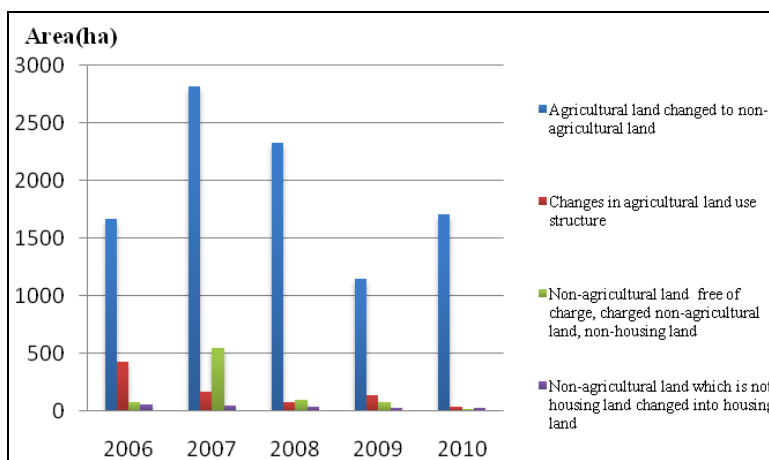


Source: Khanh Hoa Annual Statistics Yearbook, 6/2009

Figure 3.3.2 Land Use Structure

(a) Khanh Hoa Land Use Structure in the period 2005 - 2010

3.674 According to the plan, in the period 2006-2010, about 9,662 ha agricultural land shall be transferred to non-agricultural land and 47,027 ha vacant land shall be put into use.



Source: Khanh Hoa Annual Statistics Yearbook, 6/2009

Figure 3.3.3 Khanh Hoa Land Use Structure

(b) Plan For Changes in Land Use Purposes

3.675 According to data of Van Phong EZ management department: Land use management in Van Phong EZ is in accordance with Decision 3162/QĐ-UBND dated 9/12/2010 by Khanh Hoa provincial People's committee approving detailed land use plan in Van Phong EZ, Khanh Hoa Province for the period 2007-2010.

2) Land-use in Ninh Thuan Province

(1) Current Land Use

3.676 According to data of Ninh Thuan PPC, Ninh Thuan Province has a total area of

335,832 ha. Natural land is divided into different land use purposes and land types as in Table 3.3.3.

Table 3.3.3 Land Use in Ninh Thuan Province

No	Land Use Purpose	Code	Land Area in 2010 (ha)	Compared with land stock-taking in 2010	
				Land Area in 2010 (ha)	Decrease / Increase (ha)
(1)	(2)	(3)	(4)	(5)	(6)= (4)-(5)
	Total Natural Land		335,832.57	335,832.57	0.00
1	Agricultural Land	NNP	266,678.91	266,803.50	-124.59
1.1	Agricultural Production Land	SXN	74,134.14	74,193.76	-59.62
1.1.1	Land for Annual Plants	CHN	63,804.84	63,848.40	-43.56
1.1.1.1	Rice Land	LUA	18,683.32	18,702.16	-18.84
1.1.1.2	Grass Land Used For Farming	COC	154.84	154.84	0.00
1.1.1.3	Land for Other Annual Plants	HNK	44,966.68	44,991.40	-24.72
1.1.2	Land for Perennial Plants	CLN	10,329.30	10,345.36	-16.06
1.2	Forestry Land	LNP	186,259.10	186,314.66	-55.56
1.2.1	Production Forest Land	RSX	34,572.47	34,578	-14.53
1.2.2	Protection Forest Land	RPH	111,950.56	111,991.59	-41.03
1.2.3	Special-Use Forest Land	RDD	39,736.07	39,736.07	0.00
1.3	Aquaculture Land	NTS	1,824.78	1,831.92	-7.14
1.4	Salt Production Land	LMU	3,947.80	3,951.04	-3.24
1.5	Other Agricultural Land	NKH	513.09	512.12	0.97
2	Non – Agricultural Land	PNN	29,230.92	29,086.02	144.90
2.1	Housing Land	OTC	4,651.63	4,640.45	11.18
2.1.1	Rural Housing Land	ONT	3,662.35	3,652.20	10.15
2.1.2	Urban Housing Land	ODT	989.28	988.25	1.03
2.2	Special Use Land	CDG	17,321.29	17,178.05	143.24
2.2.1	Land Used for State Body Offices, Professional Institutions	CTS	150.42	149.99	0.43
2.2.2	National Defense Land	CQP	2,519.19	2,519.19	0.00
2.2.3	Public Security Land	CAN	535.74	535.62	0.12
2.2.4	Non-Agricultural Production/ Business Land	CSK	3,046.67	2,976.91	69.76
2.2.5	Land Used For Public Purposes	CCC	11,069.27	10,996.34	72.93
2.3	Land Used For Religious Purposes	TTN	105.14	105.17	-0.03
2.4	Land for Cemeteries and Graves	NTD	796.33	796.47	-0.14
2.5	River/ Spring and Special Use Water Surface Land	SMN	6,338.22	6,347.57	-9.35
2.6	Other Non-Agricultural Land	PNK	18.31	18.31	0.00
3	Unused Land	CSD	39,922.74	39,943.05	-20.31
3.1	Unused Flat Land	BCS	8,375.99	8,390.44	-14.45
3.2	Unused Hilly Land	DCS	15,465.64	15,471.50	-5.86
3.3	Rocky Mountains Without Forest	NCS	16,081.11	16,081.11	0.00

Source: Ninh Thuan PPC/2010

(2) Land Use Purpose

3.677 Agricultural land is 266,678.91 ha, among which: agricultural production land covers 74,134.14 ha; forestry land 186,259.10 ha; aquaculture land 1,824.78 ha; salt production land 3,947.80 ha; other agricultural land 513.09 ha.

3.678 Non-Agricultural Land: 29,230.98 ha, among which: housing land covers

4,651.63 ha; special use land 17,321.29 ha; land for religious purpose: 105.14 ha; land for cemeteries and graves: 976.33 ha; special use river/spring and water surface land: 6,338.22 ha; other non-agricultural land: 18.31 ha.

3.679 Unused land covers 39,922.74 ha; among which: unused flat land covers 8,375.99 ha; unused hilly land: 15,465.64 ha; rocky mountain without forest: 16,081.11 ha.

3.680 In addition to natural land, Ninh Hai district and Phan Rang – Thap Cham City also possess coastal water surface land (belonging to observation target), which covers 52.20 ha and is used for shrimp, fish farming, etc.

(3) Natural Land Depending on Each Administrative Unit of District Level

3.683 Table 3.3.4 shows natural land area at Ninh Thuan province.

Table 3.3.4 Natural Land Area of City/Districts in Ninh Thuan Province

No	Names of District's Administrative Units	Area
1	Bac Ai District	102,729.48
2	Ninh Son District	77,193.94
3	Thuan Bac District	31,922.09
4	Ninh Hai District	25,383.02
5	Thuan Nam District	56,453.11
6	Ninh Phuoc District	34,233.85
7	Phan Rang – Thap Cham City	7,917.08

Source: Ninh Thuan PPC/2010

(4) Land Users, Land Managers

3.684 Land area by land users is 255,549.84 ha (accounting for 76.1% natural land of the entire province), among which: households and individual covers 81,402.82 ha; communal people's committee: 2,371.64 ha; economic organizations: 52,620.09 ha; state offices: 118,324.06 ha; other organizations: 392.30 ha; foreign capital: 394.15 ha; residential community: 44.78 ha.

3.685 Land area by land administrative bodies: 80,282.73 ha; making up 23.9% of natural land area of the entire province; among which: residential community: 6.45 ha; communal people's committee: 62,483.20 ha; land fund development organization: 1,112.05 ha; other organizations: 16,681.03 ha.

3) Land-use in Binh Thuan Province

(1) Current issues of the Land Use

3.686 According to the land statistics in 2008, Binh Thuan Province has 781.043 ha of natural land; the average of land using areas is 152 people/km². The used land is 792.071 ha, accounted for 93.3% total natural areas and the unused areas are 51.972 ha, accounted for 6.7% of total natural areas.

Table 3.3.5 The Current Situation of the Land using in Binh Thuan

Kind of land	Areas (ha)	Percentage (%)
Total natural areas	781,043	100
I. Agricultural land group	677,948	86.8
1. Producing agriculture land	282,902	36.2
2. Forestry land	390,745	50.0
3. Aquacultural land	3,107	0.4
4. Salt making land	937	0.1
5. Other agricultural land	257	0.03
II. Non agricultural land	51,123	6.6
1. Housing areas	7,669	1.0
2. Specialized using land	23,322	3.0
3. Religious and faithful land	209	0.03
4. Cemetery land	2,115	0.3
5. River, spring land and specialized water surface	17,658	2.3
6. Other non agricultural land	149	0.02
III. Unused land	51,972	6.7
1. Unused land	18,003	2.3
2. Unused mountainous land	29,171	3.7
3. Non forestry rocky land	4,798	0.6

Source: Department of natural resources and environment

(2) Land Environment Issues

(a) Desertification

3.687 According to the statistics, total decertified area is 89,995 ha, which is equal to 11.3% of the total natural area. The decertified area spreads along the coast, concentrating mainly on Tuy Phong, Bac Binh, Ham Thuan Bac districts, with 4 main kinds of desertification:

- Sandy desert 56,740 ha
- Rocky desert 9,355 ha
- Sandy desert
 - + Coastal 1,870 ha
 - + Continental 9,540 ha
- - Arid land desert 12,490 ha

3.688 The main reasons causing this phenomenon in these areas are: the dry-hot climate conditions, strong wind, low rainfall (from 650mm- 700mm), unequal classification to time and space; Low covering level, only from 10% - 16%, most of them are poor and short term plant carpets; Contrary terrain which is sloping, strongly divided causing the erosion; the geographical ingredients are mostly SiO₂, land with slight mechanical composition, low capacity of remaining the humidity; long run exploited land with the backward method, overload terrace field burning and cattle grazing. The possibility of saline land has also increased due to the transfer of the rice fields, the destruction of the coastal plan carpet to raise shrimp in the recent years.

