



Japan International Cooperation Agency (JICA)  
Climate Finance Impact Tool  
for Mitigation and Adaptation (Summary)

# **JICA Climate-FIT (Summary)**

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Operation (Summary) by NIPPON KOEI CO., LTD.

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# Mitigation

## Table of Contents

Chapter 1	Outline of the Survey.....	1-1
1.1	Background and Objective .....	1-1
1.2	Selection of Target Sub-sectors and Review of Existing Methodologies .....	1-1
1.3	Basic Concept and Guidelines for the Quantitative Evaluation of GHG Emission Reduction (Sequestration) .....	1-1
1.4	Framework of the Report.....	1-3
Chapter 2	Selection of Target Sub-sectors and Review of Existing Methodologies .....	2-1
2.1	Selection of Target Sub-sectors .....	2-1
2.1.1	Identification of Sectors and Sub-sectors Based on Past JICA ODA Loan Projects .....	2-2
2.1.2	Trend of Projects by Other Donors.....	2-4
2.2	Methodologies of Other Certification Organizations, etc. ....	2-10
2.2.1	Reviewed Methodologies .....	2-10
2.2.2	Existing Methodologies for Targeted Sub-sectors.....	2-13
Chapter 3	Basic Concept and Guidelines for the Quantitative Evaluation of GHG Emission Reduction (Sequestration) .....	3-1
3.1	Basic Concept.....	3-1
3.1.1	Quantitative Evaluation .....	3-1
3.1.2	Basic Concept of Estimation .....	3-1
3.2	Framework of Methodology Sheet and Calculation Sheet (Excel) .....	3-3
3.2.1	Aim and Application of Methodology Sheet and Calculation Sheet (Excel) .....	3-3
3.2.2	Outline of Methodology Sheet .....	3-4
3.2.3	Outline of Calculation Sheet (Excel) .....	3-6
Chapter 4	Methodology Sheets and Calculation Sheets .....	4-1
4.1	Typical Project Outlines in Targeted Sub-sectors .....	4-2
4.2	Methodology Sheets and Calculation Sheets (Excel) for Each Sub-sector .....	4-5

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## List of Figures

Figure 2.1.1 Process of Selecting Sub-sectors.....	2-1
Figure 2.1.2 Summary of Sector Classification of World Bank Mitigation Projects.....	2-6
Figure 2.1.3 Sector Classification of GEF Registered Mitigation Projects Implemented by Various International Organizations.....	2-7
Figure 2.1.4 Summary of Sector Classification of ADB Mitigation Projects.....	2-8
Figure 4.1 Process for Formulating Mitigation Projects Sector .....	4-1

## List of Tables

Table 2.1.1 Projects in Mitigation Sub-sectors among Japan's Yen Loan Projects .....	2-3
Table 2.1.2 Sector Classification of World Bank Mitigation Projects and this Survey .....	2-5
Table 2.1.3 Sub-sectors for Mitigation Measures .....	2-9
Table 2.2.1 Target and Outline of Existing GHG Estimation Methodologies .....	2-10
Table 2.2.2 Existing Methodologies in Forest and Natural Resources Conservation Sector.....	2-14
Table 2.2.3 Existing Methodologies in Traffic and Transportation Sector .....	2-16
Table 2.2.4 Existing Methodologies in Energy Conservation (Industry) Sector(1).....	2-17
Table 2.2.5 Existing Methodologies in Energy Conservation (Industry) Sector(2).....	2-19
Table 2.2.6 Existing Methodologies in Energy Sector .....	2-20
Table 2.2.7 Existing Methodologies in Renewable Energy Sector.....	2-21
Table 2.2.8 Existing Methodologies in Sewerage and Urban Sanitation Sector .....	2-22
Table 4.1.1 Outlines of Supposed Projects for Target Sub-sector .....	4-2

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# Adaptation

## Table of Contents

Chapter 1	Outline of the Survey .....	1-1
1.1	Background and Objectives of the Survey.....	1-1
1.2	Selection of Target Sub-sectors and Review of Existing Resources.....	1-1
1.3	Basic Concept and Guidelines for Adaptation .....	1-1
1.4	Framework of the Report .....	1-2
Chapter 2	Review of the Existing Resources .....	2-1
2.1	Existing Reports on Adaptation Activities by JICA.....	2-1
2.2	Wise Adaptation to Climate Change .....	2-3
2.3	Major Reports by Other Development Aid Agencies, etc.....	2-4
Chapter 3	Definitions and Steps in Adaptation Planning .....	3-1
3.1	Study Method.....	3-1
3.2	Definitions.....	3-1
3.3	Vulnerability Assessment.....	3-3
3.4	Adaptation Project and Business-as-usual (BAU) Development Project .....	3-5
3.5	Evaluation and Monitoring of Adaptation Measures .....	3-6
Chapter 4	Selection of Target Sub-Sectors .....	4-1
4.1	Categorization of Sectors and Detailed Classifications based on Typical Adaptation Measures .....	4-2
4.2	Identification of Sectors and Detailed Classifications based on Past JICA ODA Loan Projects.....	4-2
4.3	Integration of Detailed Classifications into Target Sub-sectors .....	4-7
4.4	Trends of Projects by Other Donors.....	4-12
4.5	Selection of Target Sub-sectors.....	4-15
Chapter 5	Basic Concept and Guidelines for Adaptation Measures .....	5-1
5.1	Basic Concept .....	5-3
5.2	Guidelines .....	5-4
5.3	Reviewed Documents for Each Target Sub-sector.....	5-8
5.4	Assumptions for Preparing Guidelines for Target Sub-sectors .....	5-9
5.5	Basic Concept and Guidelines for Each Sub-sector.....	5-35

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### List of Figures

Figure 2.1	Planning Horizons - Today's Decisions Shape the Future .....	2-12
Figure 3.1	Basic Concept of "Adaptation Project" in the Irrigation Sector .....	3-7
Figure 3.2	Basic Concept of "BAU Development with Adaptation Options" in the Irrigation Sector .....	3-7
Figure 3.3	Basic Concept of "Adaptation Project" in the Flood Control Sector.....	3-8
Figure 3.4	Basic Concept of "BAU Development with Adaptation Options" in the Flood Control Sector .....	3-8
Figure 4.1	Selection Process of Sub-sectors.....	4-1
Figure 5.1	Process of Formulating Adaptation Measures.....	5-2
Figure 5.2	Formulation Process for "Adaptation Project" .....	5-5
Figure 5.3	Formulation Process for "BAU Development with Adaptation Options" .....	5-7

### List of Tables

Table 2.1	Outline of JICA's Assistance for Adaptation to Climate Change.....	2-1
Table 2.2	Key Different Features between JICA's Assistance for Adaptation to Climate Change and this Survey.....	2-2
Table 2.3	Outline of the Handbook on Climate Change Adaptation in the Water Sector.....	2-3
Table 2.4	Contents in Each Sector .....	2-4
Table 2.5	Overarching Points on Adaptation in Developing Countries.....	2-4
Table 2.6	Outline of "Integrating Climate Change Adaptation into Development Co-operation - Policy Guidance" .....	2-5
Table 2.7	Steps to Design Adaptation-related Project in "Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures" .....	2-7
Table 2.8	Definitions Related to Mapping Climate Change Vulnerability and Impact Scenarios...	2-8
Table 2.9	Evaluation Steps of Mapping Climate Change Vulnerability and Impact Scenarios.....	2-8
Table 2.10	Implementation Steps in Adapting to Climate Variability and Change.....	2-9
Table 2.11	Criteria for Analyzing Adaptations in Adapting to Climate Variability and Change .....	2-9
Table 2.12	Outline of Points in Climate Change Information for Effective Adaptation.....	2-10
Table 2.13	Expected Results and Indicators in Adaptation Fund Results Framework .....	2-12
Table 2.14	General Outline of Impact Indicators proposed for the Project by Adaptation Fund.....	2-14
Table 3.1	Definition of Adaptation .....	3-1
Table 3.2	Definition of Vulnerability.....	3-2
Table 3.3	Definition of Adaptive Capacity .....	3-3
Table 3.4	Definition of Maladaptation.....	3-3
Table 3.5	Evaluation Steps of Mapping Climate Change Vulnerability and Impact Scenarios (Reprint).....	3-4

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Table 3.6	Steps and Summary of Evaluation for Vulnerability Assessment in Target Sectors (Adaptation Project).....	3-4
Table 3.7	Definition of the Two Types of Adaptation-related Projects.....	3-6
Table 4.1	Adaptation Cases and JICA Loan Projects Implemented in Each Small Classification ..	4-3
Table 4.2	Integrated Sub-sectors.....	4-7
Table 4.3	Integration into Sub-sectors .....	4-8
Table 4.4	Comparison of Suggested Sub-sectors with Sub-sectors of WB, GEF, ADB Projects ..	4-13
Table 4.5	Sub-sectors for Adaptation Measures .....	4-15
Table 5.1	Structure of the Adaptation Concept.....	5-3
Table 5.2	Concept Comparison between “Adaptation Project” and “BAU Development with Adaptation Options” .....	5-4
Table 5.3	Evaluation Items for Guidelines on “Adaptation Project”.....	5-6
Table 5.4	Evaluation Items for Guidelines on “BAU Development with Adaptation Options”.....	5-8
Table 5.5	Reference Documents for Each Sub-sector.....	5-8
Table 5.6	Assumed Project of Each Sub-sector .....	5-10

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Japan International Cooperation Agency (JICA)  
Climate Finance Impact Tool for Mitigation

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List of Abbreviations

ADB	Asian Development Bank
ALOS	Advanced Land Observing Satellite
AR-CDM	Afforestation/Reforestation Clean Development Mechanism
ASTER	Advanced Spaceborne Thermal Emission and Reflection Radiometer
BM	Build Margin
BRT	Bus Rapid Transit
CDM	Clean Development Mechanism
CM	Combined Margin
COP	Conference of the Parties
COD	Chemical Oxygen Demand
CSP	Concentrated Solar Thermal Power
E10	Fuel containing 10% Ethanol
GEF	Global Environment Facility
GHG	Greenhouse Gas
GREEN	Global Action for Reconciling Economic Growth and Environmental Preservation (JBIC)
Green-e	Green-e
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPCC GPG	IPCC Good Practice Guidance
IPCC GPG for LULUCF	IPCC Good Practice Guidance for Land Use, Land Use Change, and Forestry
IPCC-GNGGI	IPCC Guidelines for National Greenhouse Gas Inventories
JBIC	Japan Bank for International Cooperation
J-MRV	Measurement, Reporting and Verification of GHG Emission Reductions in JBIC's GREEN
J-VER	Japan Verified Emission Reduction
LANDSAT	LANDSAT
LCA	Life Cycle Assessment
LFG	Landfill Gas
LRT	Light Rail Transit
MRT	Mass Rapid Transit
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
OM	Operational Margin
QuickBird	QuickBird
RDF	Refuse . Derived . Fuel
REDD	Reducing Emissions from Deforestation and Forest Degradation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SPOT	Satellite Pour l'Observation de la Terre
UNFCCC	United Nations Framework Convention on Climate Change
US-EPA	US Environmental Protection Agency
VCS	Verified Carbon Standard
VER	Verified Emission Reduction



## **Chapter 1 Outline of the Survey**

### **1.1 Background and Objective**

The 16th Conference of the Parties (COP16) of the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Cancun Agreements. The agreements clearly state the commitment by developed countries to provide financial support to developing countries in the field of climate change, which include i) collective commitment approaching USD 30 billion for three years from 2010 to 2012 (as Fast-start finance) and ii) joint mobilization of USD 100 billion per year by 2020 (as Long-term finance). The direction of future framework on climate change after 2013 is still under discussion. It is considered that Official Development Assistance (ODA) will continue to be actively utilized as part of the support for the developing countries in the field of climate change. The Cancun Agreements request implementation of measurement, reporting and verification (MRV) regarding quantitative evaluations of greenhouse gas (GHG) emission reduction (sequestration) through supported mitigation actions.

Taking into account the above situations, JICA is faced with the task to consider MRV regarding GHG emission reduction (sequestration) during the planning stages of country assistance strategies and individual projects to ensure its implementation. This survey presents a reference document providing estimation methodologies of quantitative evaluations of GHG emission reduction (sequestration), in order to facilitate consideration of MRV during the planning stages of country assistance strategies and individual projects. This survey is not intended to provide methodologies for estimating emission reduction credits, such as those generated by the Clean Development Mechanism (CDM). The purpose of this survey is to calculate the impacts of projects assisted by JICA. Therefore, this survey does not take into account additionality considerations required by the CDM.

This report summarizes the survey on mitigation measures as part of the “Study on Mainstreaming Climate Change Considerations into JICA Operation”.

### **1.2 Selection of Target Sub-sectors and Review of Existing Methodologies**

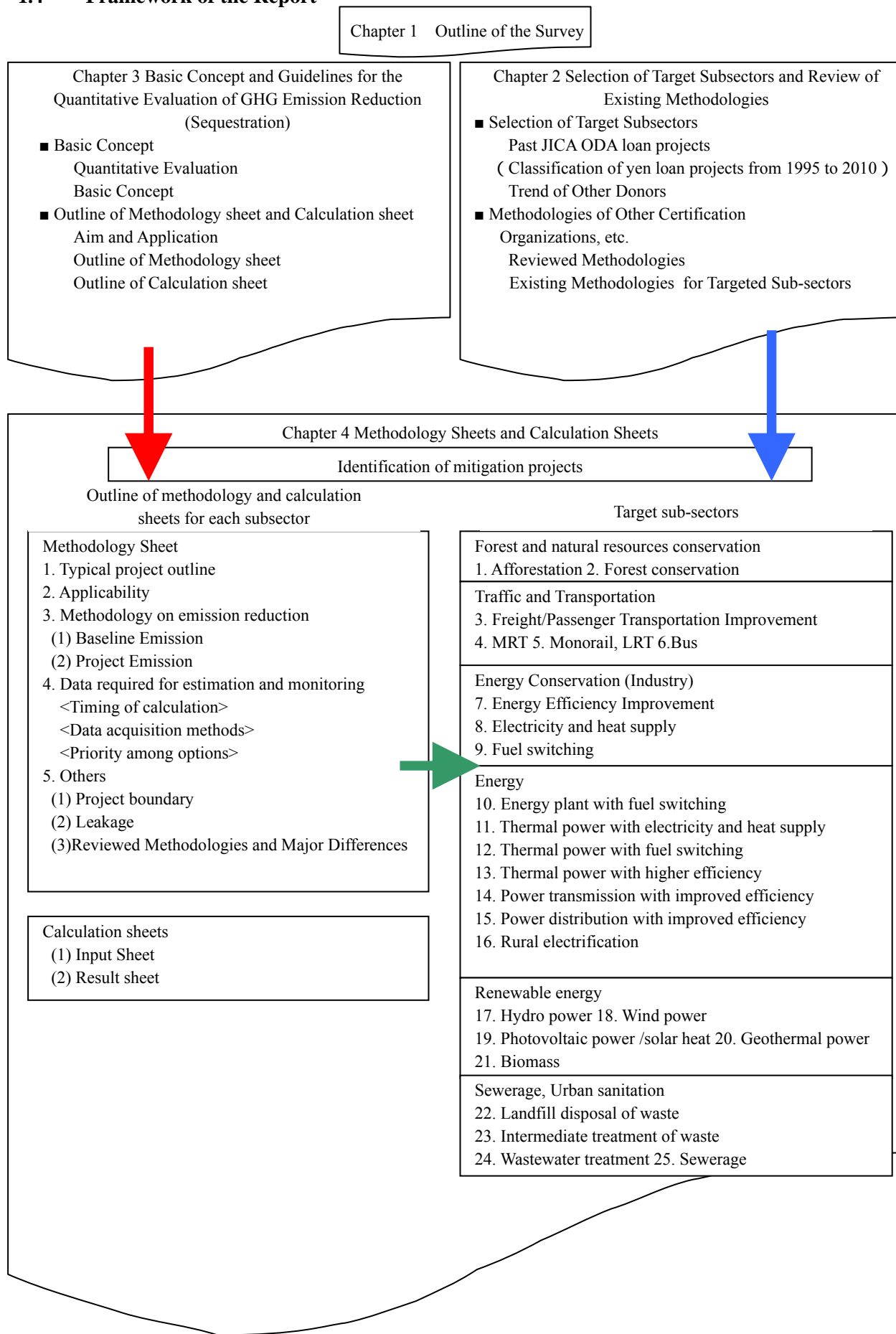
After reviewing past JICA ODA loan projects and the trend of other donors' assistance, 25 sub-sectors were chosen as potential areas of future JICA ODA loan assistance. In order to establish the estimation methodologies for quantitative evaluation of GHG emission reduction (sequestration), the survey reviewed existing methodologies and tools including those used by other donors and by credit generating mechanisms like the CDM.