(b) Erosion

3.689 Binh Thuan has 45% of the total land on the height from 300m to 1,000 m; land has the sloping degree from 12- 200 of 40,000 ha and more than 200 of 244,469 ha; the rivers, springs are often short, narrow and highly sloping; unstable classification of rainfall to time and space, therefore there usually has the problem with erosion, land washing when there is flood, especially when the covering level of the plants decreases. Especially in the basin of La Nga river, because of the erosion, the flow through Ta Pao station is 161,000 ton of sand and mud on average every year.

3.690 In the recent years, together with the growth of the growing and forest protection, the province has developed the agro-forestry projects, increasing the investment of the water resources constructions, watering pool in the dry areas such as Quao river, Da Bac, Ca Giay, etc., which helps minimize the land environment degradation in many areas in the provinces.

4) Land-use in Dong Nai Province

(1) Land Use situation

3.691 Total natural land of Dong Nai Province as of 1st, January, 2010 is 590,723.62 ha (of which 3,475.60 ha are located in islet Go Gia – Phuoc An commune – Nhon Trach district). Agricultural land covers an area of 468,575.71 ha (accounting for 79.3%); non-agricultural land 121,250.1 ha (accounting for 20.5%) and unoccupied land 897.82 ha (accounting for 0.2%).

(2) Agricultural Land

3.692 Agricultural land of the province in 2010 is 468,576 ha, accounting for 79.3% natural land, of which land for agricultural production has 277,642 ha, forestry land 181,578 ha, aquaculture land 7,956 ha and other types of agricultural land 1,399 ha. Among which:

3.693 Land for water rice field covers 38,777 ha, constituting 52.7% land for growing annual plants and equal to 8.3% agricultural land (including land specialized in growing rice crops: 20,153 ha and the rest area of land: 18,624 ha), mainly concentrating in Tan Phu district: 7,164 ha, Xuan Loc district: 6,500 ha, Nhon Trach district: 4,719 ha, Dinh Quan district: 4,629 ha, Vinh Cuu district: 4,320 ha.

3.694 Land for growing perennial plants: covers an area of 204,051 ha, accounting for 73.5% land for agricultural production and equal to 43.6% agricultural land, among which land for growing industrial perennial plants covering 139,151 ha, land for growing perennial fruit trees: 41,592 ha and land for growing other kinds of perennial trees: 23,038 ha.

3.695 Main perennial industrial trees include: rubber, coffee, pepper, cashew, mainly concentrating in such districts as: Xuan Loc (22,824 ha), Long Thanh (19,540 ha), Thong Nhat (9,077 ha), Long Khanh (8,348 ha).

3.696 Land for growing perennial fruit trees is mainly concentrating in such districts as: Thong Nhat (7,161 ha), Long Khanh town (5,723 ha), Xuan Loc (4,910 ha), Long Thanh (2,135 ha) with typical fruit trees of the eastern Nam Bo like: rambutan, durian; mangosteen.

3.697 Protection forest land: covers 36,394 ha, making up 20.0% forestry land and equal to 7.8% agricultural land (among which natural protection forest covers 14,910 ha, land having protection forest covers 20,256 ha, land for restoring protection forest 1,084 ha and land for planting protection forest 144 ha). Land for protection forest is mainly concentrated in such districts as: Dinh Quan (18,627 ha), Nhon Trach (6,789 ha), Xuan Loc (4,994 ha) and Tan Phu (4,501 ha). The majority of protection forest land in the province is managed by forest management units like: Protection forest management unit 600, Protection forest management unit Xuan Loc, Protection forest management unit Tan Phu, Protection forest management unit Long Thanh, Forestry one-member limited liability company La Nga, Bien Hoa forestry center.

3.698 Special use forest land: covers 101,257 ha, accounting for 55.8% forestry land and equal to 21.6% agricultural land (of which land for natural special use forest covers an area of 87,243 ha, land having special use forests 10,283 ha, land for restoring special use forest 3,730 ha and land for growing special use forest 1 ha). Special use forest land is concentrated in two districts: Vinh Cuu (62,213 ha) and Tan Phu (39,033 ha), which are presently managed by Cat Tien national park management unit and Dong Nai culture and nature conservation area

3.699 Land for production forests: covers an area of 43,927 ha, accounting for 24.2% forestry land and 9.4% agricultural land (of which land for natural production forest covers 11,559 ha, land for planted production forest 31,590 ha, land for restoring production forest 549 ha and land for growing production forest 230 ha). Production forests are mainly concentrated in such districts as Dinh Quan (16,996 ha), Vinh Cuu (8,576 ha), Long Thanh (5,375 ha), Xuan Loc (4,389 ha), Tan Phu (2,393 ha), Bien Hoa City (1,974 ha), Nhon Trach (1,977 ha). Land for production forests is concentrated into large areas and managed by such organizations as: La Nga forestry one-member LLC, Dong Nai culture and nature conservation area, Tan Phu protection forest management unit, Xuan Loc protection forest management unit; the rest area is planted and managed by individuals and households.

3.700 Land for concentrated aquaculture: total aquaculture land covers an area of 7,956 ha, among which 3,022 ha are land for concentrated aquaculture, accounting for 38.0% total aquaculture land. Concentrated aquaculture land is in such districts as: Nhon Trach: 1,271 ha, Tan Phu: 931 ha, Trang Bom: 458 ha, Vinh Cuu: 277 ha.

(3) Non – Agricultural Land

3.701 Area of non-agricultural land is 121,250 ha, accounting for 20.5% natural land, of which:

3.702 Land for national defense: has an area of 14,475 ha, accounting for 29.1% special use land and 11.9% non-agricultural land.

3.703 Land for security purpose: has an area of 1,190 ha, accounting for 2.4% special use land and 2.0% non-agricultural land.

3.704 Land for industrial zone: as of 10/2010 Dong Nai Province has 30 industrial zones with 9,573 ha (3,656 ha increased compared with 2006) (average increase of 731 ha/year), mainly concentrated in Nhon Trach, Long Thanh, Trang Bom and Bien Hoa City.

3.705 In terms of industrial cluster: according to land stock-taking statistics in 2010 the entire province has 18 industrial clusters and a number of industrial spots with an area of 1,164 ha, among which there are two clusters having infrastructure completed according to plan (Ho Nai 3 construction material cluster and Binh Son industrial cluster), the other clusters are being invested in infrastructure or in the process of having infrastructure investment procedures drawn up.

3.706 Land for mineral resources activities: has an area of 58 ha, accounting for 0.05% non-agricultural land, this is area used for exploiting Puzlan and Laterit in Vinh Cuu area.

3.707 Land for relics and sightseeing: has an area of 93 ha, accounting for 0.1% non-agricultural land.

3.708 Land for treating and burying harmful wastes: According to land stock-taking in 2010, land used for treating and burying harmful wastes in the province is 110 ha, concentrating in such districts and cities as: Bien Hoa 40 ha, Nhon Trach 20 ha, Dinh Quan 15 ha, Thong Nhat 12 ha, Trang Bom 11 ha. All the area is being used to treat unharmful. A small percentage of harmful waste is treated at source; the rest is transported to Hochiminh City for treatment.

3.709 Land used fore religion purposes: has an area of 821 ha, accounting for 0.7% non-agricultural land.

3.710 Land used for cemetery and gravestone: has an area of 1,193 ha, accounting for 1.0% of non-agricultural land, among which cemetery land managed by the province is 142 ha, including 116 ha Vinh Hang cemetery park (Vinh Cuu) and 26 ha martyr cemetery of the province.

3.711 Infrastructure land: has an area of 18,861 ha, accounting for 15.6% non-agricultural land, among which land for infrastructure managed by central level and provincial level is 3,347 ha. Details are as follows:

- (a) **Transport land:** covers 14,003 ha, making up 11.6% non-agricultural land, of which central level and provincial level manage 1,189 ha. Central level manages 5 national highway lines (Express way Ho Chi Minh – Long Thanh – Dau Giay, National highway 1A avoidance line, National highway 1A, national highway 20, national highway 51, national highway 56, national highway 1K, NS railway line) with total length of 389 km; provincial level manages 20 lines connected to national highway system with total length of 370 km, including such lines as: provincial road 760 to provincial road 769, expanded national highway 15, Dong Khoi street, Suoi Tre-Binh Loc road, and 25B road.
- (b) **Irrigation land:** covers 1,106 ha, accounting for 0.9% non-agricultural land, among which provincial level manages 550 ha inclusive of 45 water dams, 17 dykes preventing salinity, water and canals.
- (c) **Land used for power works:** covers 482 ha, accounting for 0.4% non-agricultural land, inclusive of land for Tri An hydro power factory and supporting works, power transmission system, power line corridor, gas transmission system, which are managed by central and provincial level.
- (d) **Land for telecommunication works:** covers an area of 24 ha, constituting 0.02% diện non-agricultural land. All is managed by provincial level.

- (e) **Land for cultural houses:** covers 993 ha, accounting for 0.8% non-agricultural land, mostly concentrating in Bien Hoa City (402 ha), Nhon Trach district (365 ha), the rest is evenly distributed in other districts. Land for cultural works managed by provincial levels covers 44 ha including such works as: Tran Bien Confucian temple, provincial centre for convention and events organization, memory park, Dong Nai cinema, Thanh Binh cinema, and Cai luong art group.
- (f) **Land for Health Facilities:** covers 146 ha, making up 0.1% non-agricultural land, among which provincial level manages 65 ha inclusive of hospital system in the province.
- (g) **Land for Education and Training Facilities:** covers 1,039 ha, making up 0.9% non-agricultural land, among which provincial level manages 253 ha, inclusive of universities, colleges, vocational schools and other tertiary schools.
- (h) **Land for Sports Facilities:** covers 723 ha, accounting for 0.6% non-agricultural land, among which central level manages 482 ha, including golf course in Trang Bom, Long Thanh, and provincial sports complex.
- (i) **Land for Scientific Facilities:** covers 217 ha, accounting for 0.2% non-agricultural land, including: biotechnology area 209 ha (Cam My) and centre for research, train and farming Binh Thang 7 ha (Trang Bom) and rubber research institute (Long Khanh). Among which central levels manages 1 ha and provincial level manages 216 ha.
- (j) **Land for Social Facilities:** covers 44 ha, accounting for 0.04% non-agricultural land, including such works as: centre for protecting and training orphans; centre for raising orphans and disabled children (Bien Hoa), rehab clinic (Xuan Loc), dioxin organization (Dinh Quan), leprosarium (Long Thanh). All is managed by provincial level.
- (k) **Land for Markets:** covers 82 ha, accounting for 0.07% non-agricultural land. All is managed by provincial and communal level.

(4) Urban Land

3.712 In the entire province, there are 8 urban areas namely Bien Hoa City, Long Khanh town and other 6 townships belonging to Trang Bam district, Long Thanh district, Tan Phu district, Dinh Quan district, Xuan Loc district and Vinh Cuu district.

3.713 Urban land (according to administrative boundary of townships and wards) has 22,815 ha, accounting for 3.9% natural land, of which: non-agricultural land covers an area of 14,621 ha, accounting for 64.1%, including housing land of 3,959 ha, special use land of 8,865 ha (among which land used for public purposes: transport, irrigation, health, education, culture, sports, etc., 19,164 ha). In addition, within administrative boundary of urban areas, there are still 8,061 ha agricultural land, accounting for 35.3% total urban land (including agricultural production land of 6,097 ha, forestry land of 1,631 ha, aquaculture land of 333 ha) and 133 ha vacant land (about 0.6%).

3.714 Urban infrastructure, especially transport, water supply and drainage are not integrated. Land for transport is narrow, therefore, the province is lacking in parking space, bus stations. Rate of land used for transport is only 7% urban land compared with necessary rate of 20 - 25%; the collection and treatment of urban waste water is

not conducted thoroughly, leading to floods in case of rains in many places. In addition, area of land used for parks, playground, and public works is not enough, failing to meet domestic and residential demands.

3.715 Houses for people, especially people with low income are lacking. There are still many drawbacks in the architecture of urban houses

(5) Land for Natural Conservation Area

3.716 Pursuant to decision No 09/2006/QĐ-UBND dated 20/2/2006 by Dong Nai people's committee regarding the merging of the centre for managing War Zone D historic relics into Vinh Cuu nature reserves and renamed as Vinh Cuu Natural conservation area (which is now Dong Nai natural and cultural conservation area). Until now, Dong Nai cultural conservation area is 6,903 ha, of which special use forest area is 59,810 ha and production forest area is 8,093 ha.

3.717 In addition, in the province, there is also Ca Tien national park with the area of 39,627 ha, which is the conservation area for typical eco-systems of the eastern Nam Bo, aimed at protecting biodiversity in terms of flora and fauna system, developing flora and fauna species in danger of extinction; protecting watershed forests serving Tri An hydro power project; in the mean time, it has a great potential to develop eco-tourism.

(6) Tourism Land

3.718 According to survey results, current land for tourism purpose is 249 ha, accounting for 0.04% natural area with such tourism areas like: Thac Giang Dien eco-tourism area, Trang Bom wild life raising (Trang Bom), Green club, Tan Van islet eco-tourism, Ba Xe islet eco-tourism area, Vuon Xoai eco-tourim area (Bien Hoa), Suoi Mo tourism area (Tan Phu), and Golden Scorpion eco-tourims (Nhon Trach).

3.719 Dong Nai has a great tourism potential; however, current development is not proportional to its current potential. Tourism activities mainly concentrate on the exploitation of drinking and eating services as well as entertainment services. The exploitation of travel tours is limited, the number of tourism areas is not high. Toursim investment projects are still behind the schedule. Quality of tourism services is not good.

5) Land-use in Binh Duong Province

(1) Land-use Situation

3.720 Land-use situation of 2010 is specified as the below table

Table 3.3.6 Land Use Situation of 2010

No.	Land-use	Area (ha)	Rate (%)
1	Agricultural land	208,691	77.5
2	Non-agricultural land	60,718	22.5
3	Un-used land	34	0.01

Source: 5ECSR 2005-2010, Binh Duong DONRE

3.721 As a whole, the land-use situation of Binh Duong in period 2005 to 2010 changed; a large area of agricultural land has been transferred into the non-agricultural one (for housing area, specialized area and public purposes). This is the inevitable trend to shift the economic structure with the development orientation of

industry – agriculture – service – trade.

3.722 The increase of the non-agricultural land is mainly caused of the development needs of industrial zones, enterprises, residential zones as well as the expansion and extension demands of roads, public facilities in accordance with the provincial socio-economic development progress. Beside the increase of the non-agricultural land, the area of un-used land is decreased, because the wild land is exploited for the purpose of agricultural production.

6) Land-use in Ho Chi Minh City

(1) HCMC Land-Use Condition

3.723 Land-use inventory is performed annually by DONRE and landuse census and mapping are conducted one in every five year. DONRE has cooperated with districts to conduct landuse census and mapping since 2010.

Table 3.3.7 Landuse Inventory by Year in HCMC

Landuse Category	2005	2006	2007	2008	2009	2010
Agricultural land	123,517	123,298	122,972	122,321	121,313	118,172
Agricultural production land	77,955	77,556	77,869	76,229	75,251	72,269
Crash-crop land	47,199	45,936	45,997	42,919	40,604	39,983
Rice land	36,738	35,555	35,139	32,610	30,708	27,796
Perennial tree land	30,756	31,620	31,873	33,309	34,647	32,285
Forestry land	33,858	33,731	33,439	34,365	34,365	34,114
Production forest land	2,168	1,302	1,897	930	930	800
Protection forest land	31,690	32,428	31,513	33,404	33,365	33,285
Special-use forest land	-	-	286	-	30	29
Aquatic land	9,765	10,073	9,724	9,886	9,856	9,443
Salt making land	1,471	1,469	1,471	1,373	1,373	1,943
Other	468	468	467	467	467	403
Non-agricultural land	83,774	83,994	84,319	84,979	85,988	90,747
Residential land	20,521	20,614	20,733	20,949	21,175	23,553
Specific Land	28,536	28,780	28,852	29,815	30,635	32,967
Religious land	400	400	400	404	404	410
Cemetery land	924	925	924	909	906	951
River and specific water surface	33,250	33,160	33,294	32,738	32,723	32,813
Other	143	114	114	142	146	54
Unused land	2,263	2,263	2,263	2,254	2,253	635

Source: HCMC DONRE

3.724 Achievement of Landuse Plan which was approved by the Prime Minister at Resolution NO. 10/2007/NQ-CP dated February 13, 2007.

3.725 Table below compares 2009 landuse plan to 2010 landuse inventory data (landuse data as of end of 2009).

Table 3.3.8 Land use Plan and Statistical Data of HCMC (ha)

No.	Landuse Category	2005 status	2009 plan	2009 Implementation	2009 plan to 2005 status	2009 plan to 2009 implementation	Achievement (%)
	Total Natural Land Area	209,554					
1	Agricultural land	123,517	110,019	118,172	(13,498)	(5,345)	40
1.1	Agricultural production land	77,955	62,485	72,269	(15,470)	(5,686)	37
1.1.1	Crash-crop land	47,199	33,053	39,893	(14,146)	(5,588)	40
1.1.1.1	Rice land	36,738	13,126	27,796	(23,612)	(8,942)	38
1.1.2	Perennial tree land	30,756	29,433	32,285	(1,323)	1,529	-
1.2	Forestry land	33,858	36,079	34,114	2,221	256	12
1.2.1	Production forest land	2,168	3,744	800	1,576	(1,368)	-
1.2.2	Protection forest land	31,690	32,335	33,285	645	1,595	247
1.3	Aquatic land	9,765	9,580	9,443	(185)	(322)	174
1.4	Salt making land	1,471	1,470	1,943	(1)	472	-
1.5	Other	468	405	403	(63)	(65)	103
2	Non-agricultural land	83,774	98,950	90,747	15,176	6,973	46
2.1	Residential land	20,521	23,200	23,553	2,679	3,032	113
2.2	Specific Land	28,536	40,604	32,967	12,068	4,431	37
	Non-agricultural production and business land	9,605	13,714	11,001	4,109	1,396	34
	Public land	16,027	23,897	19,263	7,870	3,235	41
	Transport land	10,817	13,621	11,452	2,804	635	23
	Cultural land	413	2,884	1,772	2,471	1,359	55
	Healthcare land	205	466	345	261	140	54
	Education land	942	1,773	1,229	831	287	35
2.3	Religious land	400	406	410	6	10	167
2.4	Cemetery land	924	1,060	951	136	27	20
2.5	River and specific water surface	33,250	33,313	32,813	63	(437)	-
2.6	Other	143	367	43	224	(89)	-
3	Unused land	2,263	586	635	(1,677)	(1,628)	97

Source: Five Year Environmental Status Report/2005-2009, HCMC DONRE

(2) Current Landuse based on Plan

(a) Agricultural Land

3.726 Agricultural land conversion to non-agricultural land meets 40% of the plan. As of the end of 2009, 8,150 ha has not been converted to non-agricultural land as plan. In fact, acquired and assigned land of investors is much larger but is under compensation and site clearance so this area is classified as agricultural land. Some large-scale projects got the land acquisition decision and under implementation, including Thu Thiem new urban town, Binh Quoi-Thanh Da zone, northwest urban new town, Tan Phu Trung industrial park, high-tech healthcare center, national university center and arterial roads. The unimplemented area of 15 districts and 65 communes and ward is 5,915 ha. The achievement is low due to the following additional reasons:

- (i) The World Economic Recession in 2007 and real estate market recession which affects to progress of large-scale projects.
- (ii) Difficulties in land acquisition and compensation: changing policies, affecting to compensation progress
- (iii) Weak financial capacity of some investors and project transfer
- (iv) Improper development of public utilities of some real estate projects.

3.727 Rice land has been reduced 8,942 ha comparing to the target of 23,612 ha, meeting only 37.9% of the plan due to above reasons. Rice land is reduced

due to converting to other cash-crop land, especially grass land in Cu Chi and Hoc Mon (Milk Cow Co. Ltd.).

3.728 Perennial tree area increased 1,529 ha comparing to the reduction plan of 1,323 ha since cash-crop land was converted to perennial tree land in areas near residential quarters and industrial parks.