### **1.3 Basic Concept and Guidelines for the Quantitative Evaluation of GHG Emission Reduction (Sequestration)**

For the selected 6 sectors and 25 sub-sectors, methodology sheets summarizing GHG emission reduction methodologies were prepared. The five items included in the methodology sheets are: i) typical project outline, ii) applicability, iii) methodology on emission reduction, iv) data required for estimation and monitoring, and v) others. In developing countries, it can be easily anticipated that

there exists great limitation in data availability. In order to overcome this limitation, the presented methodology allows flexibility by indicating several options when possible, along with the order of priority. Furthermore, excel sheets with embedded estimation formula were prepared to enable estimating actual GHG emission reductions (calculation sheets).

### 1.4 Framework of the Report



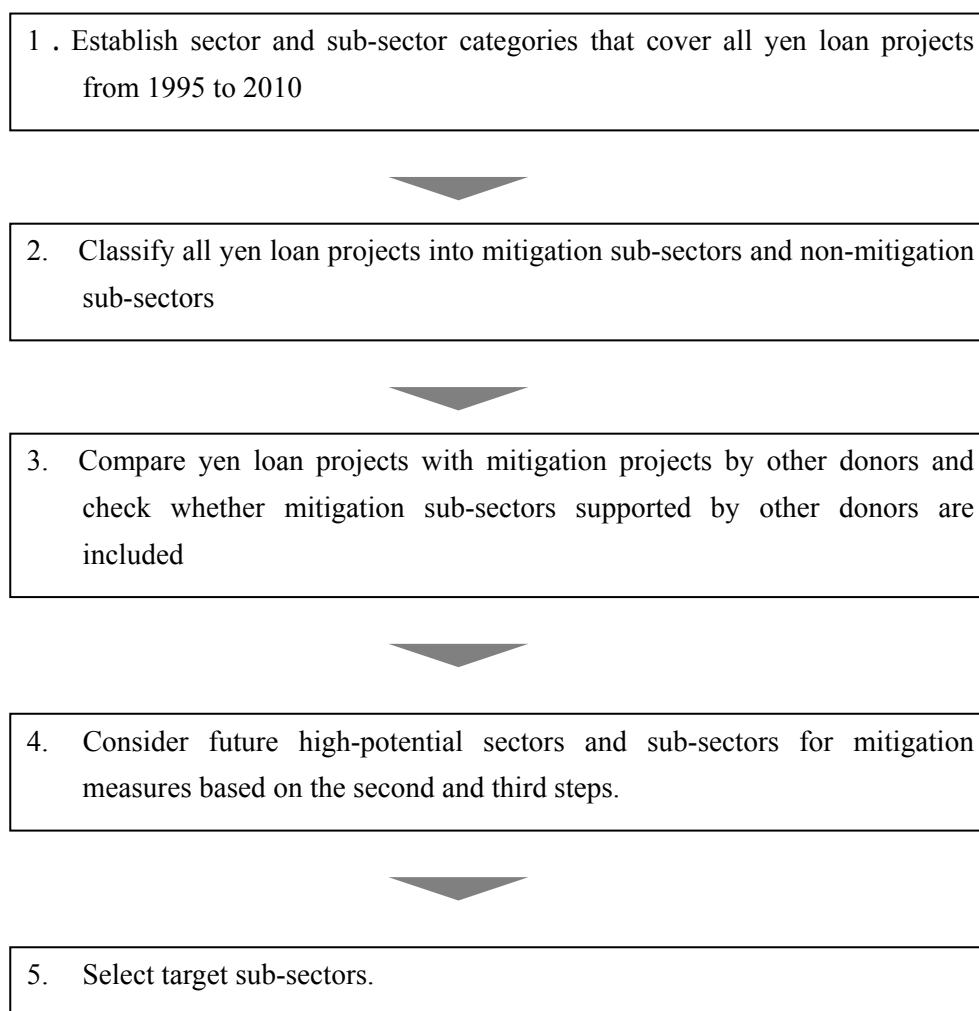
## Chapter 2 Selection of Target Sub-sectors and Review of Existing Methodologies

### 2.1 Selection of Target Sub-sectors

In this section, target sub-sectors are selected for discussion in Chapters 3 and 4. The following items are considered for selection of the sub-sectors.

- Past JICA ODA loan projects
- Potential for formulating future mitigation projects

The process of selection is as follows:



**Figure 2.1.1 Process of Selecting Sub-sectors**

### **2.1.1 Identification of Sectors and Sub-sectors Based on Past JICA ODA Loan Projects**

First, in order to classify and identify sectors and sub-sectors based on past JICA ODA loan projects<sup>1</sup>, projects classified in mitigation sub-sectors are extracted from all projects committed from 1995 to 2010 (1,139 projects). The mitigation and non-mitigation sub-sectors and the number of projects classified in each group are shown in Table 2.1.1.

There are 503 projects classified into 6 mitigation sectors (forestry/natural environment, disaster prevention, traffic and transportation, mining and industry, energy, and public utility) and 29 mitigation sub-sectors. On the other hand, there are 793 projects classified into 14 non-mitigation sectors (including miscellaneous sector) and 52 non-mitigation sub-sectors. Projects classified into more than one sub-sector are counted in their respective sub-sectors, resulting in a total of 1,296 counted projects.

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<sup>1</sup> [http://www2.jica.go.jp/ja/yen\\_loan/index.php](http://www2.jica.go.jp/ja/yen_loan/index.php)

**Table 2.1.1 Projects in Mitigation Sub-sectors among Japan's Yen Loan Projects**(Target: Committed Projects from 1995 to 2010)<sup>1</sup>

## Mitigation Sub-sectors

Sector	Sub-sector	projects
3 Forestry/natural resources conservation	01 Forestry	37
	02 Forest conservation, Slope conservation/Soil conservation	15
	03 Mangrove conservation	0
	05 Ecosystem (biodiversity)	5
4 Disaster management	07 Forest disaster prevention	0
	08 Landslide disaster management	0
6 Transportation	04 Railway	
	001 Freight (a new railway double track)	21
	002 Passenger (a new railway, a double track railway, or a quadruple track railway)	9
	003 MRT (City and suburb rapid railway: Subway, Elevated railway)	46
	004 Monorail, LRT	2
	005 Improvement of rails, High standardization, Rehabilitation of railway	10
	006 Rehabilitation of train cars and railway facilities	8
9 Mining and manufacturing industries	01 Industry	4
	02 Factory, Plant	16
	03 Mining industry	3
11 Energy	01 Energy conservation	2
	02 Intensive heat-supply system with fuel switching	26
	03 Thermal power plants with electricity and heat supply	4
	04 Thermal power plants with fuel switching	12
	05 Thermal power plants with higher energy efficiency	39
	06 Transmission and distribution	64
	07 Hydro power plants (except for small hydropower and pumped and storage hydropower...)	42
	08 Renewable energy	12
	09 Rural electrification	17
	10 Energy facilities (construction of new natural gas pipelines)	2
13 Public utilities	02 Urban health (waste disposal)	16
	03 Sewerage	56
	03 Wastewater treatment	35
Total		503

## Non-mitigation Sub-sectors

Sector	Sub-sector	projects
1 Water resources	01 Proper management of water resources	2
	02 Water resources development, facility upgrade	14
	03 Utilization of water resources	2
	04 Water and sanitary reform	0
2 Agriculture, Food	01 Irrigation, drainage	56
	02 Cultivation management (Assistance of agricultural management), enhancement of irrigation association	13
	03 Crop development	3
	04 Information system	0
	05 Livestock	1
	06 Fisheries	4
	07 Agro-economy	1
	08 Sustainable agriculture	2
	09 Development/improvement of farmland	1
	10 Agricultural process	1
3 Forestry/natural resource conservation	04 Coastal/lakefront protection/restoration	3
4 Disaster management	01 Coastal protection	3
	02 River prevention (flood control)	35
	03 Disaster-relief	1
	04 Information system	1
	05 Development of human resources, Environmental control ability	4
	06 Urban disaster prevention	0
09 Land-use management	0	
5 Urban-regional development	01 Rural development	38
	02 Urban community improvement	2
6 Transportation	01 Road, bridge	164
	02 Airport	35
	03 Port	36
	05 Marine transportation	7
	06 TDM and other soft measures	1
	07 Logistic facilities	1
	08 ICT	0
	06 Medical care	15
7 Health	01 Adaptation capacity development	0
	02 Adaptations for high risk area	0
	03 Heat prevention	0
	04 Malaria control	0
	05 Waterborne (infectious) disease control	1
	06 Medical care	15
8 Architect	01 Architect	31
10 Government administration	01 Finance, monetary	25
	02 Environmental-related issues	21
	03 Survey/cartography	1
	04 General government	5
	05 Assistance in policy-making system	57
	06 Assistance for rehabilitation and reconstruction	0
12 Human resources	01 Education	42
	02 Healthcare education	13
13 Public Utility	01 Water Supply	96
14 Commerce	01 Tourism	7
15 Communications and broadcasting	01 Telecommunications	17
	02 Broadcasting	11
99 Others	01 Instauration	1
	02 Poverty program	19
Total		793

<sup>1</sup> 1,139 projects are extracted from JICA's database of Japan's ODA loan projects from 1995 to 2010, and classified into sectors.

<sup>2</sup> As for agricultural and food sectors, countermeasures and utilization for "methane emissions from paddy fields", "domestic animals' waste", "loss of soil organic material due to surface soil runoff", "nitrous oxide originated from fertilizers", and "methane emissions from paddy fields" are expected as promising projects in the future.

### 2.1.2 Trend of Projects by Other Donors

The trend of mitigation projects implemented by other donors is as follows:

(1) World Bank (WB)

Projects whose major theme is climate change are extracted from WB database<sup>2</sup> and classified into project fields. Project fields are divided into major sectors and sectors. The WB database system allows projects to be classified into more than one major sector and/or sector as shown in Figure 2.1.2. The figure summarizes the result for 193 projects classified into major sectors and sectors. Among the major sectors, energy has 124 projects, which is overwhelmingly greater than that of other major sectors. Sectors with a larger number of projects include, power generation, renewable energy, agriculture, forestry, and public utility (sewerage, etc.).

(2) Global Environment Facility (GEF)

From GEF's database<sup>3</sup>, 645 projects whose focal area is climate change and implemented after year 2000 are extracted. 385 projects are classified as mitigation projects. These projects are further classified into project fields and implementing international organizations (Figure 2.1.3). 298 of the total 385 projects are energy projects.

(3) Asian Development Bank (ADB)

From ADB's database<sup>4</sup>, 38 loan projects related to mitigation measures are extracted. ADB's project classification system allows selection of multiple sectors and sub-sectors for one project (Figure 2.1.4). It is noted that there are more mitigation projects in the energy sector than other sectors.

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<sup>2</sup> <http://www.worldbank.org/>

<sup>3</sup> <http://www.gefonline.org/>

<sup>4</sup> <http://www.adb.org/Climate-Change/projects.asp#promoting>

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Table 2.1.2 Sector Classification of World Bank Mitigation Projects

Major Sector	Sector	count					Total
		only	1st	2nd	3rd	4th	
Agriculture, Fishing, and Forestry	AB Agricultural extension and research	1	1	3	0	0	5
	AJ Animal production	0	1	0	0	0	1
	AH Crops	2	0	0	0	0	2
	AI Irrigation and drainage	2	4	0	0	0	6
	AT Forestry	12	2	10	0	0	24
	AZ General agriculture, fishing and forestry	19	3	9	4	0	35
	BC Central government administration	7	3	5	0	0	15
Public Administration, Law and Justice	BE Compulsory pension and unemployment insurance	0	0	0	0	0	0
	BG Law and justice	0	0	0	0	0	0
	BH Sub-national government administration	6	3	0	0	0	9
	BK Compulsory health finance	0	0	0	0	0	0
	BZ General public administration	2	3	5	0	0	10
	BL Public administration - Agriculture, fishing and forestry	0	0	0	0	0	0
	BM Public administration - Information and communications	0	0	0	0	0	0
	BN Public administration - Education	0	0	0	0	0	0
	BO Public administration - Finance	0	0	0	0	0	0
	BQ Public administration - Health	0	0	0	0	0	0
	BS Public administration - Other social services	0	0	0	0	0	0
	BT Public administration - Industry and trade	0	0	0	0	0	0
	BU Public administration - Energy and mining	0	0	3	0	0	3
	BV Public administration - Transportation	0	1	0	0	0	1
	BW Public administration - Water, sanitation and flood protection	0	1	1	0	0	2
	Information and Communications	CA Information technology	0	0	0	0	0
CB Media		0	0	0	0	0	0
CT Telecommunications		0	0	0	0	0	0
CZ General information and communications		0	0	0	0	0	0
Education	EL Adult literacy/non-formal education	0	0	0	0	0	0
	EC Pre-primary education	0	0	0	0	0	0
	EP Primary education	0	1	0	0	0	1
	ES Secondary education	0	0	0	0	0	0
	ET Tertiary education	0	0	0	0	0	0
	EV Vocational training	0	0	0	0	0	0
	EZ General education	0	0	0	0	0	0
	FA Banking	0	0	0	0	0	0
Finance	FB Non-compulsory health finance	0	0	0	0	0	0
	FC Housing finance and real estate markets	0	0	0	0	0	0
	FD Non-compulsory pensions, insurance, and contractual savings	0	2	0	0	0	2
	FE Micro- and SME finance	0	0	0	0	0	0
	FG Payment systems, securities clearance, and settlement	0	0	0	0	0	0
	FK Capital markets	0	0	0	0	0	0
	FZ General finance	0	0	0	0	0	0
Health and Other Social Services	JA Health	0	0	0	1	0	1
	JB Other social services	0	0	2	2	0	4
Industry and Trade	YA Agricultural marketing and trade	0	0	0	0	0	0
	YB Agro-industry	0	0	1	0	0	1
	YC Housing construction	0	0	0	0	0	0
	YD Petrochemicals and fertilizers	0	1	0	0	0	1
	YW Other industry	2	0	4	3	0	9
	YY Other domestic and international trade	0	0	0	0	0	0
	YZ General industry and trade	0	0	0	8	0	8
Energy and Mining	LA District heating and energy efficiency services	12	7	0	0	0	19
	LB Mining and other extractive	1	5	0	0	0	6
	LC Oil and gas	2	0	0	0	0	2
	LD Power	29	6	0	0	0	35
	LE Renewable energy	23	16	0	0	0	39
	LZ General energy	6	17	0	0	0	23
Transportation	TA Roads and highways	1	0	0	0	0	1
	TV Aviation	0	0	0	0	0	0
	TP Ports, waterways and shipping	0	0	0	0	0	0
	TW Railways	2	0	0	0	0	2
	TZ General transportation	3	0	5	4	1	13
Water, Sanitation, and Flood Protection	WD Flood protection	3	0	5	3	0	11
	WA Sanitation	0	0	0	0	0	0
	WS Sewerage	1	0	0	0	0	1
	WB Solid waste management	8	0	1	0	2	11
	WC Water supply	0	0	2	1	0	3
	WZ General water, sanitation and flood protection	8	0	13	5	1	27