3.729 Forestry land increased 256 ha comparing to 2005 forestry land area, which was only 11.5% of the plan. Protective forest land in Can Gio biosphere reserve zone increased 1,595 ha comparing to 2005 figure, meeting 247.3% of the plan while production forest land reduced 1,368 ha comparing to the plan of increasing 1,576 ha since lacking of proper policies to encourage investment in production forest development.

3.730 Aquatic land reduced 322 ha comparing to the plan of reduction of 175 ha (equally to 174% of the plan).

3.731 Salt making land is planned at 1,470 ha but in four year, it increased only to 472 ha, equally to 32% of the target.

(b) Non-agricultural Land

3.732 Non-agricultural land implementation meets only 46% of the plan due to poor achievement of agricultural land plan as evaluated above.

3.733 Residential land achieved 113.4% of the plan since housing for low income groups has been increasing despite of real estate market recession. In addition, various social housing projects have been implemented by DOC.

3.734 Specific land target is achieved only 36.7% while only 33.9% of non-agricultural production and business land target and 41.1% of public land target are implemented, specifically as follows:

- (i) Transport land achieved only 22.6% target due to lacking of budget for transport project and difficulty in land acquisition and compensation.
- (ii) Cultural land (including greenery space) meets only 55.0% of the target
- (iii) Healthcare facility land meets only 53.6% of the target
- (iv) Education land meets only 34.5%.

3.735 River and specific water area reduced 437 ha since some ditches and canals were encroached during urbanization process. HCMC PC recently promulgated regulation on compensating area for regulating reservoir development. HCMC Authority for Architecture Planning, DOT and districts has applied this regulation on approving detail plans and housing development projects.

(c) Unused Land

3.736 Unused land has reduced from 2,263 ha in 2005 to 635 ha, sharing 0.3% of total city area at the end of 2009, meeting 97.1% of the plan, reflecting the city direction in exploitation of unused land for city development.

3.737 Unused land exists scatter in District 9 (42.38 ha), Cu Chi (371.2 ha), Hoc Mon (43.17 ha), Binh Chanh (172.85 ha), Nha Be (40.76 ha), and Can Gio (17.93 ha), which mainly covers ineffective hilly and marine land, rocky and bare land in

Ly Nhon commune, Can Gio district (8.51 ha) and excavated area (>50 m deep land) in Cu Chi district.

3.3.2 Land Acquisition and Compensation

2.753 Through the baseline survey, relevant laws and regulations were collected at city/province level.

Table 3.3.9 Relevant Laws and Regulations on Land Acquisition and Compensation

No	Province/City	Available documents Description
1	Khanh Hoa	<ul style="list-style-type: none"> • Decision No. 101/2009/QĐ-UBND dated 21 Dec 2009 by Khanh Hoa Provincial People's Committee on the promulgation of the regulations for compensation, support and reallocation upon land acquisition by the Government in Khanh Hoa province. • Decision No. 46/2011/QĐ-UBND Khanh Hoa provincial PC dated 30/12/2011 on unit price of construction works, architectural objects and compensation price and support for construction works on land in Khanh Hoa province. • Decision No. 31/2011/QĐ-UBND dated 26/10/2011 - Promulgating regulations on the valuation of trees, crops, livestock in case of land acquisition in Khanh Hoa province. • Decision No. 2575/2009/QĐ-UBND dated 20 November 2011 by Khanh Hoa Provincial People's Committee on the promulgation of the regulations for price adjustment method on construction and structure. • Decision No. 44/2011/QĐ-UBND dated 30/12/2011 - Promulgating regulations on order up, evaluation and approval of general plan, compensation details and assistance when the land acquisition in Khanh Hoa Province.
2	Ninh Thuan	<ul style="list-style-type: none"> • Decision No. 2380/2010/QĐ-UBND dated 21/12/2010 - Promulgating the Regulation on Compensation, Support and Resettlement when the government acquires lands for implementing the investment projects within Ninh Thuan province. • Decision No. 69/2011/QĐ-UBND dated 22/12/2012 - On land price by-type in 2012 within Ninh Thuan. • Decision No. 33/2011/QĐ-UBND dated 15/8/2011 - On stipulating the price table of houses, buildings, architectural structures in Ninh Thuan province.
3	Binh Thuan	<ul style="list-style-type: none"> • Decision No. 54/2010/QĐ-UBND dated 24/12/2010 - Issuing regulations on pricing types of land in 2011 in Binh Thuan Province. • Decision No. 14/2008/QĐ-UBND - on principles and price units compensating for damages when the government acquires lands to develop facilities within Binh Thuan. • Decision No. 38/2011/QĐ-UBND dated 23/12/2011 - Regulating on the land-price within Binh Thuan province.
4	Dong Nai	<ul style="list-style-type: none"> • Decision No. 25/2012/QĐ-UBND dated 3/4/2012 - On the issue of formalities of compensation, rehabilitation, resettlement and land acquisition, allocation, land lease in Dong Nai province. • Decision No: 12/2012/QĐ-UBND dated 23/2/2012 - Promulgating regulations on compensation, support price for assets in case of land acquisition by the state. • Decision No: 13/2012/QĐ-UBND dated 24/22/2012 - Promulgating regulations on difference subsidies land prices in case of land acquisition by the state for relocate households. • Decision No. 72/2011/QĐ-UBND dated 22/02/2011 - on the land price by-type within Dong Nai in 2012. • Decision No. 20/2010/QĐ-UBND dated 5/4/2010 - On the of regulations on rehabilitation policies and standards and formalities of resettlement consideration in case of land acquisition in Dong Nai province.
5	HCMC	<ul style="list-style-type: none"> • Decision No. 35/2010/QĐ-UBND dated 28/5/2010 - Promulgation of regulation on compensation, support and resettlement upon land recovery by the State in Ho Chi Minh area. • Decision No. 51/2011/QĐ-UBND dated 12/7/2011 - Promulgating the regulation on organization and operation of the evaluation Council compensation Ho Chi Minh City. • Decision No. 82/2011/QĐ-UBND dated 18/12/2011 - Regulating on the land-price within Ho Chi Minh city. • Decision No. 43/2011/QĐ-UBND dated 30/6/2011 - On adjusting the price of urban residential land of district. • Decision No. 12/2008/QĐ-UBND dated 20/3/2008 - Promulgated standard on investment rate for constructions in territory of Ho Chi Minh city.

Source: DONRE, compiled by JICA Study Team

3.3.3 Socio economic condition

2.754 Mainly from statistical sources, socio-economic information was collected. Collected information of (1). Housing and Property, (2). Education, and (3) Employment and Income are summarized as follows.

Table 3.3.10 Percentage of Households having House by Type of House and Province

No.	Province	Total (%)	Permanent House(%)	Semi-Permanent House(%)	Less-Temporary House(%)	Temporary House and other house(%)
1	Khanh Hoa	100	45.6	47.0	4.4	3.1
2	Ninh Thuan	100	21.9	69.3	3.8	5.0
3	Binh Thuan	100	25.2	69.2	1.8	3.8
4	Dong Nai	100	9.3	81.9	3.4	5.5
5	HCMC	100	23.0	75.3	1.2	0.6

Source: Viet Nam Household Living Standards Survey, 2010

Table 3.3.11 Living Area per capital by Type of House and Province

(Unit: m2)

No	Provinces	Total	Permanent House	Semi-Permanent House	Less-Temporary House	Temporary House and other house
1	Khanh Hoa	16.8	18.0	16.5	9.6	9.7
2	Ninh Thuan	13.0	15.9	12.7	9.8	6.2
3	Binh Thuan	14.8	16.3	14.8	9.7	7.5
4	Dong Nai	16.4	22.4	16.2	13.1	12.0
5	HCMC	19.2	27.6	16.7	14.0	13.0

Source: Viet Nam Household Living Standards Survey, 2010

Table 3.3.12 Durable goods per 100 households by region

Items	Whole Country	South Central Coast	South East
Car	1.3	0.6	2.2
Motorbike	96.1	98.8	130.9
Telephone	128.4	121.5	160.5
Refrigerator	39.7	37.3	55.8
Video	54.2	49.1	58.1
Color TV	85.9	79.4	92.8
Computer	17.0	15.9	30.8
Air conditioner	9.4	5.0	16.3
Washing machine	17.6	13.4	32.9

Source: Viet Nam Household Living Standards Survey, 2010

Table 3.3.13 Illiterate Rate (over 15 year old)

No.	Province	District	Illiterate Rate (over 15 year old, %)
1	Khanh Hoa	Province Average	5.1
		Nha Trang City	5.0
		Cam Ranh Town	5.2
		Cam Lâm District	5.2

2	Ninh Thuan	Province Average	19.5
		Phan Rang-Tháp Chàm City	20.0
		Ninh Hải District	19.9
		Ninh Phước District	19.0
		Thuận Bắc District	18.8
3	Binh Thuan	Province Average	-
		Phan Thiết City	5.5
		Tuy Phong District	12.6
		Bắc Bình District	10.8
		Hàm Thuận Bắc District	6.7
		Hàm Thuận Nam District	6.3
		Hàm Tân District	5.7
4	Dong Nai	Province Average	1.0
		Long Khánh Town	0.8
		Cẩm Mỹ District	1.0
		Long Thành District	1.0
		Xuân Lộc District	1.0
		Nhơn Trạch District	1.0
5	HCMCC	City Average	2.3
		No 2 district	2.4
		No 9 district	2.3

Source: Viet Nam Household Living Standards Survey, 2010

3.3.4 Cultural and Historical Heritages

2.755 Table 3.3.14 shows cultural and historical heritage at each province.

1) Cultural/Historical Heritage

Table 3.3.14 Cultural and Historical Heritages at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	List of national cultural and historical relics in Khanh Hoa Province. List of provincial cultural and historical relics in Khanh Hoa province.	There are 153 nationally and provincially designated relics spreading in Khanh Hoa province. Especially, those relics located in 6 target Districts; Van Ninh, Ninh Hoa, Nha Trang City, Diem Khanh, Cam Lam and Cam Ranh town should be taken into due consideration. National cultural and historical relics: 13 Provincial cultural and historical relics: 140
8	Ninh Thuan	List of cultural and historical relics at both provincial and national ranks Name of Cham villages and the localities where they living (file name: Lang Cham Ninh Thuan).	There are 58 relics in which 13 national ranking relics, 24 provincial ranking relics and 21 Cham villages spreading in Ninh Thuan province. Especially, Polong Giarai Tower in Phan Rang-Thap Cham City and 21 Cham villages should be paid special attention. National cultural and historical relics: 13 Provincial cultural and historical relics: 24 Major relics: 21 Cham villages
9	Binh Thuan	Some related issues on the north-south high speed railway (for discussion with JICA study team). * See the location map of heritages marked by Binh Thuan DOCST.	There are 30 nationally and provincially recognized relics allocating in Binh Thuan Province. Especially, those relics located in 6 target Districts Tuy Phong, Bac Binh, Han Thuan Bac, Hanh Thuan Nam, Ham Tan and Tanh Linh should be considered in next stages. National cultural and historical relics: 11 Provincial cultural and historical relics: 19
10	Dong Nai	List of cultural and historical relics at both	There are 40 nationally and provincially designated relics spreading

		provincial and national ranks provided by Dong Nai DOCST.	in Dong Nai Province. Especially, those relics located in 6 target Districts: Xuan Loc, Long Khanh Town, Long Thanh, Trang Bom and Bien Hoa City should be surveyed properly in next stages. National cultural and historical relics: 24 Provincial cultural and historical relics: 16
11	HCMC	List of cultural and historical relics at both provincial and national ranks provided by HCMC DOCST.	There are 132 relics in which 53 national ranking relics, 79 city ranking relics spreading in the City. Especially, 1 specially designated relic- Reunification palace should be paid special attention. National cultural and historical relics: 53 City cultural and historical relics: 78 Special historical relic: 1(Reunification palace-135 Nam Ky Khoi Nghia, Ben Thanh comm, Dist.1).

Source: DOCST/DONRE, compiled by JICA Study Team

2) Pagodas/Churches

3.738 Limited information was extracted from land use map and compiled as environmental sensitivity map (See Technical Report No.4).

3) Craft Villages

3.739 Some information regarding to this topic in Ninh Thuan Province: Name of Cham villages and the localities where they live. Other information was not available.

4) Underground Heritages

3.740 Related information has only been provided partially by Dong Nai DOCST.

3.3.5 Public Health

3.741 Public health at each province is shown in Table 3.4.15.

Table 3.3.15 Public Health at Each Province

No	Province/City	Available documents	Description
7	Khanh Hoa	No information has been provided.	N/A
8	Ninh Thuan	Report of DOH regarding to HIV/AIDS prevention and control of the first 6 months of 1011. Summary tables of infected and common diseases during 2005-2010 in Ninh Thuan province.	The first HIV/AIDS case was found in 1995. As of June 2011, there were totally 902 HIV cases in the province with 202 cases at AIDS stage and 134 death cases of HIV. 7/7 city and districts have HIV/AIDS cases. The HIV/AIDS patients are injecting drug users and prostitutes mostly at ages from 19-39. About 70.4% HIV/AIDS cases are male and 29.6% are female. The majority of cases are found in Phan Rang City, followed by Ninh Phuoc dist, Ninh Hai dist, and Ninh Son dist.
9	Binh Thuan	No information has been provided.	N/A
10	Dong Nai	Decision No 2202/2009/QD-UBND issued by Dong Nai PPC regarding to the establishment of Steering Committee for AIDS and social issues control. Directive No 17/2011/CT-UBND issued by Dong Nai PPC regarding to solutions to cope with petechial fever as well as foot and mouth diseases. Directive No 06/2011/CT-TU issued by Communist Party Office of Dong Nai province regarding intervention/solution to cope with common diseases in the province. Official letter No 5709/2011/UBND-VX issued by Dong Nai PPC regarding to the implementation of Decree No 69/2011/ND-	As reported by DOH, from 1 January 2011 to 16 June 2011, hand, food, mouth disease was found in 1,272 cases, and there were 9 fatal cases. Lately, there are over 100 cases every week, mainly found in children less than 5 years old. The number of dengue cases and fata cases is also going up. Since the early year, 1.164 cases of dengue have been found and 3 cases are fatal. The causes are from weather situation and climate change with rain and humidity; inefficiency of disease prevention at nursery schools, young families, environment sanitation, mosquito prevention at residential areas.

No	Province/City	Available documents	Description
		CP issued by the Government of Viet Nam dated on August 8, 2011. Document No 2009/2011/KH-SYT prepared by the Department of Health concerning with the urgent solution or intervention of petechchial fiver as well as foot and mouth diseases in the province. Summary data on affected cases of HIV/AIDS.	
11	Binh Duong	No information has been provided.	N/A
12	HCMC	No information has been provided.	N/A

Source: DOH, compiled by JICA Study Team

3.3.6 Vulnerable Groups

1) Ethnic Minority and Women

3.742 Ethnic minority usually lives in mountainous areas. For the south priority section, many ethnic minorities, especially Cham and Ra Glai People are found in Ninh Thuan province. For more detailed information, target provinces are requested to provide relevant data on ethnic minority.

3.743 The demographic information of ethnic minority and women is summarized below. The distribution of ethnic minority is summarized in the environmental sensitivity map (See Technical Report No.4).

Table 3.3.16 Gender and Ethnic Minority at Each Province

No.	Province	City/Town/District	Population			Ethnic Group (%)	
			Male	Female	Total	Kinh	Ethnic Minority
1	Khanh Hoa	Total province	585,972	571,632	1,157,604	94.7	5.3
		Nha Trang city	202,542	189,737	392,279	99.2	0.8
		Cam Ranh town	60,968	60,082	121,050	93.1	6.9
		Cam Lam city	50,979	49,871	100,850	95.0	5.0
2	Ninh Thuan	Total province	281,579	283,414	564,993	77.0	23.0
		Phan Rang – Thap city	79,657	82,073	161,730	98.0	2.0
		Ninh Hai district	44,680	44,740	89,420	91.0	9.0
		Ninh Phuoc district	90,453	89,885	180,338	68.0	32.0
		Thuan Bac district	18,871	18,898	37,769	33.0	67.0
3	Binh Thuan	Total province	281,579	283,414	564,993	91.0	9.0
		Phan Thiet city	105,729	110,598	216,327	99.0	1.0
		Tuy Phong district	70,398	70,310	140,708	95.0	5.0
		Bac Binh district	59,070	57,831	116,901	66.0	34.0
		Ham ThuanBac district	84,026	83,620	167,646	92.0	8.0
		Ham Thuan Nam district	49,918	48,714	98,632	95.0	5.0
		Ham Tan district	35,140	61,347	96,487	68.0	32.0
4	Dong Nai	Total province	1,231,279	1,254,875	2,486,154	93.0	7.0
		Long Khanh town	64,774	65,930	130,704	91.0	9.0
		Cam My district	69,584	68,286	137,870	83.0	17.0
		Long Thanh district	143,950	143,794	287,744	97.0	3.0
		Xuan Loc district	105,340	100,207	205,547	92.0	8.0
		Nhon Trach district	78,307	79,949	158,256	99.0	1.0
5	Ho Chi Minh city	Total province	3,435,734	3,727,130	7,162,864	94.0	6.0
		2 district	72,661	74,829	147,490	99.0	1.0
		9 district	127,387	128,870	256,257	99.0	1.0

Source: Statistics Data at District Level and Province Level, 2011

3.744 Distribution of ethnic groups at each province in the project area is shown in the following tables.

Table 3.3.17 Ethnic Distribution at Khanh Hoa Province
 (unit: persons)

Town/District Ethnicity	Nha Trang	Cam Ranh	Cam Lam
Kinh	389,279	112,740	95,785
Tay	304	49	26
Thai	65	11	0
Muong	102	10	29
Kho Me	54	6	5
Chinese	1,424	238	182
Nung	264	40	18
Hmong	2	0	0
Dao	20	7	0
Gia Rai	47	2	0
E De	146	2	4
Ba Na	2	0	0
San Chay	3	0	0
Cham	191	38	7
Co Ho	63	3	0
Xo Dang	10	0	0
Hre	3	2	0
Ra Glai	12	0	0
Mnong	225	7,894	4,730
Tho (4)	13	1	0
Xitieng	15	0	33
Kho Mu	0	0	0
Bru Van Kieu	0	0	0
Co Tu	3	0	0
Giay	10	0	0

Source: Statistics Data at District level, Province Level 2011

Table 3.3.18 Ethnic Distribution at Ninh Thuan Province
 (unit: persons)

Town/District Ethnicity	Phan Ran Thap Cham	Ninh Hai	Ninh Phuoc	Thuan Bac
Kinh	158,121	81,334	123,184	12,530
Tay	42	12	7	1
Thai	8	7	7	1
Muong	26	28	24	19
Kho Me	10	6	4	4
Chinese	1,053	37	369	14
Nung	42	4	3	5
Hmong	0	0	2	1
Dao	2	0	0	1
Gia Rai	8	5	6	2
E De	7	1	20	14
Ba Na	0	1	1	0
San Chay	1	0	15	1
Cham	2,075	7,407	51,527	3,094
Co Ho	23	1	8	0
Xo Dang	7	0	12	3
San Dieu	0	9	0	2
Hre	5	0	2	6
Ra Glai	284	560	5,126	22,067

Town/District Ethnicity	Phan Ran Thap Cham	Ninh Hai	Ninh Phuoc	Thuan Bac
Mnong	0	0	1	0
Tho (4)	0	0	0	0
Xitieng	0	0	0	0
Kho Mu	0	0	0	0
Bru Van Kieu	3	1	2	0
Co Tu	0	0	0	0
Giay	1	1	0	1
Ta Oi	0	0	0	0

Source: Statistics Data at District level, Province Level 2011

Table 3.3.19 Ethnic Distribution at Binh Thuan Province

(unit: persons)