Project Total 193



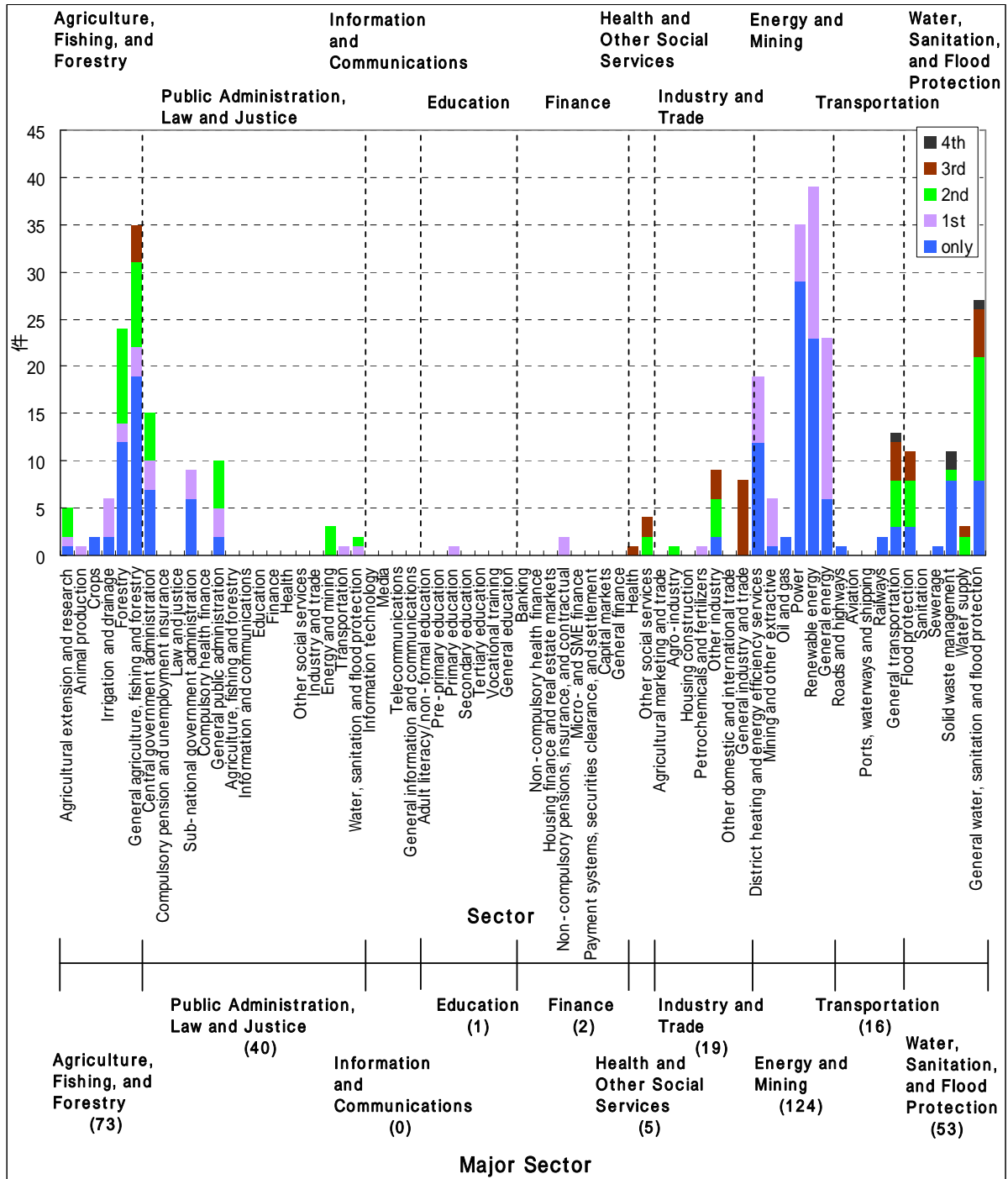
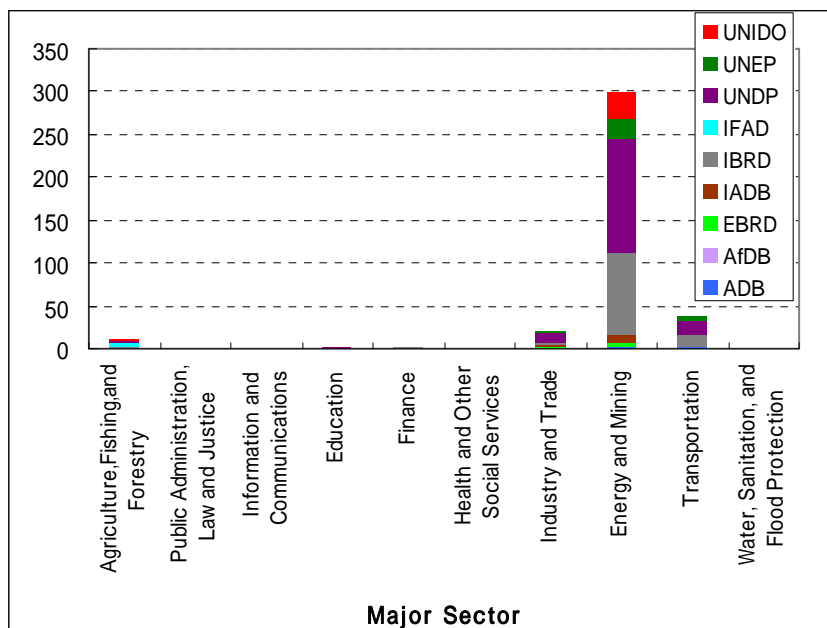


Figure 2.1.2 Summary of Sector Classification of World Bank Mitigation Projects



ADB	Asian Development Bank
AfDB	African Development Bank
EBRD	European Bank for Reconstruction and Development
IADB	Inter-American Development Bank
IBRD	International Bank for Reconstruction and Development
IFAD	International Fund for Agricultural Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization

**Figure 2.1.3 Sector Classification of GEF Registered Mitigation Projects Implemented by Various International Organizations**

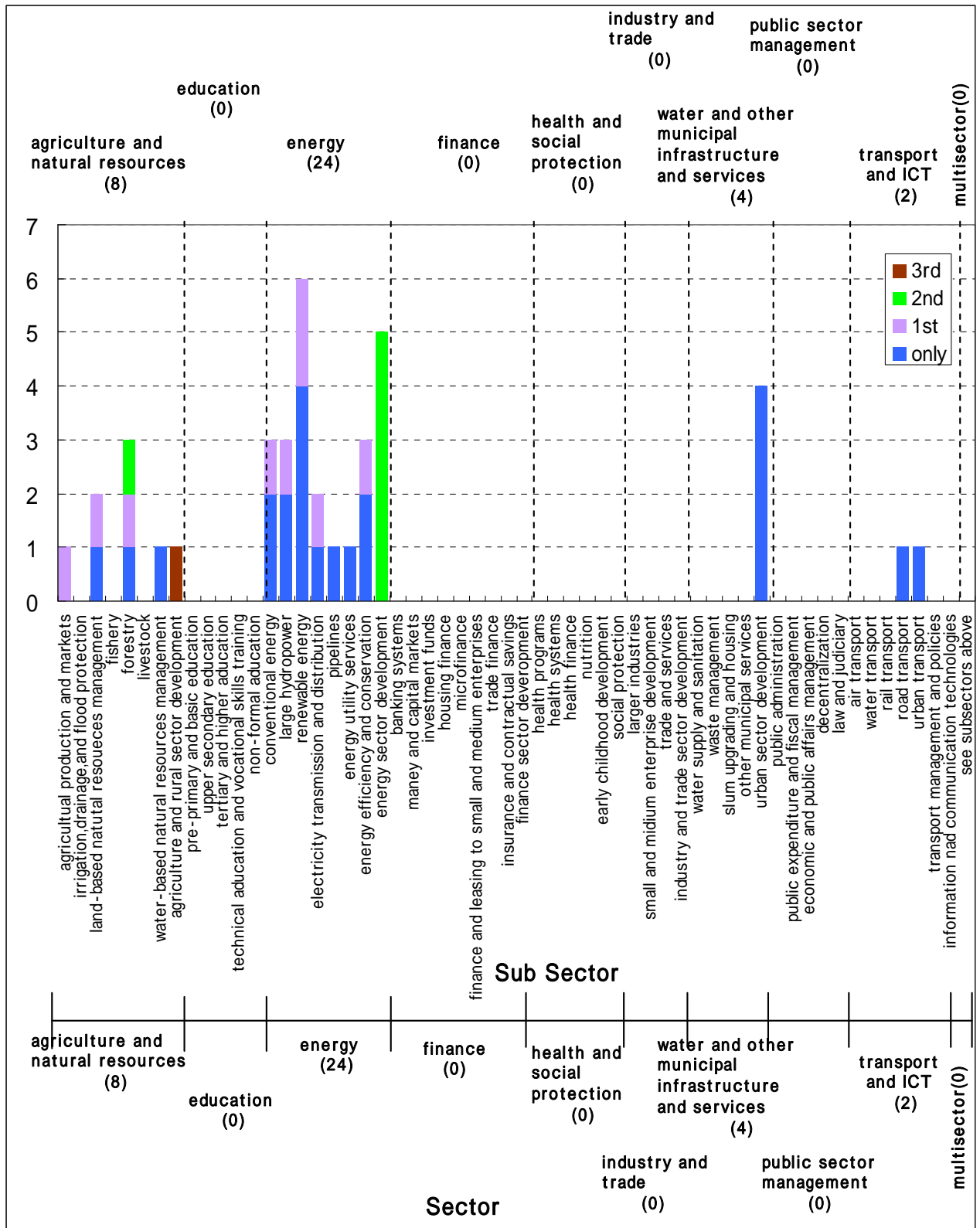


Figure 2.1.4 Summary of Sector Classification of ADB Mitigation Projects

## (4) Selection of Target Sub-sectors

Based on the above investigation, the potential of mitigation actions in each sub-sector are re-classified. As a result, the following 6 sectors and 25 sub-sectors shown in Table 2.1.3 are selected.

**Table 2.1.3 Sub-sectors for Mitigation Measures**

Sector	Sub-sector	Examples of mitigation measures
Forest/natural resource conservation	1.Afforestation	Afforestation , reforestation
	2.Forest conservation	Forest conservation
Transportation	3.Passenger/Freight transportation improvement	Passenger (a new railway, a double track railway, or a quadruple track railway)
		Freight (a new railway , double track railway)
		Improvement of rails, High standardization
	4.MRT(Mass Rapid Transit)	City and suburb rapid railway (Subway, Elevated railway)
	5.Monorail, LRT	Monorail and Light Rail Transits
	6.Bus (BRT,Trunk bus)	BRT , Trunk bus
Energy conservation (Industry)	7.Energy efficiency improvement in industrial facilities	Introduction of high efficiency facilities and technology
	8.Electricity and heat supply in industrial facilities	Effective utilization of waste heat and waste gas
	9.Fuel switching in industry facilities	Fuel switching from coal or petroleum to natural gas
Energy	10.Energy plant construction with fuel switching	Natural gas pipeline
		Natural gas supply system
		Intensive heat-supply facilities
	11.Thermal power with electricity and heat supply	Cogeneration(waste heat and waste gas use)
	12.Thermal power with fuel switching	Natural gas plants
		Natural gas pipeline
	13.Thermal power with high efficiency	Fuel switching from coal or petroleum to natural gas for existing thermal power plants
		Combined-cycle electric generation
		High efficient coal thermal power plants
	14.Power transmission with improved efficiency	Thermal power plants improvement
15.Power distribution with improved efficiency	Decreasing of electrical loss due to improved power transmission systems	
16.Rural electrification	Decreasing of electrical loss due to improved power distribution systems	
	Rural electrification project by renewable energy use	
Renewable energy	17.Hydro power	Small hydro power , river-runoff hydro power
		Reservoir hydro power (except for pumped and storage hydro power)
	18.Wind power	Wind power plants
	19.Photovoltaic power/Solar heat	Solar power plants
	20.Geothermal	Geothermal plants
21.Biomass	Biomass power generation and heat-supply	
Sewerage, Urban sanitation	22.Landfill disposal of waste	Landfill LFG power generation
	23.Intermediate treatment of waste	Waste power plants , waste composition
	24.Wastewater treatment	Methane emission reduction by improving wastewater treatment
	25.Sewerage	Biomass generation and composting sewage sludge

## 2.2 Methodologies of Other Certification Organizations, etc.

Existing methodologies and tools are reviewed in order to clarify the basic concept and guidelines to be provided under this survey.

### 2.2.1 Reviewed Methodologies

This survey mainly reviews CDM methodologies. Other methodologies, including domestic and international Voluntary Emissions Trading methodologies, GHG emission reduction calculation manual or tool used by international organization for assistance to developing countries, and VER certification organization methodologies are also considered.

Table 2.2.1 below shows the surveyed methodologies and their outlines.