Town/District Ethnicity	Phan Thiet	Tuy Phong	Bac Binh	Ham Thuan Bac	Ham Thuan Nam	Ham Tan
Kinh	214,625	133,934	77,4445	153,830	94,169	65,790
Tay	81	16	4,319	320	37	43
Thai	14	6	16	26	21	14
Muong	57	4	99	108	51	142
Kho Me	62	22	48	63	35	115
Chinese	1,021	513	7,775	246	176	148
Nung	36	79	1,249	149	37	102
Hmong	1	0	0	0	1	2
Dao	1	6	4	10	2	5
Gia Rai	47	34	128	114	42	37
E De	8	8	21	11	3	7
Ba Na	14	11	22	21	19	8
San Chay	0	0	21	6	2	0
Cham	301	5,088	20,044	5,068	983	1,296
Co Ho	21	2	1,918	6,105	10	3
Xo Dang	3	1	2	3	2	0
San Dieu	1	0	14	2	6	7
Hre	0	0	1	1	78	7
Ra Glai	16	980	3,608	1,488	2,952	1,557
Mnong	3	0	7	7	0	0
Tho (4)	3	0	1	6	0	0
Xitieng	2	0	0	0	0	0
Kho Mu	0	0	0	0	0	0
Bru Van Kieu	0	0	0	0	0	0
Co Tu	0	1	0	0	0	5
Giay	0	0	0	0	0	0
Ta Oi	0	0	0	0	0	0

Source: Statistics Data at District level, Province Level 2011

Table 3.3.20 Ethnic Distribution at Dong Nai Province

(unit: persons)

Town/District Ethnicity	Long Khanh	Cam My	Long Thanh	Xuan Loc	Nhon Trach
Kinh	118,354	114,262	280,334	188,118	155,939
Tay	631	1,694	1,429	1,627	215
Thai	48	28	149	30	136
Muong	50	86	467	312	206

Town/District Ethnicity	Long Khanh	Cam My	Long Thanh	Xuan Loc	Nhon Trach
Kho Me	324	380	1,135	679	504
Chinese	7,339	15,317	2,144	5,236	897
Nung	791	4,937	667	1,500	102
Hmong	2	6	3	9	2
Dao	4	46	63	688	29
Gia Rai	0	3	0	3	0
E De	44	1	9	8	11
Ba Na	0	0	3	2	0
San Chay	1	2	81	17	18
Cham	131	29	391	2,119	17
Co Ho	81	28	7	2	11
Xo Dang	1	0	1	0	0
San Dieu	7	26	49	32	111
Hre	0	0	3	77	6
Ra Glai	1	0	1	0	0
Mnong	0	0	1	2	0
Tho (4)	17	43	21	39	19
Xitieng	1	0	202	519	1
Kho Mu	0	0	2	0	0
Bru Van Kieu	0	0	0	0	1
Co Tu	0	0	1	0	2
Giay	0	1	0	0	0
Ta Oi	4	0	2	0	1

Source: Statistics Data at District level, Province Level 2011

Table 3.3.21 Ethnic Distribution at HCMC
(unit: persons)

Town/District Ethnicity	District 2	District 9
Kinh	146,003	253,829
Tay	98	140
Thai	25	24
Muong	59	134
Kho Me	381	969
Chinese	675	661
Nung	36	49
Hmong	0	8
Dao	4	27
Gia Rai	4	1
E De	15	20
Ba Na	2	4
San Chay	2	3
Cham	94	268
Co Ho	10	247
Xo Dang	9	53
San Dieu	7	224
Hre	5	78
Ra Glai	3	75
Mnong	8	79
Tho (4)	3	362
Xitieng	5	58
Kho Mu	0	60
Bru Van Kieu	0	26

Town/District Ethnicity	District 2	District 9
Co Tu	9	54
Giay	1	19
Ta Oi	0	27

Source: Statistics Data at District level, Province Level 2011

2) The Poor

3.745 Little information was collected regarding the poor from city/provincial government. According to the statistics, the rate of the poor people is still quite high in Ninh Thuan and Binh Thuan provinces.

3.746 The poverty ratio of each city/province is shown in the table below.

Table 3.3.22 Poverty Rate by Province at Each Province

No	Provinces	Poverty Rate by Provinces (%)			
		2004	2006	2008	2010
	Whole Country	18.1	15.5	13.4	14.2
1	KhanhHoa	-	11.0	9.1	9.5
2	NinhThuan	-	22.3	19.3	1.9
3	BinhThuan	-	11.0	9.2	10.1
4	Dong Nai	-	5.0	4.3	3.7
5	Binh Duong	-	0.5	0.4	0.5
6	HCMC	-	0.5	0.3	0.3

Source: Viet Nam Household Living Standards Survey, 2010

3.4 Others

3.4.1 Climate Change

3.747 All city/provinces are aware of the potential threat of the climate change to the area especially by the rise of sea level. Also the tendency of the change of temperature, rainfall and some cases of extreme weather (ex. typhoons) are discussed in this item.

Table 3.4.1 Characteristics of Climate Change at Each Province

No	Province/ City	Available documents	Description
7	Khanh Hoa	5ECSR, chapter 1. Heading 1.1.2, pp. 9-11.	The annual average temperature of Nha Trang has been increased remarkably with the rise of the global temperature. At the same time, the global climate change has and will change the characteristics of the hydrological and climatic factors of Khanh Hoa Province.
8	Ninh Thuan	5ECSR, chapter 9, heading 9.1, pp.146-151.	Ninh Thuan is located in the driest region of the country, characterized by a typical tropical monsoon climate, dry, hot, windy, strong evaporation from 1670-1827mm. The average annual temperature is 27°C, with two distinct seasons, the rainy season from Sep to Nov, and the dry season from December – August of the following year.
9	Binh Thuan	5ECSR in Binh Thuan Province" in 2005 – 2009.	There are a lot of statistics on the change of green gas volume in the atmosphere The report of Intergovernmental Committee of UN about climate change in 2004 has shown the reason why the change of temperature of the Earth had impact on the climate and other factors and the development of this change directly affected the life of all creatures and our economic development.
10	Dong Nai	5ECSR, chapter 9, pp.145-155.	Increasing CO ₂ concentration in the air and fluctuating objects affect the

			balance between the natural ecosystems and their living conditions. Rapid pace of changes in climate will pose a threat to many species of plants.
11	HCMC	Five-Year Env.Report, chapter IX, pp. 146-166.	The study shows that sea level has been on the rise trend over the decades. The high temperature, global warming, icebergs melting leads to the sea level rise associated with global trend.

Source: DONRE, compiled by JICA Study Team

1) Climate Change in Khanh Hoa Province

3.748 As the analysed result, the annual average temperature of Nha Trang has been increased remarkably with the rise of the global temperature. The total annual rainfall volume has changed greatly (especially since 1996). Therefore, superfloods seemed to occur every year; particularly, the flood-peaks of some years were as approximately high as the historical one. In addition, there are also other extreme natural phenomena (hurricanes, tropical depression, heavy rain, hot weather) also occurred with greater frequency, more extreme in size and quantity

3.749 Hence, the global climate change has and will change the characteristics of the hydrological and climatic factors of Khanh Hoa Province. As the studied results, most of analysed climatic factors have negatively changed trend, especially the increased temperature, the change of rainfall, the rise of the sea-level as well as the frequency of extreme climatic phenomena.

3.750 In coming decades, if the annually increased rainfall maintains with 2 to 3% and the rainfall of rainy-season increases yearly with 10 to 20%, the flood situation of Northern Central Region in general and Khanh Hoa in particular will become more complex, the inundation risk of downstream area will be more serious that the potential factor causes of the human and the production. The inundation of areas, especially the downstream areas of Cai river (in Nha Trang) and Ninh river (in Ninh Hoa) will indirectly affect to the focal economic zones, the traditional tourism zones due to the change of water-level within the bay-areas.

3.751 Meanwhile, the rainfall is short of 13 to 16% in the dry season, this situation will cause of the water shortage, droughts, salinization at areas. Especially in the mountainous districts and the coastal ones, it is difficult to secure the water volume for production, fire prevention, and flood-tides, etc.

3.752 The climatic change increases the average temperature as well as makes-up other damages.

- (a) **Thermal Waves:** The thermal waves will occur more popularly due to the climatic change. The increased temperature together the thermal wave (especially in the time El-nino occurs) will damage seriously the natural environment and human health. This risk rarely occurs in Nha Trang City, but it may happen in Van Ninh (where The South-west Foehn Wind often occurs) and Cam Ranh peninsula (where there are many grassland, hot and dry sandy-hills).
- (b) **Rain and Floods:** the lasting-rain and the flood damage to the human life and properties. Although, the superfloods occasionally occur in Khanh Hoa, the devastating risk of the floods may be serious in the future, for example:
 - More rainfall will concentrate within only some months;
 - The hydroelectric reservoirs will be threatened with the dam-rupture risk;
 - The risk of high flood may occurs;
 - The estuaries may be clogged with sedimentation, so the drainage will be prevented in the flooding-season.
- (c) **Typhoons:** In recent years, the floods, cyclones, vortexes, thunderstorms, and etc. occur mutatively in Khanh Hoa due to the global climatic change (Vietnam is one of the ten most seriously affected countries). According to the statistic data, there are four typhoons in period 2006 – 2009. Particularly, the intensity and the damages caused by the typhoons have increased gradually. Especially, in the early November of 2009, the no.11 typhoon (Marinae) affected directly to Khanh Hoa and caused of the heavy rain and the historical flood which damaged seriously of people and proerties (it was estimated that the total damage caused by the no.11 typhoon was 450 billion VND which was 4.5 times higher than the one caused by the typhoons of 2008).
- (d) **Droughts:** Extreme and prolonged drought will be a major risk of the province, especially in the year El-Nino occurring. Forest-fires and crop damages will be increased. It is necessary to construct more reservoirs and dams (thought the existing irrigational system of Khanh Hoa is relatively good). In addition, the fresh-water should be used effectively.

2) Climate Change in Ninh Thuan Province

(1) Greenhouse gas emissions situation Ninh Thuan

3.753 Ninh Thuan is located in the driest region of the country, characterized by a typical tropical monsoon climate, dry, hot, windy, strong evaporation from 1,670-1,827 mm. The average annual temperature is 27°C, with two distinct seasons, the rainy season from Sep to Nov, and the dry season from December – August of the following year. The average annual rainfall is 700 mm in Phan Rang and increases with the height of 1,100 mm in the mountainous regions. Humidity of 71-75%, the radiation energy is at 160 Kcl/m², total the 9,500-10,000 °C heat.