**Table 2.2.1 Target and Outline of Existing GHG Estimation Methodologies (1)**

Survey Targets		Overview
CDM Methodology	Approved methodologies, Approved consolidated methodologies, Small-scale CDM methodology, Afforestation/reforestation CDM methodology Approved consolidated afforestation/reforestation CDM methodology, Small-scale approved consolidated afforestation/reforestation CDM methodology	International standard method for project-based GHG emission reductions as a method to quantify. Covering all sectors, there are 179 methodologies applied to more than 2,400 projects, as of April 28, 2011. <sup>1</sup>
Domestic Voluntary Emissions Trading methodologies	J-VER ( offset-credit system: Ministry of the Environment, Japan )	This is the methodology for calculation and certification of project-based voluntary GHG emission reduction (sequestration). <sup>2</sup>  Energy:24 , Forestry:3 , Waste:1
	Domestic Credit System (Domestic emission certification system) ( Ministry of the Environment, Ministry of the Environment, Ministry of Agriculture, Forestry and Fisheries, Japan )	This is the methodology for authentication and GHG estimation done by small businesses <sup>3</sup>  Energy, Waste, etc.:34
	J-MRV ( Japan Finance Corporation, Japan Bank For International Cooperation )	This is JBIC's tool for MRV for environmental protection activities (GREEN: Global action for Reconciling Economic growth and ENvironmental preservation) <sup>4</sup>  Energy Sector: 4, as of February 28, 2011.
Manual or tool to estimate GHG emission reduction by international organization(Developing country support)	WB ( The World Bank/Carbon Finance Unit)	The handbook has been published.  CDM projects are in accordance with the CDM methodology while other projects conform to the GEF manual. <sup>5</sup>
	IFC ( International Finance corporation)	IFC offers project-GHG calculation sheet for sectors such as forestry, water supply and sewerage and drainage, urban sanitation, others ) <sup>6</sup>
	OECD Organization for Economic Co-operation and Development)	Published a power sector manual for calculating GHG. <sup>7</sup>
	ADB(Asian Development Bank)	Released a transportation and energy sector manual on basic concept for GHG estimation. <sup>8</sup>

Table 2.2.1 Target and Outline of Existing GHG Estimation Methodologies (2)

Survey Targets		Overview
Manual or tool to estimate GHG emission reduction by international organization(Developing country support)	UNEP (United Nations Environment Program)	Released energy, transportation and industrial processes GHG calculation sheets. <sup>9</sup>
	GEF(Global Environment Facility)	In the published manual, CDM-like approach is used to quantify GHG. <sup>10</sup>
	GHG protocol (the Greenhouse Gas Protocol Initiative)	Released energy consumption, transportation and industrial processes GHG calculation sheets. <sup>11</sup>
	USAID ( United States Agency for International Development )	Released forestry and transportation sectors GHG calculation sheets (outline). <sup>12</sup>
	CIDA ( Canadian International Development Agency )	GHG calculations are conducted under a fund targeting climate change operations. Details of the program are unknown.
	GTZ(Deutsche Gesellschaft für Technische Zusammenarbeit) (*Now GIZ : The Deutsche Gesellschaft für Internationale Zusammenarbeit)	GHG calculator is released in the waste sector. <sup>13</sup>
	KFW ( Kreditanstalt für Wiederaufbau )	Released tool for GHG calculation for landfill. <sup>14</sup>
	PROPARCO (single pour Promotion et Participation pour la Coopération économique)	Estimates GHG of the project they assist. Information on the program is unknown. <sup>15</sup>
Methodology of VER Certification agency	Gold Standard	In addition to the verification and certification of CDM projects, the following criteria is used to determine the quality of CDM /JI projects. <sup>16</sup> i) Project Eligibility, ii) Additionality and baseline iii) Contribution to sustainable development
	VER+	Certification audit is basically being done using the same methodology as with CDM and JI projects. <sup>17</sup>
	CCB Standards(The Climate, Community and Biodiversity Project Design Standards)	Assessment of biodiversity, climate change mitigation effects and impact to the local community. <sup>18</sup>
	Green-e	Green Power Certification Program (Green-e) is aimed at consumer protection when power credits are sold, verifying whether the goods satisfy environmental standards. <sup>19</sup>
	VOS(Voluntary Offset Standard)	Certification system equivalent to the standard of the Kyoto credits. Target countries are mainly countries that did not ratify the Kyoto Protocol, and in particular, the U.S. and Australia (Australia ratified the Protocol). <sup>20</sup>
	CCX(Chicago Climate Exchange)	System has its own validation criteria. Provides manuals for calculation of GHG in multiple sectors. <sup>21</sup>
	CCAR(California Climate Action Registry )	The methodology of California NPO. Provides manuals for calculation of GHG in multiple sectors. <sup>22</sup>
	Plan Vivo	Grass root criteria that offer high standard for environmental protection and local benefits. The methodology is an expensive option compared to those used in the global carbon market. <sup>23</sup>

**Table 2.2.1 Target and Outline of Existing GHG Estimation Methodologies (3)**

Survey Targets		Overview
Methodology of VER Certification agency	Social Carbon	The feature of the methodology is to evaluate and verify the long-term impact assessment of sustainable development. <sup>24</sup>
	NCOS(National Carbon Offset Standard )	Efforts by the Australian Government started in July 2010, replacing Greenhouse Friendly™. The targets are Australian companies. <sup>25</sup>

<sup>1</sup> <http://www.kyomecha.org/cdm.html#method>

<sup>2</sup> [http://www.4cj.org/jver/system\\_doc/methodology.html](http://www.4cj.org/jver/system_doc/methodology.html)

<sup>3</sup> <http://jcdm.jp/process/methodology.html>

<sup>4</sup> <http://www.jbic.go.jp/ja/about/environment/j-mrv/pdf/jmrv-guideline.pdf>

<sup>5</sup> <http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/ENVIRONMENT/EXTCARBONFINANCE/0,,contentMDK:22366206~pagePK:64168445~piPK:64168309~theSitePK:4125853,00.html>

<sup>6</sup> <http://www.ifc.org/ifcext/climatebusiness.nsf/Content/GHGaccou>

<sup>7</sup> <http://www.oecd.org/dataoecd/45/43/1943333.pdf>

<sup>8</sup> <http://www.adb.org/documents/papers/adb-working-paper-series/ADB-WP09-Transport-CO2-Emissions.pdf>

<sup>9</sup> <http://www.unemg.org/MeetingsDocuments/IssueManagementGroups/SustainabilityManagement/UnitedNationsGreenhouseGasCalculator/tabid/3975/Default.aspx>

<sup>10</sup> <http://www.thegef.org/gef/node/313>

<sup>11</sup> <http://www.ghgprotocol.org/calculation-tools>

<sup>12</sup> [http://www.usaid.gov/our\\_work/environment/climate/docs/forest\\_carbon\\_calculator\\_jan10.pdf](http://www.usaid.gov/our_work/environment/climate/docs/forest_carbon_calculator_jan10.pdf)

<sup>13</sup> <http://www.gtz.de/en/themen/umwelt-infrastruktur/abfall/30026.htm>

<sup>14</sup> [http://www.kfw-entwicklungsbank.de/EN\\_Home/Sectors/Waste\\_management/Solid\\_Waste\\_Management\\_Greenhouse\\_Gas\\_Calculator/index.jsp](http://www.kfw-entwicklungsbank.de/EN_Home/Sectors/Waste_management/Solid_Waste_Management_Greenhouse_Gas_Calculator/index.jsp)

<sup>15</sup> <http://www.proparco.fr/jahia/webdav/site/afd/shared/PUBLICATIONS/INSTITUTIONNEL/plaquettes-presentation/AFD-Brochure-english-2008.pdf>

<sup>16</sup> <http://www.cdmgoldstandard.org/Current-GS-Rules.102.0.html>

<sup>17</sup> [http://www.netinform.de/KE/Beratung/Service\\_Ver.aspx](http://www.netinform.de/KE/Beratung/Service_Ver.aspx)

<sup>18</sup> [http://www.climate-standards.org/standards/pdf/second\\_edition/CCB\\_Standards\\_2nd\\_Edition\\_JAPANESE.pdf](http://www.climate-standards.org/standards/pdf/second_edition/CCB_Standards_2nd_Edition_JAPANESE.pdf)

<sup>19</sup> [http://www.green-e.org/getcert\\_ghg\\_products.shtml](http://www.green-e.org/getcert_ghg_products.shtml)

<sup>20</sup> <http://www.carboninvestors.org/ECISVoluntaryOffsetStandardFINALJune.pdf>

<sup>21</sup> <https://registry.chicagoclimatex.com/public/projectsReport.jsp>

<sup>22</sup> <http://www.climateregistry.org/>

<sup>23</sup> <http://planvivo.org.34spreview.com/documents/standards.pdf>

<sup>24</sup> <http://www.socialcarbon.org/>

<sup>25</sup> <http://www.climatechange.gov.au/en/government/initiatives/national-carbon-offset-standard.aspx>

### 2.2.2 Existing Methodologies for Targeted Sub-sectors

The existing methodologies and tools are classified into each of the mitigation sub-sectors chosen in the earlier section “Selection of Targeted Sub-sectors” and served as basic data for discussion of this survey. Some of the applied methodologies in past projects were introduced. (All existing methodologies and tools are shown in Table 2.2.2, including those in sectors with a relatively small number of or no past applications.)

#### (1) Forest and Natural Resources Conservation Sector

Some of the methodologies of CDM and J-VER are applied in the forestry sector. CDM is only applicable for afforestation and reforestation in the first commitment period (2008 ~ 2012), excluding forest management (REDD) or farmland management. Application of CDM to afforestation projects is limited. AR-AM003 has the most applied numbers, with only 4 approved projects. On the other hand, there is progress in application of Japan’s J-VER methodologies to domestic forest management projects. There are two methodologies on increase of CO<sub>2</sub> sequestration through forest management activities, with 51 applications for one of the methodologies (Thinning Promotion R001).

The ‘forest conservation’ explained here means the “Reduced Emission from Deforestation and Forest Degradation (REDD)”. The VCS guideline is referred to because the United Nations has not approved any of the REDD methodologies at the timing of the survey.



**Table 2.2.2 Existing Methodologies in Forest and Natural Resources Conservation Sector**

Sub-sector	CDM			J-VER			VCS			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
Afforestation	AR-AM0003	Afforestation and reforestation of degraded land through tree planting, assisted natural regeneration and control of animal grazing	4							Forestation	37
	AR-AM0002	Restoration of degraded lands through afforestation/reforestation	1								
	AR-AM0001	Reforestation of degraded land	2								
	AR-ACM0001	Afforestation and reforestation of degraded land	2								
	AR-AM0004	Reforestation or afforestation of land currently under agricultural use	1								
	AR-AM0005	Afforestation and reforestation project activities implemented for industrial and/or commercial uses	1								
	AR-AM0010	Afforestation and reforestation project activities implemented on unmanaged grassland in reserve/protected areas	1								
Forest conservation				R001	Increase in CO <sub>2</sub> sequestration through forest management activity (Thinning Promotion Project)	51	VM0003	Methodology for Improved Forest Management through Extension of Rotation Age, v1.0	Unknown	Forest Conservation, Slope Conservation/ Soil Conservation, Mangrove Conservation, Ecosystem ( Biodiversity ) conservation, Restoration, Forest disaster prevention	31
			VM0004				Methodology for Conservation Projects that Avoid Planned Land Use Conversion in Peat Swamp Forests, v1.0				
			VM0005				Methodology for Conversion of Low-productive Forest to High-productive Forest				
			VM0006				Methodology for Carbon Accounting in Project Activities that Reduce Emissions from Mosaic Deforestation and Degradation				

Sub-sector	CDM			J-VER			VCS			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
				R002	Increase in CO <sub>2</sub> sequestration through forest management activity (Thinning Promotion Project)	9	VM0007	REDD Methodology Modules (REDD-MF)			
							VM0009	Methodology for Avoiding Mosaic Deforestation of Tropical Forests			
							VM0010	Methodology for Improved Forest Management: Conversion from Logged to Protected Forest			
							VM0003	Methodology for Improved Forest Management through Extension of Rotation Age, v1.0			

Note : Application number is indicated in the approved real ones. In ( ) indicate the number of cases pending projects. ( as of March 31, 2011 )

## (2) Traffic and Transportation Sector

Some methodologies are currently available for CDM and J-VER in traffic and transportation sector. However, only CDM methodologies have been applied to actual project activities. There are only 6 projects because of the geographically large project boundary and difficulties in estimating/verification/monitoring of GHG emission reductions effect. As shown in Table 2.2.3, there are 5 modal shift projects applied, including 2 for bus rapid transit or BRT projects, 1 for railway, 1 for rolling stock cars for subways, 1 for cable cars, and 1 for bio-diesel production projects.

**Table 2.2.3 Existing Methodologies in Traffic and Transportation Sector**

Sub-sector	CDM			ODA Loan Projects	
	Method No.	Title	Project	Classification	Project
Freight/Passenger Transportation Improvement	AM0090	Modal shift in transportation of cargo from road transportation to water or rail transportation	0	Freight (a new railway , double track railway)	48
	AMS-III.C.	Emission reductions by electric and hybrid vehicles	1	Passenger (a new railway, a double track railway, or a quadruple track railway) Improvement of railway facilities, High standardization , Rehabilitation of railway bridges	
MRT (Mass Rapid Transit)	ACM0016	Baseline and monitoring methodology for Mass Rapid Transit Projects	0	MRT (City and suburb rapid railway : Subway, Elevated railway)	46
	AMS-III.U.	Cable Cars for Mass Rapid Transit System (MRTS)	1		
Monorail, LRT	ACM0016	Baseline and monitoring methodology for Mass Rapid Transit Projects	0	Monorail, LRT	2
	AMS-III.U.	Cable Cars for Mass Rapid Transit System (MRTS)	1		
Bus(BRT , Trunk bus)	ACM0016	Baseline and monitoring methodology for Mass Rapid Transit Projects	0		
	AM0031	Cable Cars for Mass Rapid Transit System (MRTS)	2		0

## (3) Energy Conservation (Industry) Sector

Energy conservation (Industry) sector has methodologies and actual application examples in the CDM, J-VER, Domestic Credit System and J-MRV. Domestic Credit System 001 is ranked highest at 248 applications in the sub-sector of energy efficiency improvement for industrial facilities. Also, the small-scale approved methodologies, AMS-II.D, ranked highest at 42 among other methodologies for the CDM. These are projects that include upgrading of boilers in industrial facilities.

The CDM-approved consolidated methodology, ACM0012, ranked highest at 22 in cogeneration (supply of electricity and heat) for industrial facilities. There are many scenarios in approved consolidated methodologies; however, cogeneration (supply of electricity and heat) by effective utilization of waste energy (waste gas, waste heat, waste pressure) is the target.

Small-scale CDM methodology AMS-III.B and consolidated methodology ACM0003, both with 13 applications each, rank the highest among the methodologies in the sub-sector of fossil fuel switching measure for industrial facilities. These involve fuel switching to low-carbon fuel, from fossil fuel to natural gas, etc..

**Table 2.2.4 Existing Methodologies in Energy Conservation (Industry) Sector (1)**

	CDM			J-VER			Domestic Credit System			J-MRV			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
Energy Efficiency Improvement	AMS-II.D.	Energy efficiency and fuel switching measures for industrial facilities	42	E011	Upgrade of fuel switch of boiler equipment	Update of boiler.	001	Upgrading of boiler.	248	J-MRV002	Methodology for Energy conservation project	Unknown	Energy conservation	2
	AMS-II.C.	Demand-side energy efficiency activities for specific technologies Baseline Methodology for steam optimization systems	11				004	Upgrading of air-conditioning equipment.	109					
							001-A	Installing a new boiler.	33					
	AM0018	Energy efficiency measures through centralization of utility provisions of an industrial facility	10				002	Upgrading of heat source equipment by introducing a heat pump.	28					
	AMS-II.H.	Methodology for improved electrical energy efficiency of an existing submerged electric arc furnace used for the production of SiMn	1				002-A	Upgrading of heat source equipment by introducing a heat pump. (Heat-collecting type)	8					
							002-B	Installing a new heat source equipment by introducing a heat pump	3					
	AM0038	Energy efficiency and fuel switching measures for industrial facilities; Demand-side energy efficiency activities for specific technologies	1				003	Upgrading of industrial furnace	14					
							005	Intermittent operational control, Inverter control, or Install of regulating equipments for pumps and fans	43					
AM0059	Baseline methodology for	1	010				Upgrading of transformer	5						

	CDM			J-VER			Domestic Credit System			J-MRV			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
			steam optimization systems					022	Upgrading of refrigeration equipment	2				
Electricity and heat supply	ACM0012	Consolidated baseline methodology for GHG emission reductions for waste gas or waste heat or waste pressure based energy system	22(1)	E006	Recovery and utilization of waste heat	2	014	Introduction of a small steam generator by utilizing excess steam	5	J-MRV003	Recovery and utilization of waste energy project	Unknown	Industry	15
	AMS-III.Q	Waste gas based energy systems	11(1)				009	Energy utilization of hot spring heat and waste heat	2				Factory, plant	
	AM0024	Methodology for greenhouse gas reductions through waste heat recovery and utilization for power generation at cement plants	9				013	Switching to thermal applications from the external high-efficiency heating equipment	1					
	AMS-III.P.	Recovery and utilization of waste gas in refinery facilities	4											

Table 2.2.5 Existing Methodologies in Energy Conservation (Industry) Sector (2)

	CDM			J-VER			Domestic Credit System			J-MRV			ODA Loan Projects	
	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
Fuel switching	AMS-III.B.	Supply side energy efficiency improvements – generation	13(1)	E001	Switch from fossil fuel to unused woody biomass for boiler fuel	8	012	Switch from coke to biocoke in melting furnace	1				Factory, plant Mining industry	8
	AMS-II.D.	Methodology for conversion from single cycle to combined cycle power generation	42	E002	Switch from fossil fuel to unused wood pellets for boiler fuel	5								
	ACM0003	Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology	13(1)											
	ACM0009	Supply side energy efficiency improvements – transmission and distribution	5											
	AM0036	Methodology for installation of energy efficient transformers in a power distribution grid	3											
	AMS-II.G.	Supply side energy efficiency improvements – transmission and distribution	1											

Note : Application number is indicated in the approved real ones. Values in ( ) indicate the number of cases of pending projects. ( as of March 31, 2011 )

## (4) Energy Sector

The energy sector has methodologies and actual application examples in the CDM and VCS. Projects under CDM-approved methodology AM0029 ranked highest at 31 in the sub-sector of plant supplying energy maintenance with fuel switching, targeting projects that supply natural gas originated electricity to a grid.