3.754 Ninh Thuan is the driest regions in the country. The severe droughts occurred in recent years such as 1997, 1998, 2002, 2004, 2005, due to which many people suffered from hunger because of insufficient agricultural production conditions, disease problems, environmental risks, serious impacts on people's production and life in the districts. Although there have been many remedies such as damming, dams, drought monitoring, reforestation, forest protection, it cannot avoid the harsh climate in the dry season. The prolonged heat together with the hot dry west wind rapidly decline for flow in the rivers in the province, leading to drought and lack of water during the annual dry season.

3.755 Decision 2340/QD - Committee issued by the PPC's Chairman decided on the establishment of the compilation team for the action plan framework to adapt to climate change. Action plan to adapt to climate change aimed at integrated coastal management, water resources and agriculture, protection and restoration of areas affected by drought, desertification and floods, and incorporates it to the feasible extent in the socio-economic development and environment policies and plans of the province.

3.756 Action plan to adapt to climate change in Ninh Thuan (hereinafter referred to as the Action Plan) is one of the most important products of the project VN/05/009 that the province involved. At the same time, the development of the action plan to adapt to climate change in Ninh Thuan will also contribute significantly to the implementation of the aforementioned correspondences of the Prime Minister.

3.757 Ninh Thuan is characterized by agricultural economy accounted for 44.4%, services 36.5% of GDP, and so that the industrial activity creates the cause of climate change, is still low.

3.758 However, in order to reduce greenhouse gas emissions in Ninh Thuan, the followings should be noted:

- (i) The operation of the plant, which uses fossil fuel (coal, oil, and gas), charcoal, frozen chamber creates CO₂, NO₂, and CFC.
- (ii) Limit to the least causes of forest fires by human or natural causes. Preparedness, detection, firefighting in time, prevention of fire spread, fire lasted. Following the contracting, management, protection, payment of environment service is to encourage people, small business in protection and development of forests.
- (iii) In agriculture, promoting the application of biosecurity measures, limiting the use of pesticides and inorganic fertilizers.
- (iv) Limit deforestation for cultivation. Maintain the forest area over 45% in order to prevent erosion, landslides or washed away, and especially desertification, which are threats to one arid province as Ninh Thuan.

(2) Climate Change, Scenarios of Climate Change and their Impact on the Socio-Economic Development of Ninh Thuan Province

(a) Scenario of the evolution of climate change in Ninh Thuan in the near future:

3.759 Under scenarios of climate change in Vietnam in 2010, 2050 and 2070, the temperature in the coastal areas will increase 0.30 °C; 1.10 °C; 1.50 °C respectively and in the interior, it will be higher at 0.50 °C; 1.80 °C; 2.50 °C. According to this scenario, the sea level rises to 9 cm in 2010; 33 cm by 2050 and 45 cm by 2070. Climate change has many negative impacts on agriculture, water resources, forestry, fisheries, coastal areas, the ecological environment, energy, transportation, human health.

3.760 According to the scenario of the Intergovernmental Panel on climate change (IPCC) in 2010, with a sea level rise of 100 cm, the coastal erosion and flooding will happen without the protective embankment systems. Sea level rise combined with storm would threaten the coastal construction works and neighborhoods.

(b) Impacts of climate change on socio-economic development in Ninh Thuan

3.761 Adverse impacts of natural disasters, including the impacts of climate change on socio-economic development of Ninh Thuan, mainly drought and desertification; salinization; lack of drinking water and water for production in the dry season; floods during the rainy season; erosion of river coast.

3.762 Industries and economic sectors directly and severely affected are Agriculture - Forestry - Fisheries.

3.763 Measures to cope with the disaster that the Ninh Thuan government and people have done include:

- (i) Irrigation systems such as water storage dams have been constructed at national, provincial, district scale and lakes at town and village scale, even to each household. The construction of canal systems II, III to regulate water to the areas and residential areas for living and production has been completed.
- (ii) Afforestation and greening of barren hills, wasteland and coastal sand, scattered trees in forest group, with perennial trees, drought-tolerant fruit trees; grass at large scale to serve for cattle, goats, and sheep.
- (iii) Economic and crop Restructuring (rice, corn, wheat, cotton, tobacco, sugarcane, grapes, cashews), livestock (cows, goats, sheep) is to adapt to arid climatic conditions, but still bring high economic efficiency.
- (iv) However, due to the shortage of state funds and Ninh Thuan Province is poor, the results achieved by the project is very limited. Therefore, within the framework of the action plan to adapt to climate change in the province, these solutions need to put into the long-term strategy and plan and they need to gain the concern from the central government and local government and the active support and participation from the public.

(3) The Subjects of Climate Change Impacts in Ninh Thuan Province

(a) Forest Resources

3.764 Forest and green vegetation (so-called forest), which are absorb sources of greenhouse gases, help increase the likelihood of rainwater stored in the soil, reduce evaporation, contributing to climate regulation, protection of natural resources water, desertification and flood mitigation in Ninh Thuan. In contrast, the consequences of climate change increase the likelihood of forest fires, forest degradation, the difficulty of reforestation. Along with the irrational exploitation of forests, it will lead to an increase in greenhouse gas emissions, if there is no appropriate response strategy. Thus forests are strongly affected not only climate change, but also the socio-economic development due to increasing population pressure.

3.765 Thus, the vegetation is both as the affected subject and as the key factor to adapt to adverse effects of climate changes. For these reasons, conservation and development of forests and scattered trees (referred to as vegetation growth), adaptable to drought conditions and lack of fresh water, both as the subject and as the target of strategies to

adapt to drought, desertification and severe water shortages due to the impact of climate change in Ninh Thuan.

(b) Agriculture, Forestry and Fisheries

3.766 Agriculture, forestry and fishery are the main economic sectors, attracting over 60% of the labor force in rural areas (these are the subjects to suffer the most severe consequences caused by natural disasters in Ninh Thuan), is the area of the direct consequences of climate change. Therefore, economic restructuring in the sector of agriculture, forestry and fisheries, changing the structure of plants and animals, the application of advanced farming techniques, construction of irrigation systems to surface water storage, flood control, water regulation and increasing the area of the reservoir (lake ecology), regulating the weather and climate are the strategic solutions to adapt to local climate change.

(c) Water Resources

3.767 Ninh Thuan Province has low density of rivers and streams, at average of 0.1 km/1km². In general, surface water and groundwater in Ninh Thuan are little, total rainfall is less than the total amount of water evaporation (1,600-1,800 mm / year), leading to severe shortage of surface water and groundwater. The use of groundwater depletion leads to widespread groundwater salinization in the coastal strip. The surface water storage, scientific protection and rational exploitation of the groundwater resources and water use savings are the strategic targets to cope with climate change in Ninh Thuan.

(d) Land Planning

3.768 These are favorable conditions to adjust the economic structure of the province, for each sub-region and economic sector, aiming to develop the socio-economic sustainability. However, the plan needs to be adjusted in accordance with the solutions to cope with climate change of the industry and other socio-economic sectors of the province.

(e) Coastal Strip

3.769 Ninh Thuan Province is directly affected by the rise in sea level due to the impact of climate change. The rise of sea level increases coastal erosion, storm surge, saltwater intrusion, threatening the construction works and industrial infrastructures, transport, security and defense, shelters of thousands of coastal residents, affecting coastal ecosystems. Marine economic sectors have been identified as key sectors of Ninh Thuan province; therefore, to find solutions to cope with sea level rise on coastal Ninh Thuan is identified in the action plan framework to adapt to climate change.

3.770 The socio-economic development plan of Ninh Thuan identified to focus on developing post-salt chemical industry, shipping mechanical engineering, granite quarrying, and small hydro combined with tourism. Development of agro-forestry-fishery products (grape processing, wheat processing, meat processing, fish meal), high-quality construction materials (paving stones granite), NaOH industrial production and chlorine from salt water and brine ingredients, marine engineering industry, garment processing, mineral extraction industries.

3.771 Industrial activities causing environmental pollutions (sewage and industrial waste gas) are very large, requiring the construction planning of industrial parks and industrial clusters to adapt to climate change, in which the investors are required to explain the plan to invest in technology (clean technology) and the waste treatment options before

approving investment projects.

(f) Public Health

3.772 The impact of climate change on human health is considered the most serious and diverse impact. It increases the number of deaths due to diseases (cholera, typhoid, dengue, etc.), mainly due to the prolonged sunny heat is intense and occurs more frequently; Ninh Thuan Province should pay attention to evaluating the cause of the eye disease and intestines for people in rural areas, as they always have to use untreated water. In response strategies to climate change of Ninh Thuan, it requires proposing the solution of clean water and sanitation in rural areas, strengthening health facilities.

3) Climate Change in Binh Thuan Province

3.773 Besides, climate change had great impact on biodiversity. The environmental degradation of Binh Thuan is part of it. There are a lot of statistics on the change of green gas volume in the atmosphere. The report of Intergovernmental Committee of UN about climate change in 2004 has shown the reason why the change of temperature of the Earth had impact on the climate and other factors and the development of this change directly affected the life of all creatures and our economic development.

3.774 As predicted, if we do not have any effective solutions to reduce green gas, it will result in a lot of consequences. The Earth's temperature will increase by 1.8 °C to 6.4 °C in 2100, the rain volume will rise 5 to 10%, ice in both poles of the Earth and on the mountain will melt more, the sea level will raise about 70-100cm. All these phenomenon happen in unpredictable way with intensify and frequency. In addition, the rise of sea level will erode seashore, flood inshore areas, degrade the flooded land, saline water areas, and kill the creatures living in the fresh water. In the regions that the climate change raised intensify of rain resulting in the land erosion, floods, and landslide and affected the structure and function of water area and contaminated water. All the consequences above had great influence on creatures, the degradation of the eco-system and made difficulties in the socio-economic development, especially, in poor country that people's life depend on natural resources.

3.775 In the context of the world with the climate change that affect negatively or positively to the biodiversity, Binh Thuan people's committee deployed some activities to recover the biodiversity: establishing the nature preservation area, protecting forest resources, protecting the resources of seafood.