Projects under CDM-approved consolidated methodology ACM0012 ranked second at 22 in the sub-sector of fossil fuel fired power plants for supplying electricity. Projects under CDM small-scale methodology MS-III.B ranked third at 13 in the sub-sector of fossil fuel-fired power plants for fuel switching.

10 projects have applied CDM small-scale methodology AMS-II.B in the sub-sector of fossil fuel-fired power plants for efficiency improvement, targeting projects that replace plants such as boilers in fossil fuel-fired power plants.

**Table 2.2.6 Existing Methodologies in the Energy Sector**

Sub-sector	CDM			ODA Loan Projects	
	Method No.	Title	Project	Classification	Project
Energy plant with fuel switching	AM0029	Baseline Methodology for Grid-Connected Electricity Generation Plants using Natural Gas	31	Intensive heat-supply system with fuel switching Energy facilities(Establishment of natural gas pipeline)	28
	AM0014	Natural gas-based package cogeneration	5		
	AM0058	Introduction of a new primary district heating system	0(1)		
Thermal power with electricity and heat supply	ACM0012	Consolidated baseline methodology for GHG emission reductions for waste gas or waste heat or waste pressure based energy system	22(1)	Thermal power with electricity and heat supply	4
	AM0055	Baseline and Monitoring Methodology for the recovery and utilization of waste gas in refinery facilities	1		
Thermal power with fuel switching	AMS-III.B.	Switching fossil fuels	13(1)	Intensive heat-supply system with fuel switching	12
	ACM0011	Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation	1		
Thermal power with higher efficiency	AMS-II.B.	Supply side energy efficiency improvements – generation	10	Thermal power with high efficiency	39
	ACM0007	Methodology for conversion from single cycle to combined cycle power generation	4		
	ACM0013	Consolidated baseline and monitoring methodology for new grid-connected fossil fuel-fired power plants using a less GHG-intensive technology	3		
Power transmission with improved efficiency	AMS-II.A.	Supply side energy efficiency improvements – transmission and distribution	0	Transmission and distribution	53
	AM0067	Methodology for installation of energy efficient transformers in a power distribution grid	0		
Power distribution with improved efficiency	AMS-II.A.	Supply side energy efficiency improvements – transmission and distribution	0	Transmission and distribution	11
	AM0067	Methodology for installation of energy efficient transformers in a power distribution grid	0		
Rural electrification	AMS-I.F.	Renewable electricity generation for captive use and mini-grid	0	Renewable energy Rural electrification	31

Note : Application number is indicated in the approved real ones. Values in ( ) indicate the number of cases of pending projects. ( as of March 31, 2011 )

## (5) Renewable Energy Sector

The renewable energy sector has some methodologies available with the CDM, J-VER, and Domestic Credit System. However, only the CDM and Domestic Credit System exhibit actual application examples. Most CDM methodologies fall into two sub-sectors. One group is categorized into hydro, wind, photovoltaic and geothermal. The other is biomass.

Projects under approved consolidated methodology ACM0002 ranked highest at 900, while projects under small-scale approved methodology AMS-I.C ranked second at 846 in the sub-sector group of hydro, wind, photovoltaic and geothermal. These are all projects for grid-connected electricity generation from renewable sources. The above 2 methodologies account for about half of the current CDM approved projects.

Bio-diesel production and use for transportation applications are referred separately in the fuel switching methodologies. In this chapter, approved consolidated methodology for electricity generation with biomass residues under ACM0006 is regarded as the highest ranking methodology with 93 application cases.

**Table 2.2.7 Existing Methodologies in Renewable Energy Sector**

Sub-sector	CDM			Domestic Credit System			Yen Loan Aid Projects	
	Method No.	Title	Project	Method No.	Title	Project	Classification	Project
Hydro power, Wind power, Photovoltaic power /solar heat, Geothermal power	ACM0002	Consolidated baseline methodology for grid-connected electricity generation from renewable sources	900(29)	008	Methodology for grid-connected electricity generation from photovoltaic power system	21	Hydro power plants (except for small hydropower and pumped and storage hydropower )  Renewable energy	54
	AMS-I.D.	Grid-connected renewable electricity generation	846(21)					
	AMS-I.C.	Thermal energy production with or without electricity	114(4)					
	AM0026	Methodology for zero emissions grid-connected electricity generation from renewable sources in Chile or in countries with merit order based dispatch grid	4					
Biomass	ACM0006	Consolidated methodology for electricity and heat generation from biomass residues	93(1)	-	-	-	Renewable energy	0

Note : Application number is indicated in the approved real ones. Values in ( ) indicate the number of cases of pending projects. ( as of March 31, 2011 )



## (6) Sewerage and Urban Sanitation Sector

Sewerage and urban sanitation sector have methodologies, but only the CDM has actual application examples. In the sub-sector of waste management, projects under approved consolidated methodology ACM0001 ranked highest at 129. These include the methodologies for landfill gas capture projects.

In the 2 sub-sectors of treatment of wastewater and sewerage, 93 projects have applied small-scale approved methodology, targeting projects for methane recovery in wastewater treatment.

**Table 2.2.8 Existing Methodologies in Sewerage and Urban Sanitation Sector**

Sub-sector	CDM			Yen Loan Aid Projects	
	Method No.	Title	Project	Classification	Project
Landfill disposal of waste	ACM0001	Consolidated baseline and monitoring methodology for landfill gas project activities	129	Urban sanitation (waste disposal)	7
	AMS-III.E.	Avoidance of methane production from decay of biomass through controlled combustion, gasification or mechanical/thermal treatment	27		
	AMS-III.G.	Landfill methane recovery	13		
	AM0083	Avoidance of landfill gas emissions by in-situ aeration of landfills	1		
	AM0025	Avoided emissions from organic waste through alternative waste treatment processes	17		
Intermediate treatment of waste	AMS-III.F.	Avoidance of methane emissions through composting	36	Urban sanitation (waste disposal)	9
	AM0039	Methane emissions reduction from organic waste water and bioorganic solid waste using co-composting	2		
Wastewater treatment	AMS-III.H.	Methane recovery in wastewater treatment	93(5)	Drainage	35
	AMS-III.I.	Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems	7		
	AMS-III.Y.	Methane avoidance through separation of solids from wastewater or manure treatment systems	1		
Sewerage	AMS-III.H.	Methane recovery in wastewater treatment	93(5)	Sewerage	56
	AMS-III.I.	Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems	7		
	AMS-III.Y.	Methane avoidance through separation of solids from wastewater or manure treatment systems	1		
	ACM0014	Mitigation of greenhouse gas emissions from treatment of industrial wastewater	2		

Note : Application number is indicated in the approved real ones. Values in ( ) indicate the number of cases of pending projects. ( as of March 31, 2011 )

## Chapter 3 Basic Concept and Guidelines for the Quantitative Evaluation of GHG Emission Reduction (Sequestration)

### 3.1 Basic Concept

#### 3.1.1 Quantitative Evaluation

Mitigation measures against global warming are intended to stop the progress of global warming by reducing (or sequestering) GHG emissions and stabilize the concentrations of GHG in the atmosphere. The mitigation measures need time to show their effects but are the fundamental solutions. Actual mitigation measures such as effective use of energy and energy conservation, carbon dioxide capture and storage, and increasing carbon sinks are being implemented.

Quantification of GHG emission reduction (sequestration) aims to calculate the impact of mitigation through individual measures.

#### 3.1.2 Basic Concept of Estimation

- (1) Traffic and Transportation, Energy Conservation, Energy, Renewable Energy, Sewerage and Urban Sanitation Sectors

The effects of GHG emission reductions through a mitigation measure ( $ER_y$ ) can be estimated as the difference between the GHG emissions without the mitigation measure (baseline emissions:  $BE_y$ ) and those with the mitigation measure (project emission:  $PE_y$ ). For example, the mitigation measure involving implementation of mass rapid transportation (MRT) is as follows:

$$ER_y = BE_y - PE_y$$

Basically, the baseline emission is the GHG emission in case present conditions would continue without project implementation (other concepts can be adopted depending on individual circumstances in each project). To compare between 'with' and 'without' mitigation measure, GHG is estimated based on the assumption that the level of activities is equivalent to the 'with' mitigation measure case (such as the amount of electricity used or the volume of production).

On the other hand, the project emission is determined as the GHG emission by implementing the project. Generally, the volume of project emission is smaller than that of the baseline emission. Also, the project emission of a renewal energy project activity becomes zero.

For financial intermediary loans (two-step loans) which provide assistance to numerous small-scale or medium-scale projects through intermediate financial organizations, etc., a simplified methodology based on the methodologies presented in this report can be applied to estimate the effects of GHG emission reductions, considering the availability of the required data and work volume.

$BE_y$  : Baseline Emission (Without project)

$PE_y$  : Project Emission (With Project)



Ex. MRT Project

(2) Forestry and Natural Resources Conservation Sectors

Because trees grow by sequestering carbon dioxide from the air through photosynthesis and capturing of carbon, a forested site can be considered as a sink of carbon dioxide (or carbon). According to IPCC guidelines, net anthropogenic GHG removals by sinks ( $ER_{AR,y}$ ) can be estimated by extracting the increase (or the decrease) without the forestry (baseline absorptions:  $\Delta C_{BSL,y}$ ). Meanwhile, GHG emissions at the initial stage of the forestry project (project emissions:  $GHG_{PRJ,y}$ ) can be estimated from the increase of carbon dioxide sink after the forestry project progresses over a certain period (or the decrease by thinning and harvesting) (project absorptions:  $\Delta C_{PRJ,y}$ ).

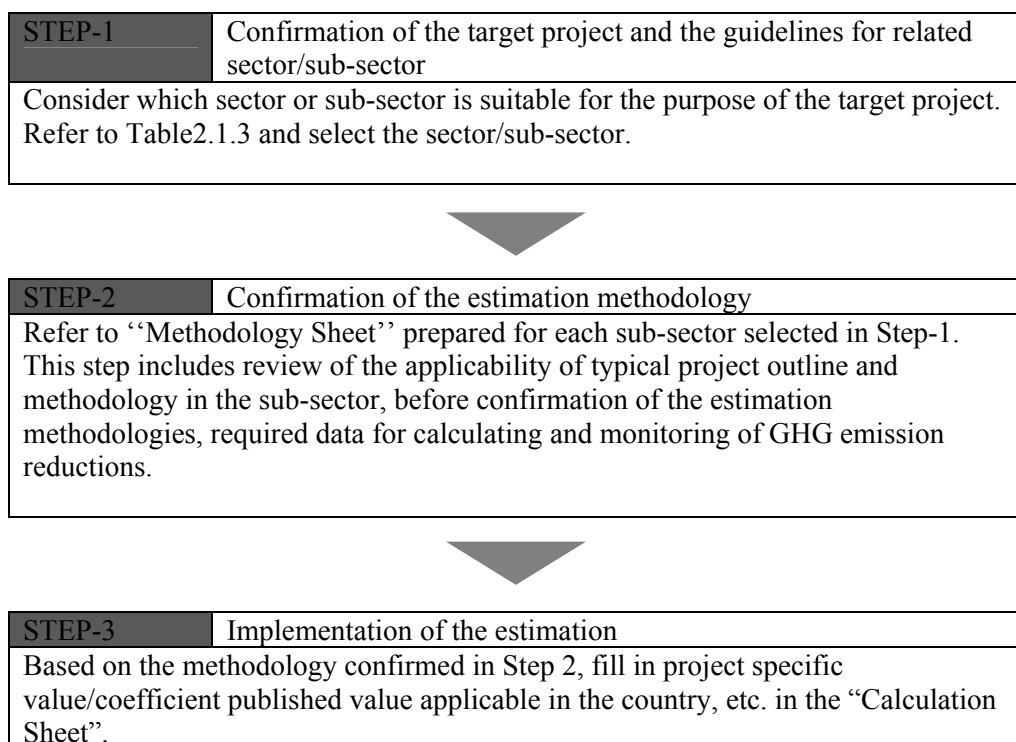
The details are also shown in the explanatory sheets for forestry and natural resources conservation sub-sectors in Chapter 4.

$$ER_{AR,y} = \Delta C_{PRJ,y} - \Delta C_{BSL,y} - GHG_{PRJ,y}$$

## 3.2 Framework of Methodology Sheet and Calculation Sheet (Excel)

### 3.2.1 Aim and Application of Methodology Sheet and Calculation Sheet (Excel)

Methodology sheets are prepared to simply estimate the quantitative effects of the GHG emission reduction at the pre-project and post-project stages on the individual project. Workflow and utilization of the methodology sheet and calculation sheets are shown in the figure below.



### 3.2.2 Outline of Methodology Sheet

Outline of the methodology sheet is described as follows:

13. Energy/ Thermal Power with higher efficiency

1. Typical Project Outline  
The project intends to suppress the greenhouse gas (GHG) from fossil fuel combustion in the fossil fired plants by reducing the fuel consumption per electric supply through the new construction of high efficient fossil fired plants or improvement of the existing power plants (upgrading to the combined cycle power plants, efficiency improvement by the improvement/upgrading of the power plants or upgrading to the higher efficiency power plants)

2. Applicability  
 For new facility: new facility construction equipped with highly efficient facilities through the project activity  
 For existing facility: replacement, upgrading, and improvement of facilities using conventional fuel  
 For the new and the existing facility: i) fossil fuel fired plants connecting the grid and ii) non-cogeneration facilities

3. Methodology on Emission Reduction  
GHG emission reduction through energy efficiency improvement shall be determined as the difference between baseline emissions (from facilities with low efficiency) and project emission (after improvement). In order to compute emission, the amount of electricity power supply is multiplied by its CO<sub>2</sub> emission factor. GHG emission factor is computed from the respective efficiency in power generation before and after the project starts. Compute the emission from generating the same amount of power supply (after the project starts) and compare them. For the existing facilities, baseline emission is computed with the monitored emission factor before the improvement of the power plants.

$$ER_y = BE_y - PE_y \quad (t-CO_2/y)$$

$ER_y$  : GHG emissions reduction in year y achieved by the project (t-CO<sub>2</sub>/y)  
 $BE_y$  : GHG emission from low efficiency facilities in year y (t-CO<sub>2</sub>/y) (Baseline emission)  
 $PE_y$  : GHG emission from improved efficiency facilities in year y (t-CO<sub>2</sub>/y) (Project emission)

[New facilities]  $BE_y$  : Baseline emission  $PE_y$  : Project emission

[Existing facilities]

1. Typical project outline  
Outline of the typical mitigation project for the sub-sector

2. Applicability  
Applicability of the methodology of GHG reduction calculation shown in this sheet

3. Methodology on emission reduction  
Description of the basic concept and formula of the estimation method

Image figure of baseline emission and project emission of typical mitigation project for the sub-sector

(1) Baseline Emission  
Baseline emission is the emission calculated based on the assumption that the current condition continues in the absence of the mitigation measure. (However, a different assumption can be made according to individual circumstances in each project.) To compare between ‘with’ and ‘without’ mitigation measure, GHG is estimated based on the assumption that the level of activities is equivalent to the ‘with’ mitigation measure case (such as the amount of electricity used or the volume of production)  
Here, basic calculation formula and explanation on the required parameters or figures, including the sub-formula for calculating the required parameters or figures, are described.

13. Energy/ Thermal Power with higher efficiency

3. Methodology on Emission Reduction (Continuation)

(1) Determination of baseline emission  
CO<sub>2</sub> emission factor is computed from the power generation efficiency without replacement, upgrading and improvement of power generator before the project starts. GHG emission necessary to generate the amount of electricity supply, equivalent to the existing power generators after the project starts.

$$BE_y = EG_{P1,y} \times EF_{BL,y}$$

Type	Parameter	Description
Output	$BE_y$	Baseline emission: GHG emission from low efficiency power generators (t-CO <sub>2</sub> /y)
Input	$EG_{P1,y}$	annual energy production after the project starts (transmission edge)(MWh)
	$EF_{BL,y}$	CO <sub>2</sub> emission factor per electric power supply (t-CO <sub>2</sub> /MWh)

**Determination of  $EF_{BL,y}$**   
 [New facilities]  
 Baseline CO<sub>2</sub> emissions factor in the new facilities is defined as the average emission factor of all power plants supplying the grid where the project activity is implemented. (Refer to Appendix C-1). The national default emission factor, data adopted by Kyoto Mechanisms or data based on IED are used for calculation. However, if the national default is not available, it should be calculated using the net electrical output of all plants, fuel used, net fuel consumption, net calorific value and CO<sub>2</sub> emission factor in addition to the interview subject from the measurement activities of the target activities. (Refer to Appendix C-1)

13. Energy/ Thermal Power with higher efficiency

(2) Determination of project emission  
To calculate project GHG emission, monitor CO<sub>2</sub> emission from the power generation efficiency what the power generator that are replaced, upgraded and improved after project activity.

$$PE_y = EG_{P2,y} \times EF_{P2,y}$$

Type	Parameter	Description
Output	$PE_y$	Project emission: GHG emission after the project starts (t-CO <sub>2</sub> /y)
Input	$EG_{P2,y}$	Annual energy production after the project starts (transmission edge)(MWh)
	$EF_{P2,y}$	CO <sub>2</sub> emission factor per electric power supply (t-CO <sub>2</sub> /MWh)

**Determination of  $EF_{P2,y}$**   
 [New facilities] [Existing facilities]  
 CO<sub>2</sub> emission factor per electric power supply after the project starts is computed using the efficiency after improvement. In order to compute  $EF_{P2,y}$  please use the planned data before the project starts and the monitoring data after the project starts.

$$EF_{P2,y} = \frac{COEF_f}{\eta_{P2,y}} \times 3.6 \left( \frac{GJ}{MWh} \right)$$

$COEF_f$  : CO<sub>2</sub> emission factor of fuel if (t-CO<sub>2</sub>/TJ)  
 $\eta_{P2,y}$  : Planned or monitoring efficiency data after the efficiency improvement of the power generation  
 3.6 : Electrical output per electric energy (1MWh=3.6GJ)

(2) Project Emission  
Project emission is the emission calculated based on the result of the mitigation measure.  
Here, basic calculation formula and explanation on the required parameters or figures, including the sub-formula for calculating the parameters or figures, are described.

13. Energy / Thermal Power with Higher Efficiency

Data Type	Description of Data	Data Acquisition Methods			
		Baseline Emissions		Project Emissions	
		Before the Project Starts	After Project Completion	Before the Project Starts	After Project Completion
Quantity of power supply (After : $EG_{P2,p}$ )	Quantity of power supply of the fossil fuel fired plants by the project activity (MWh/y)	Planned data	Measured data	Planned data	Measured data
Efficiency of power generation (Before : $\eta_{EG,p}$ ) (After : $\eta_{EG,p}$ )	Efficiency of power generation in the fossil fuel-fired plants	Measured data of one or two old and typical power plants existing in the area		Planned data	Measured data
CO <sub>2</sub> emission factor of each fuel type (COEF <sub>f</sub> )	CO <sub>2</sub> emissions factor of each fuel type (t-CO <sub>2</sub> /TJ)	Data availability is validated in the following order because it is preferable to calculate using data and information unique to the project: i) Unique data obtained from interview with power management entity ii) National default iii) IPCC Guideline default data (Annex C-3)			

4. Data required for estimation and monitoring  
Description of the data to be collected

<Timing of calculation>  
Before the project starts:  
During preparatory survey  
After project completion:  
During monitoring after project completion.

<Data acquisition methods>  
Planned data: Planned data during the preparatory survey before the project starts  
Actual data: Data measured (monitored) at power plants and factories after project completion

< Data type >  
Description of the terms in formula.

<Priority among options>  
If there are options, such as publicly available country specific value and default values issued by international organizations, the sheet presents options plus priority, based on the recognition that calculation based on project / country specific data is more desirable. If other appropriate data can be collected, users can apply a more suitable data for calculation.

13. Energy/ Thermal Power with higher efficiency

5.Others	(1)Project boundary The physical boundary for measuring GHG emissions includes power facilities where project activity is implemented.
(2)Leakage Project activity could lead to the following leakages: Plant replacement, the indirect emissions potentially lead to leakage due to activities such as product manufacturing or materials transport. This respective emission is temporary and negligible considering the project scale. Therefore it can be ignored.	
(3)Reference methodology and differences 1)AM0061(ver02) Methodology for rehabilitation and/or energy efficiency improvement in existing power plants. [Differences] - Though the reference methodology excludes new facilities as element, new facilities are used in this formula. - Power plants which run over 10 years and the last 5 year data is available is used in the reference methodology. This formula excludes these conditions. - Different calculation method is used for baseline emission when it exceeds the average electric power supply or not. It is determined using the efficiency in power supply with the specific formula. However, it is determined simply using the net power supply or the amount of power supply of the representative year in this formula. - The reference methodology excludes the leakage potential unless there are great influences. This formula also excludes the leakage in the same manner.	
2)AM0062(ver.1): Energy efficiency improvements of a power plant through retrofitting turbines [Differences] - Though the reference methodology excludes new facilities as element, new facilities are used in this formula. - The reference methodology is applied to the steam turbine and gas turbine. The amount of steam supply and the amount of power supply of the steam turbine should be able to be measured in the turbine improved under the project activities. This formula excludes these conditions. - The reference methodology excludes the leakage potential unless there are great influences. This formula also excludes the leakage in the same manner.	
3)ACM0013(ver02): Consolidated baseline and monitoring methodology for new grid connected fossil fuel fired power plants using a less GHG intensive technology [Differences] - Though the reference methodology excludes new facilities as element, new facilities are used in this formula. - Regarding the baseline fuel based on the reference methodology, applicability of the formula is for fossil fuel used in the absence of the project, which is more than 50% of the net electricity power supply in the last three years. This formula excludes these conditions. This formula excludes these conditions.	
4)AMS-ILB(ver09) Supply side energy efficiency improvements – generation [Differences] - The reference methodology is applied to reduction of the electric power at 60GWh or less or fuel consumption reduction from thermal application through improvement of existing facilities, however, the formula here has no restrictions with quantity of electricity nor excludes heat supply. - The reference methodology applies to the cogeneration facilities however, in this formula cogeneration	

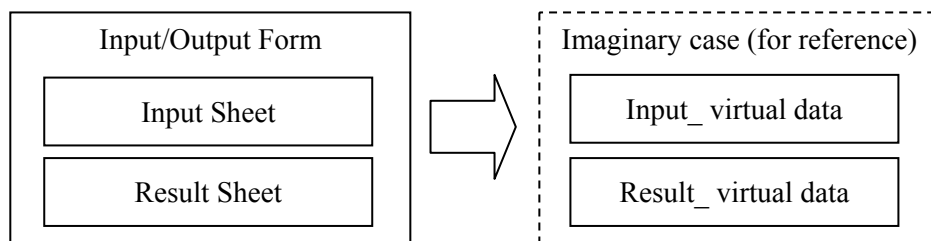
5. Others  
(1) Project boundary  
Basically, the project boundary is the project area itself. However, if special considerations are necessary for the sub-sector, it is described in this column.

(2) Leakage  
Leakage means the possibility of GHG emission outside the boundary due to the project activities. Expected leakage and how leakage is dealt with is described for each sub-sector.

(3) Reviewed Methodologies and Major Differences  
Brief description of major differences between reviewed methodologies and the methodology presented in this sheet is shown

### 3.2.3 Outline of Calculation Sheet (Excel)

Calculation sheet is composed of two sheets: "Input Sheet" and "Result Sheet.". For each sub-sector, an imaginary case using virtual data is attached to help users understand how the sheets can be utilized.



#### (1) Input Sheet

The contents of the "Data required for monitoring and estimation" indicated in the "Methodology Sheet" serve as inputs to the "Input Sheet".

**Input Sheet: New facilities**

Project Name: [Yellow input field]

**1. Quantity of power supply (of the target facilities after the project starts) (MWh/y)**  
 Input the planned data for the calculation before the project start and the measured data for the calculation after the project start.

Item	Entry field	Unit
Quantity of power supply of the fossil fuel fired facilities after the project start	[Yellow input field]	MWh/y

**2. Efficiency of power generation**  
 Input the monitoring data for the efficiency of the target facilities in absence of the project. Input the planned data for the calculation of the efficiency of the target facilities before the project start and the monitoring date for the calculation of the efficiency of the target facilities after the project start.

Before project	Item	Entry field
After project	Monitoring data before start of the project from the target facilities	[Yellow input field]
source:	Efficiency of power generation from the target facilities	[Yellow input field]

**4. CO<sub>2</sub> emission factor according to fuel type (t-CO<sub>2</sub>/TJ)**  
 Data availability is validated in the following order because it should preferably be calculated using data and information unique to the project.  
 i) The unique data of the project obtained from the interview with power management entity  
 ii) National default  
 iii) IPCC Guideline default data

[The fuel used in the target facilities]

Input item	Entry field	Unit
[Yellow input field]	[Yellow input field]	t-CO <sub>2</sub> /TJ
source:	[Yellow input field]	

Legend:  
 [Yellow box] Entry field  
 [Light yellow box] Entry field of the reference documents

Callouts:  
 - "Input the Project name."  
 - "Input data indicated by 'Methodology Sheet' into the yellow cells. (Input field is different for each sub-sector.)"  
 - "Input the source of data under the entry field."

#### (2) Result Sheet

The calculation results are shown in the "Result Sheet".

**Calculation result sheet: New facilities**

0

**GHG emission reduction with the project (t-CO<sub>2</sub>/y)  $ER_y = BE_y - PE_y$  (t-CO<sub>2</sub>/y)**

**1. Baseline emission  $BE_y = EG_{B,y} \times EF_{B,y}$**

$BE_y$	Baseline emission: GHG emission from low efficiency power generators	0	CO <sub>2</sub> /y
$EG_{B,y}$	Annual energy production after the project starts (transmission edge)	0	MWh
$EF_{B,y}$	CO <sub>2</sub> emission factor of electric power	0	CO <sub>2</sub> /MWh

**2. Project emission  $PE_y = EG_{P,y} \times EF_{P,y}$**

$PE_y$	Project emission: GHG emission after the project	0	CO <sub>2</sub> /y
$EG_{P,y}$	Annual energy production after the project starts (transmission edge)	0	MWh
$EF_{P,y}$	CO <sub>2</sub> emission factor of electric power	0	CO <sub>2</sub> /MWh

**3. GHG emission reduction with the project  $ER_y = BE_y - PE_y$  (t-CO<sub>2</sub>/y)**

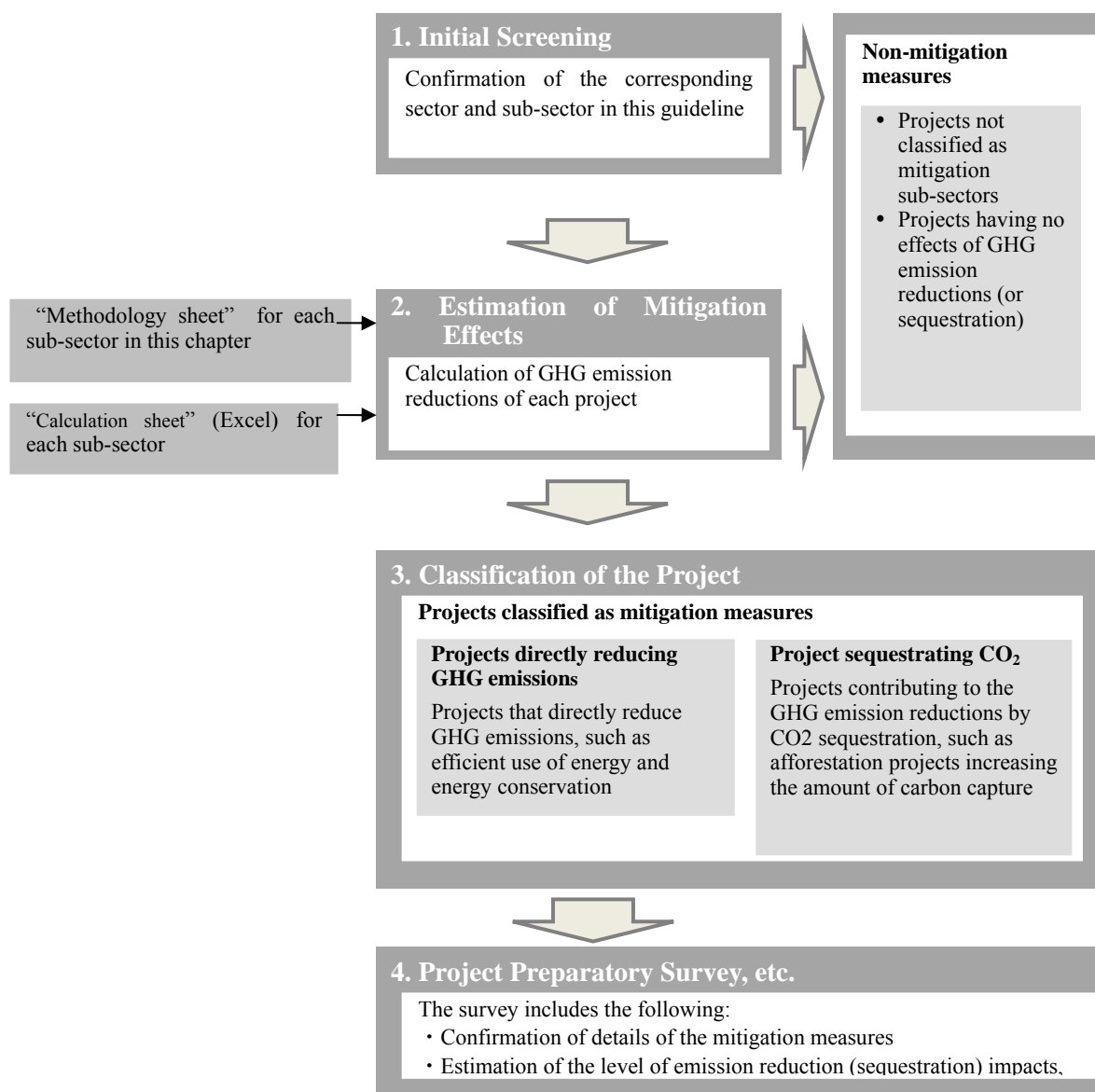
$ER_y$	GHG emission reduction with the project	0	CO <sub>2</sub> /y
$BE_y$	Baseline emission: GHG emission from low efficiency power generators	0	CO <sub>2</sub> /y
$PE_y$	Project emission: GHG emission after the project	0	CO <sub>2</sub> /y

Callouts:  
 - "Formula of 'Methodology Sheet' is embedded."  
 - "The value is inputted automatically from the 'Input Sheet'. Thus, it need not be edited."  
 - "GHG emission reductions will be calculated automatically in this sheet."