4) Climate Change in Dong Nai Province

3.776 Being aware of impacts of climate changes, since the early, the Government of Vietnam joined and ratified the UN Framework Convention on climate changes and the Kyoto Protocol. In recent years, Vietnam has had a lot of programs, research projects on situation, changes and impacts of climate changes on environment and natural resources as well as socio-economic development, and Vietnam has initiated implementation of countermeasures to climate changes. However, these efforts are not sufficient to ensure effective response to the impacts of climate changes in the future.

(a) Potential Impacts of Climate Changes

3.777 Predictions by climate models show that the ecosystems will not be able to adjust to adapt to the rapid fluctuations in climate. Increasing CO² concentration in the air and

fluctuating objects affect the balance between the natural ecosystems and their living conditions. Rapid pace of changes in climate will pose a threat to many species of plants. The threat that ecosystems are being herded into get worse, since some has been incurred by the ecological pressures of human activities (the destruction of groundwater, air pollution, and acid soil, local climate change, etc.). The increase in frequency and intensity of storms will cause greater damage to natural ecosystems.

3.778 The fluctuations of the ecosystems could lead to a degradation of biodiversity of species on a globe scale. Once the natural ecosystems or pro natural ecosystem are degraded, it will cause severe socio-economic effects, particularly in developing countries, where most residents live upon natural ecosystems.

3.779 Besides the frequent flooding, rising sea levels also increase the frequency and intensity of large-scale floods. In addition, the destruction of the natural shield as coral reefs, offshore sand bars, salt water pools and the loss of continental drainage systems caused by the rivers and canals will be a chance for floods to occur more frequently. This flooding is the threat of humanity and hinder to agricultural production in areas of alluvial soil with high yields.

3.780 In some areas, the frequent flooding together with the coastal erosion will damage coastal sand, which is the main factor to attract tourists. Hence, many countries will take into account the significant impact on tourism.

3.781 The saltwater intrusion into estuaries and groundwater system near the cost will lead to considerable consequents in water supply for millions of residents.

3.782 One other threat to groundwater and surface water sources in areas prone to flood in the future will be the accumulation of contaminations in sediments of the plains and estuaries of severely polluted rivers. The toxin can be mobilized by changes in land status and saltwater intrusion. .

(b) Impacts of Climates Changes on natural Ecosystem and Biodiversity

3.783 The ecosystem on earth along with the biodiversity is a source of economic value, environment and human culture. Climate change will shift climatic areas. The reactive species will be adapted to new climate conditions. The changes will alert species' composition and geographical distribution of the ecosystem.

- (i) Due to the global warming, the thermal boundary of continental and freshwater ecosystems will shift toward the poles and move higher. In contrast, psychrophilic species will be diminished or migrated to other places.
- (ii) Some species are well adapted to climate change while others do not adapt well exposing to gradual degradation. Perhaps the shift of species in climate zones will depend on many conditions such as physiological development and growth in the new climatic conditions, nutrient conditions. In general, many species which are sensitive to the weather conditions or in high-risk situation, climate change will be the big threat to them;
- (iii) Climate change with the extreme climatic conditions such as drought, floods, and forest fires. will make the number of species likely to be declined even more. The mountainous areas will be impacted. Many mammals and birds will be reduced by the unsuitable living conditions and a reduction in nutrients.

(c) Impacts on Agriculture

3.784 Agriculture is subject to the direct impact of the climate. The potential yield of crops is coverable function with solar radiation. Significant effects to seasonality, growth rate and development of plants are the mode of heat, rain and humidity. The metrological disasters such as hurricanes, tornados, heavy rains provoking flood, droughts and etc. exist in a short time; however, they affect not only growth, yield but also output after harvest.

(d) Impacts on Forest

3.785 Climate change together with rising temperature and changing rainfall patterns will affect to the forest vegetation and ecosystem in many directions; distribution of boundaries of primary forest type as well as movable secondary forest can be moved;

3.786 High temperatures combined with abundant light will drive the photosynthesis process to enhance the assimilation process of the trees. In particular, increased levels of CO₂ will contribute to increasing growth of forest ecosystem. However, due to increased evaporation, soil moisture should be reduced, resulting in a decline in growth index of forest biomass.

(e) Impacts on Aquaculture

3.787 Salt water encroaches further into the continent, occupying living places of some freshwater species.

3.788 Mangrove is narrowed, affecting ecosystems of some aquatic species;

3.789 A loss of ability to maintain organic matters of seaweed ecosystem lessens supply sources of photosynthesis and nutrients to the benthos. Therefore, the environmental quality of a variety of aquatic life is deteriorating;

3.790 A surge in temperature causes to distinct stratification in water areas, affecting the biological patterns of organism. A rise in temperature fastens the mineralization and decomposition of organic matters, affecting food sources of organism. Rising temperature also leads to the degradation and destruction of coral reefs, which changes the physiology, biochemistry taking place in a symbiotic relationship between corals and algae.

3.791 A drop in rainfall intensity and concentration from 10 - 20% in a long period (from several days to several weeks) has killed a variety of organisms living in brackish water and coastal ecosystem, particularly oyster, shell and clams.

3.792 The rise in water level makes the regime of water, aquatic and hydration management worse. As a result, existing biomes change the structure and composition, and additional reserves plunge. Reserves of economic seafood species are forecasted to recede by 1/3 less than at present;

3.793 Rising temperatures make aquatic sources dispersed. The tropical fish (with low economic value) increases, the sub-tropical species (high value) reduce or disappear completely. Seasoned fish in the coral reef is destroyed;

- Species of phytoplankton as the first link of the food chain for zooplankton are destroyed or it drastically reduces zooplankton, thereby a major source of food for middle stratum animal and upper stratum animal. The consequences are: - Rising temperature makes fisheries resources dispersed, by the migration of fish to other water areas and reduced body weight of fish.

(f) Impacts of Climate Changes on Water Resources

3.794 Climate change will alter the distribution of water resources, river flows, water quality and supply.

3.795 The radical impact is altering rainfall patterns and distribution of rainfall in the regions. Temperature increase will cause to more evaporation and therefore there will be more rain. Rain patterns will alter in each region. Rainfall may go up or down. The rainy season will also change the start time and end time. However, the increased rainfall occurs unevenly.

3.796 The change in rainfall patterns will alter river flows, frequency, intensity of flood, drought and groundwater. The water supply for production and domestic life will be more difficult.

3.797 The change of the ice area on the mountain due to global warming also significantly affect the flow of rivers and thus affect water resources. Increasing temperature will melt the ice in the mountains and lead to increase flow in the rivers and provoke flooding. When the ice blocks melt, water supplies will dry up, accompanied by floods will reduce the river flow greatly. Some rivers will be depleted, severe water shortages occur.

3.798 Reservoirs are also affected by climate change. Rainfall caused landslides and sedimentation phenomenon will narrow reservoir capacity and more seriously reservoirs will become death lake. Rainfall also makes water loss from reservoirs due to flows. The water quality will change accordingly.

3.799 Water-related disasters have also increased, whereas floods and droughts are considered most serious. In recent years, water – related disasters have occurred more.

3.800 Moonsoon, particularly Western moonsoon, has greatly impacted on rainfall, and therefore affecting water resources of Asian countries. Once the western moonsoon comes late or ends early, it will also cause drought to agricultural production and severe effects on million of people living upon agriculture in countries and South Asian countries. On the contrary, the rainy season prolongs, it will provoke more flooding on a larger scale at basin of big rivers.

3.801 Extended droughts may cause more serious social effects than floods. Droughts, accompanied by desertification increase risks of forest fires, which lead to tremendous damage to socio-economics and environment.

3.802 The change of flows, droughts and floods will also affect the supply and use of water. Throughout the world, there will be about 3 million people living under increasing pressure of water resources if climate change continues. Change caused by climate that diminishes water resources will cause serious effects and influence on many activities related to agriculture, fishing, marine, energy, domestic water supply and so on.

(g) Impacts of Climate Changes on Public Health

3.803 The impact of climate changes on human health seems rather complex. There are direct effects through the direct exchange between the surroundings with the body. There also are indirect effects through other factors such as food, housing, insect, disease-carrying hosts. Six issues caused to impacts of climate changes on health are:

- Heat pressures (solar heat/cool);
- Extreme phenomena and natural disasters (storms, floods and drought);

- Air pollution;
- Infectious disease;
- Issues relating to coastal water;
- Matters relating to food and nutrition; the collapse of the population and economic plans.

3.804 There are different kinds of direct impacts of climate change on human body. Wet and hot weather, high intensity of radiation, strong fluctuation of climate are the direct causes of diseases for human body.

(h) Impacts of Climate Changes on Energy

3.805 Rain pattern, which was deformed by climate change, will certainly affect hydropower in the regions. Increased temperature accompanied by increased evaporation contributes to varying reserves and flows of hydropower reservoirs, reducing the ability to produce and regulate the hydropower plans. Water demand on downstream areas also increases, especially during the dry season or drought, will affect the ability to balance water, regulate lakes and conduct the plans for electricity generation. High rainfall intensity due to storm is not only difficult for the regulatory process but also causing floods and threatening the safety of downstream areas.

(i) Impacts of Climate Changes on Industrial Sector

3.806 The construction technology has an intimate relationship with climatic factors. The proliferation of several types of natural disasters will affect the planning and design, construction organization, increasing the cost of construction:

3.807 The infrastructures of railway and road will be greatly impacted by climate changes, primarily due to upsurging floods and storms; due to sea level rise in coast regions, inundation phenomena in delta regions.

(j) Impacts of Climate Changes on Tourism and Resorts

3.808 Tourism is becoming an important service sector. Climate change also affect this sector in such as coastal beach, resorts etc.

5) Climate Change in HCMC

3.809 The study shows that sea level has been on the rise trend over the decades. The high temperature, global warming, ice bergs melting leads to the sea level rise associated with global trend.

3.810 Due to climate change, change by urbanization, forest coverage also has negative impacts on local climate of HCMC and surrounding areas. The lowest and highest temperature is gradually increasing, evaporation is on the rise and humidity is decreasing. As a result, water level is rapidly soaring yearly. A special attention should be paid in construction planning, civil structures, and irrigation work and salinity intrusion in the city.