## Chapter 4 Methodology Sheets and Calculation Sheets

This chapter shows how to formulate the mitigation measures.

In Figure 4.1, a workflow shows how to identify a mitigation project, and how corresponding information should be provided to the partner nation at the preparatory survey.



**Figure 4.1 Process for Formulating Mitigation Projects**



#### 4.1 Typical Project Outlines in Targeted Sub-sectors

A typical project is outlined before preparing a guideline for each sub-sector, based on past JICA ODA loan project information. The outlines of the typical projects are shown in Table 4.1.1.

**Table 4.1.1 Outlines of Supposed Projects for Target Sub-sector(1)**

Sub-sector		Typical Project Outline
1. Afforestation		The project intends to expand CO <sub>2</sub> sink through afforestation in non-forest lands including degraded, pasture or agricultural lands. For reducing emissions from deforestation and forest degradation (REDD), refer to “2. Forest Conservation”.
2. Forest conservation		The project intends to reduce GHG emission through prevention of deforestation such as unregulated logging in developing countries (REDD). Refer to “1. Afforestation” for CO <sub>2</sub> sinks increase through afforestation.
3. Passenger /Freight transportation improvement	3.1 Railway ,passengers	The project intends to reduce GHG emissions by realizing “modal shift” from existing passenger transport systems (i.e., conventional buses, passenger cars, taxis and bikes) to passenger railway systems such as a new railway, a double track railway, or a quadruple track railway. In addition, “electrification” of passenger railway systems will reduce GHG emissions.
	3.2 Railway , freight	The project intends to reduce GHG emissions by realizing “modal shift” from existing freight transport systems (i.e., conventional trucks and trailers) to freight railway systems such as a new railway, a double track railway. In addition, “electrification” of freight railway systems will reduce GHG emissions.
4.MRT(Mass Rapid Transit)		The project intends to reduce GHG emissions by realizing “modal shift” from existing transport systems (i.e., buses, private cars, taxis and bikes) to a Mass Rapid Transit (MRT) system.
5.Monorail, LRT		The project intends to reduce GHG emissions by realizing “modal shift” from existing transport systems (i.e., buses, private cars, taxis and bikes) to a light or medium transport system such as monorail and LRT (Light Rail Transit).
6.Bus ( BRT, Trunk bus )		The project intends to reduce GHG emissions by realizing “modal shift” from existing transport systems (i.e., buses, private cars, taxis and bikes) to Bus Rapid Transit (BRT) or trunk bus systems.
7.Energy efficiency improvement		The project intends to inhibit greenhouse gas (GHG) emissions by reducing fuel consumption in industrial facilities through energy efficiency improvements such as efficient motors adoption.
8. Electricity and heat supply		The project intends to directly suppress electricity/fuel consumption and reduce GHG emissions in industrial facilities, such as steel plants and cement plants, through recovery and utilization from waste energy (waste heat, waste gas pressure).
9.Fuel switching		The project intends to inhibit GHG emissions through switching from high carbon content heavy oil fuel in order to lower carbon content fuel in new and existing industrial facilities.
10.Energy plant with fuel switching		The project intends to inhibit GHG emissions by switching from high carbon content heavy oil fuel in order to lower carbon content fuel of new and existing intensive heat-supply facilities.
11.Thermal power with electricity and heat supply		The project intends to directly reduce GHG emissions and suppress fuel consumption for electricity generation through recovery and utilization (new construction of combined cycle power plants etc.) from waste energy (waste heat, waste) at fossil fuel fired power plants.

**Table 4.1.1 Outlines of Supposed Projects for Target Sub-sector(2)**

Sub-sector		Typical Project Outline
12. Thermal power with fuel switching		The project intends to inhibit GHG emissions by switching from high carbon content heavy oil fuel to lower carbon content fuel at new and existing intensive heat supply facilities.
13. Thermal power with higher efficiency		The project intends to suppress the greenhouse gas (GHG) from fossil fuel combustion in the fossil fired plants by reducing the fuel consumption per electric supply through the new construction of high efficient fossil fired plants or improvement of the existing power plants (upgrading to the combined cycle power plants, efficiency improvement by the improvement/upgrading of the power plants or upgrading to the higher efficiency power plants)
14. Power transmission with improved efficiency		The project intends to directly suppress GHG emissions associated with transmission loss, through reducing power loss in the transmission grid or through maintenance of high voltage substation at new and existing facilities for electric energy transmission-transformation.
15. Power distribution with improved efficiency		The project intends to directly suppress GHG emissions associated with distribution loss, through reducing power loss in the distribution grid or efficiency improvements of distribution equipment at new and existing facilities for electric energy distribution.
16. Rural electrification		The project intends to directly reduce greenhouse gas (GHG) emissions by generating power from renewable energy sources, which generate limited amounts of GHG. This is realized through the implementation of renewable energy utilization project in the area where there is no connection to the main electricity transmission grid, or diesel power generation or kerosene lamp is not applied.
17. Hydro power		The project intends to directly contribute to GHG emission reduction through hydropower plants construction aiming to generate renewable energy, which does not emit GHG at flaring, with the use of natural resources such as hydro power.
18. Wind power		The project intends to directly contribute to GHG emission reduction through the use of wind power plants in generating power. Thus, no GHG is generated with the use of natural resources such as wind power.
19. Photovoltaic power /Solar heat	19.1 Photovoltaic power	The project intends to directly contribute to GHG emission reduction through generation of power from photovoltaic power plants. Thus there is reduction in GHG emission with the use of non-fossil fuel source such as photovoltaic power.
	19.2 Solar heat	The project intends to directly reduce GHG emissions by generating power from solar power plants, which generate limited amounts of GHG. The requirement for flaring of GHGs to reduce emissions, with the use of natural resources such as concentrated solar power, is eliminated.
20. Geothermal power		The project intends to directly reduce GHG emissions by generating power from geothermal power plants, which generate limited amounts of GHG. The requirement for flaring of GHGs to reduce emissions with the use of natural resources such as geothermal power is eliminated.
21. Biomass		The project intends to directly reduce GHG emissions through electricity generation or heat generation from biomass residues instead of fossil fuel fired at power plants or factories which leads to reduce consumption of electricity or fossil fuel.

**Table 4.1.1 Outlines of Supposed Projects for Target Sub-sector(3)**

Sub-sector	Typical Project Outline
22.Landfill disposal of waste	The project intends to reduce GHG emission through recovery and utilization of landfill gas (LFG) generated from landfill after the completion of reclamation and from active landfill.
23.Intermediate treatment of waste	The project intends to reduce the GHG emissions without disposing in landfill but by waste treatment such as composting or anaerobic digestion etc.
24.Wastewater treatment	The project intends to reduce the GHG emissions by suppressing CH <sub>4</sub> from the sewage sludge decay through composting the sewage sludge.
25.Sewerage	The project intends to reduce GHG emission through improving the living condition and reducing CH <sub>4</sub> from sewer water with wastewater treatment from the houses or factories.

## 4.2 Methodology Sheets and Calculation Sheets (Excel) for Each Sub-sector

Methodology sheets and calculation sheets are prepared for the following sub-sectors.

Forest and Natural Resources Conservation Sector

1. Afforestation
2. Forest Conservation

Traffic and Transportation Sector

- 3.1 Railway, Passengers
- 3.2 Railway, Freight
4. MRT (Mass Rapid Transit)
5. Monorail, LRT
6. Bus ( BRT , Trunk Bus )

Energy Conservation (Industry) Sector

7. Energy Efficiency Improvement
8. Electricity and Heat Supply
9. Fuel Switching

Energy Sector

10. Energy Plant with Fuel Switching
11. Thermal Power with Electricity and Heat Supply
12. Thermal Power with Fuel Switching
13. Thermal Power with Higher Efficiency
14. Power Transmission with Improved Efficiency
15. Power Distribution with Improved Efficiency
16. Rural Electrification

Renewable Energy Sector

17. Hydro Power
18. Wind Power
- 19.1 Photovoltaic Power
- 19.2 Solar Heat
20. Geothermal Power
21. Biomass

Sewerage and Urban Sanitation Sector

22. Landfill Disposal of Waste
23. Intermediate Treatment of Waste
24. Wastewater Treatment
25. Sewerage

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Japan International Cooperation Agency (JICA)  
Climate Finance Impact Tool for Adaptation

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List of Abbreviations

ADB	Asian Development Bank
AGCM	Atmospheric Global Climate Model / Atmospheric General Circulation Model
AOGCM	Coupled Atmosphere-Ocean Global Climate Model/ Atmospheric Ocean General Circulation Model
CBD	Convention on Biological Diversity
COP15	Fifteenth Conference of Parties
CMIP3	phase 3 of the Coupled Model Intercomparison Project
DAC	Development Assistance Committee
DALYs	Disability Adjusted Life Years saved
EB	Environmental Benefits
EPOC	Environment Policy Committee
FAO	Food and Agriculture Organization
GCM	Global Climate Model / General Circulation Model
GEF	Global Environment Facility
GIS	Geographic Information System
GIZ	Gesellschaft für Internationale Zusammenarbeit
GTZ	Gesellschaft für Technische Zusammenarbeit
IPCC	Intergovernmental Panel on Climate Change
IPCC AR4	IPCC Forth Assessment Report
IUFRO	International Union of Forest Research Organization
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LDC	Least Developed Countries
MLIT	Ministry of Land, Infrastructure and Transportation
MoE-J	Ministry of the Environment Japan
ODA	Official Development Assistance
OECD	Organization for Economic Cooperation and Development
OGCM	Oceanic Global Climate Model / Ocean General Circulation Model
RCM	Regional Climate Model
SH	Saved Health
SRES	Special Report on Emissions Scenarios
SW	Saved Wealth
TOR	Terms of References
UFW	Unaccounted-For-Water
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank
WHO	World Health Organization
WMO	World Meteorological Organization

## Chapter 1 Outline of the Survey

### 1.1 Background and Objectives of the Survey

The 16th Conference of the Parties (COP16) of the United Nations Framework Convention on Climate Change (UNFCCC) adopted the Cancun Agreements. The agreements clearly state the commitment by developed countries to provide financial support to developing countries in the field of climate change, which include i) collective commitment approaching USD 30 billion for three years from 2010 to 2012 (as Fast-start finance) and ii) joint mobilization of USD 100 billion per year by 2020 (as Long-term finance). The direction of future framework on climate change after 2013 is still under discussion. It is considered that Official Development Assistance (ODA) will continue to be actively utilized as part of the support for the developing countries in the field of climate change. For assistance in the climate change sector, the Cancun Agreements request vulnerability reduction, sustainability and increase in adaptability and resistance, particularly in least developed countries (LDC), the Alliance of Small Island States (AOSIS), and Africa.

Taking into account the above situations, JICA is faced with the task to tackle adaptation during the planning stages of country assistance strategies and individual projects to ensure planning and implementation of appropriate adaptation-related projects based on vulnerability assessment.

This survey presents a reference document that discusses issues for mainstreaming climate change adaptation during the planning stages of country assistance strategies and individual projects by summarizing them as "concepts" and "guidelines".

This report summarizes the survey on adaptation measures as part of the "Study on Mainstreaming Climate Change Considerations into JICA Operation".

### 1.2 Selection of Target Sub-sectors and Review of Existing Resources

Based on the review of past JICA ODA loan projects and the trend of other donors' assistance, 15 sub-sectors were chosen as potential areas of future JICA ODA loan assistance. In order to establish the concepts and guidelines for designing the adaptation measures, existing documents on vulnerability assessment and adaptation measures prepared by other donors and funding agencies were reviewed.

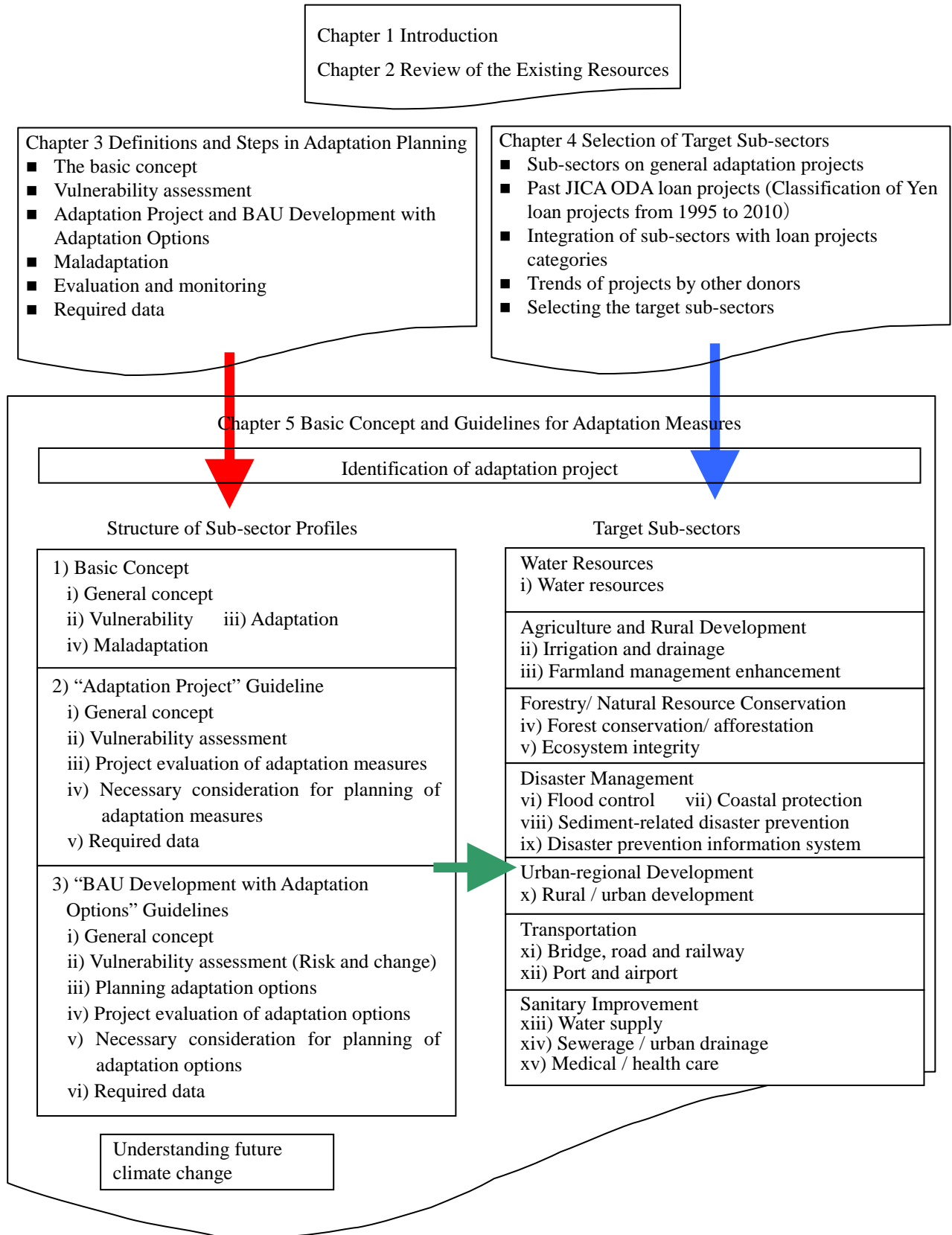
### 1.3 Basic Concept and Guidelines for Adaptation

For the selected 15 sub-sectors, basic concept and guidelines, which include the contents shown in Section 1.4, are prepared. Definitions and interpretations of technical terms are presented in Chapter 3. In developing countries, it can be easily anticipated that there exists great limitation in data availability. In order to overcome this difficulty, the presented guidelines allow flexibility in data selection.

Understanding the future climate change, which is a common step for considering adaptation measures in all sub-sectors, is presented in a separate section (Chapter 5 0. Understanding Future

Climate Change).

### 1.4 Framework of the Report





## Chapter 2 Review of the Existing Resources

### 2.1 Existing Reports on Adaptation Activities by JICA

#### (1) JICA's Assistance for Adaptation to Climate Change<sup>1</sup>

The report summarizes the result of researches implemented in the fiscal year 2006 in order to systematically understand how to position JICA's role in cooperation and promotion of assistance for adaptation to climate change.

Since the report was prepared before the JICA-JBIC merger in October 2008, the contents and most examples raised in the report as adaptation activities are for technical assistance implemented by pre-merger JICA. The report mainly focuses on two basic concepts for adaptation activities: a) human security-oriented assistance and b) capacity development-oriented assistance.

Table 2.1 outlines the report contents, while Table 2.2 summarizes the key different features between the report's and this survey's focuses.

**Table 2.1 Outline of JICA's Assistance for Adaptation to Climate Change**

Outline of adaptation measures	<p>Outline of climate change          Adaptation is not clearly defined; however, there is wide recognition about the need for adaptation measures.          Relationship between development assistance and adaptation measures          Significance of JICA's engagement to adaptation measures</p>																												
International trend for adaptation	<p>Trend of discussion at international conferences          Trend of efforts to support adaptation measures in developing countries by Japan, developed countries, international organizations, etc.</p>																												
Adaptation-related projects of JICA	<p>The report counts past JICA projects that contribute to adaptation. These projects were not classified and implemented as "Adaptation" measures.</p> <table border="1" data-bbox="563 1395 1254 1906"> <thead> <tr> <th colspan="2">Technical cooperation</th> </tr> </thead> <tbody> <tr> <td>Water resources</td> <td>11 projects</td> </tr> <tr> <td>Agriculture and rural development</td> <td>84 projects</td> </tr> <tr> <td>Forestry/ natural resource conservation</td> <td>14 projects</td> </tr> <tr> <td>Disaster management (including coastal protection)</td> <td>7 projects</td> </tr> <tr> <td>Urban-regional development</td> <td>2 projects</td> </tr> <tr> <td>Transportation</td> <td>4 projects</td> </tr> <tr> <td>Health</td> <td>16 projects</td> </tr> <tr> <td>Tourism</td> <td>2 projects</td> </tr> <tr> <td>Promotion of small and medium enterprises and supporting industries</td> <td>2 projects</td> </tr> <tr> <td>Electricity, energy</td> <td>1 projects</td> </tr> <tr> <td>Resources, energy conservation</td> <td>4 projects</td> </tr> <tr> <td>Global environment</td> <td>14 projects</td> </tr> <tr> <td>Grant Aid</td> <td>33 projects</td> </tr> </tbody> </table>	Technical cooperation		Water resources	11 projects	Agriculture and rural development	84 projects	Forestry/ natural resource conservation	14 projects	Disaster management (including coastal protection)	7 projects	Urban-regional development	2 projects	Transportation	4 projects	Health	16 projects	Tourism	2 projects	Promotion of small and medium enterprises and supporting industries	2 projects	Electricity, energy	1 projects	Resources, energy conservation	4 projects	Global environment	14 projects	Grant Aid	33 projects
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<sup>1</sup> JICA.(2007). JICA's Assistance for Adaptation to Climate Change

Adaptation in each target sector	The chart below summarizes the contents of adaptation activities expected in each target sector.	
	Sector	Expected principal adaptation activity
	Water resources	Proper management, development, utilization of water resources, and water and sanitary improvement
	Agriculture and rural development	Upgrading irrigation facilities, crop development, local participation in rural development, adaptations for climate extremes
	Forestry/ natural resource conservation	Cultivation of trees resistant to diseases and pests, mangrove conservation, forest disaster prevention, afforestation in degraded land of arid region
	Disaster management	Coastal protection, river basin disaster management, sediment-related disaster prevention, assistance for disaster prevention planning
	Urban-regional development and transportation	Development planning, infrastructure construction
	Health	Malaria prevention, waterborne (infectious) disease control, adaptations for high risk area
Others (training, volunteer)	Tropical disease prevention, water resources management technology in arid region, wind and flood prevention against precipitation increase, cultivation of agricultural crops, ecosystem conservation	

**Table 2.2 Key Different Features between JICA’s Assistance for Adaptation to Climate Change and this Survey**

Items	JICA’s Assistance for Adaptation to Climate Change	This Survey
Focused Aid Schemes in Selection of Target Sectors	Technical Assistance	Loan Assistance
Structures	After the review of climate change impacts, general concept of adaptation measures, and trends of global and Japan’s assistance, it outlines adaptation measures in each target sector.	After the review of approaches and methodologies toward adaptation measures undertaken by other major donors, it outlines definitions and formulation process for adaptation measures to be adopted by JICA’s assistance scheme, and finally describes the guidelines for each target sub-sector.
Descriptions for Each Sector	It discusses possible adaptation measures and way forward for the measures based on the review of the past implemented cases in technical assistance scheme.	It outlines a concept of “Adaptation Project” as well as “Business-as-usual (BAU) Development”, which incorporates adaptation options in response to anticipated climate change impacts. Furthermore, it presents the guidelines to formulate assistance project in both cases for each target sub-sector.

(2) Handbook on Climate Change Adaptation in the Water Sector<sup>1</sup>

This handbook provides JICA’s guideline in implementing adaptation activities as ODA project in developing countries for the water sector, which is greatly influenced by climate change. Outline of the Handbook is as shown in Table 2.3.

<sup>1</sup> JICA.(2010). Handbook on Climate Change Adaptation in the Water Sector

**Table 2.3 Outline of the Handbook on Climate Change Adaptation in the Water Sector**

Approach	5 basic concepts for approach to implementing sustainable actions under uncertainty of the future climate 1) Human security 2) Engagement with the society 3) Building a sustainable adaptive society 4) Disaster risk management 5) "Zero victim" goal of flood control
Methods for forecasting extreme events with climate change	The report presents concepts for utilizing projected results from IPCC Fourth Assessment Report, etc. Specifically, the report discusses the following prediction methods with consideration to the uncertain nature of climate forecasting. <ul style="list-style-type: none"> <li>▪ Downscaling of AGCM20</li> <li>▪ Downscaling of GCM</li> <li>▪ Bias-correction on AGCM20</li> <li>▪ GCM ensemble averaging</li> <li>▪ Simple statistical downscaling of GCM</li> </ul>
Impact assessment analysis	The following 3 steps are explained as methods for impact assessment. Examples are used to explain procedures in each step. 1) Climate change prediction 2) Monitoring of existing facilities and current adaptation mechanisms 3) Impact assessment
Adaptation planning	The report describes adaptation measures typically planned in the water sector. 1) River basin governance 2) Meteorological/hydrological observation, warning, evacuation 3) Flood control 4) Integrated water resources management 5) Coastal protection 6) Protection of the socially vulnerable and the poor 7) Disaster insurance 8) Monitoring/maintenance
Capacity development assistance	In addition to the business-as-usual technical assistance, it explains the need for capacity development at various levels such as individuals, organizations and society for adaptation to climate change.

## 2.2 Wise Adaptation to Climate Change<sup>1</sup>

The report was prepared by the "Committee on Climate Change Impacts and Adaptation Research", which was established in October 2007 by the Ministry of the Environment, Japan. In the report, priority was given to adaptation activities resulting from conscious efforts and interventions by humans, in addition to the definition by IPCC AR4. In other words, the report has mostly targeted adaptation that is undertaken based on the decision of policymakers in national and local governments, and adaptation that is driven by individuals, communities, etc.

The contents shown in Table 2.4 are discussed in every chapter for the following 8 sectors: Food, Water Environment and Water Resources, Natural Ecosystems, Disaster Prevention and Large Coastal Cities, Health, Citizen's Life and Urban Life, Developing Countries, and Others. Among the discussed points, 2) and 3) are focused on Japan. Methods and tools for vulnerability assessment and case studies are shown in 4) for some sectors. In addition to adaptations in developed countries including Japan, adaptations that can be used worldwide are shown in 5).

<sup>1</sup> MoE-J.(2008). Kikouhendou heno Kashikoi Tekiou (in Japanese)

**Table 2.4 Contents in Each Sector**

- |   |
|---|
| <ol style="list-style-type: none"> <li>1) Mechanism of impacts</li> <li>2) Observed impacts</li> <li>3) Projected impacts</li> <li>4) Vulnerability assessment</li> <li>5) Adaptation measures</li> <li>6) Future challenges</li> </ol> |
|---|

Chapter 8 deals with adaptation in developing countries, presenting overarching points shown in Table 2.5 .

**Table 2.5 Overarching Points on Adaptation in Developing Countries**

Approach to Adaptation	<p>According to the case studies of adaptation (McGray et al. 2007), adaptations are divided into three categories as follows:</p> <ol style="list-style-type: none"> <li>1) Activities seeking to address economic development which collaterally contributes to adaptation to climate change as a result</li> <li>2) Activities seeking to incorporate climate information into design and implementation of development action</li> <li>3) Activities seeking to address impacts associated exclusively with climate change</li> </ol> <p>There are 2 major approaches to deal with the relationship between adaptation and development. The first approach is to address specific risk caused by climate change, so called the "climate risk oriented approach". The other is the approach to reduce vulnerability through capacity development for many climate and non-climate change related tasks, so called "vulnerability oriented approach".</p>
Necessary Actions	<p>The following actions are regarded as necessary in the planning and implementation of adaptation:</p> <ol style="list-style-type: none"> <li>1) Integration of adaptation into development and poverty prevention.</li> <li>2) Evaluation and utilization of existing adaptation methods.</li> </ol> <p>Numerous adaptations have been conducted in the past to cope with natural climate fluctuation in Asia. Strengthening of the measures, evaluation of its limitations, and integration of these with new technology and methods are needed.</p> <ol style="list-style-type: none"> <li>3) Mainstreaming of adaptation in related sectors</li> </ol> <p>Natural resources, agriculture, disaster, and health sectors are typically vulnerable to climate change. The strategy and plans of these sectors should be implemented in consideration of climate risk (known as "mainstreaming of adaptation").</p> <ol style="list-style-type: none"> <li>4) Promotion of co-benefit type adaptation; avoidance of maladaptation</li> <li>5) Involvement of stakeholders</li> <li>6) Awareness raising and capacity development</li> </ol>

## 2.3 Major Reports by Other Development Aid Agencies, etc.

### 2.3.1 OECD

#### (1) Addendum on the Climate Change Adaptation Marker<sup>1</sup>

OECD introduced "New Marker on Climate Change Adaptation" since February 2010. An activity should be classified as adaptation-related if it intends to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing the adaptive capacity and resilience.

<sup>1</sup> OECD/DAC.(2010). ADDENDUM ON THE CLIMATE CHANGE ADAPTATION MARKER. DCD/DAC(2007)39/FINAL/ADD3

(2) Integrating Climate Change Adaptation into Development Co-operation – Policy Guidance<sup>1</sup>  
 In this report, the OECD Environment Policy Committee (EPOC) and Development Assistance Committee (DAC) discuss about the need for integration of climate change adaptation into local development planning processes and their approaches. Because of the high vulnerability to climate change and scarce resource availability, assistance to developing countries in the aspect of planning should be flexible for climate change adaptation. Therefore, integration of climate change adaptation into the development policy is introduced as a key factor (Table 2.6).

**Table 2.6 Outline of “Integrating Climate Change Adaptation into Development Co-operation - Policy Guidance”**

Executive Summary	Objectives and target audience(co-operation agencies, policy makers) and structure of guidance
Weather, Climate Variability and Climate Change	Overall future climate change is outlined in reference of the projection based on the IPCC reports
Vulnerability of the Developing World to Climate Change	High vulnerability to climate change and impacts on societies in developing countries are assumed. In this section, sensitivity, adaptive capacity and adaptation are defined as follows:  Sensitivity: Sensitivity is the degree to which a system can be affected, either negatively or positively, by changes in climate. This includes change in mean climate and the frequency and magnitude of extremes. The effect may be direct (for example, a change in crop yield due to a change in temperature) or indirect (such as damage caused by increased frequency of coastal flooding due to sea level rise). Sensitivity also includes exposure which considers the nature and magnitude of climate change and whether a system would be affected by such change.
	Adaptive capacity: Adaptive capacity is a system’s ability to adjust to climate change (including climate variability and extremes), to moderate potential damage, to take advantage of opportunities or to cope with consequences.
	Vulnerability: Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude and rate of climate change, and the degree to which a system is exposed, along with its sensitivity and adaptive capacity.
	Adaptation: Adaptation is defined as adjustment in human and natural systems, in response to actual or expected climate stimuli or their effects that moderate harm or exploit beneficial opportunities.

<sup>1</sup> OECD/DAC.(2009).Integrating Climate Change Adaptation into Development Co-operation – Policy Guidance

Adapting to the Impacts of Climate Change	<p>The report topic mainly focuses on classification of adaptation to climate change and differences between the regular development planning and adaptation planning. Adaptation is classified as follows:</p> <ul style="list-style-type: none"> <li>▪ Bear losses</li> <li>▪ Share losses</li> <li>▪ Modify the threat (include flood control works such as dams, dikes, and levees)</li> <li>▪ Prevent effects. For example, in agriculture, increased irrigation water.</li> <li>▪ Change in use (a farmer may choose to substitute a more drought tolerant crop)</li> <li>▪ Change of location</li> <li>▪ Research</li> <li>▪ Encourage behavioral change through education, information and regulation</li> </ul>
	<p>How is adaptation different from regular development?  In principle, a range of development activities oriented towards reduced poverty and improved nutrition, education, infrastructure and health would be synergistic with adaptation to climate change.  For example, in order to respond to the impact of climate change on coral reefs or the increased risk of glacial lake outburst floods, targeted adaptation activities need to be developed.</p>
	<p>Maladaptation:  In this policy guidance, maladaptation is defined as business-as-usual development which, by overlooking potential impacts, inadvertently increases exposure and/or vulnerability to climate change. Maladaptation could also include actions undertaken to adapt to climate impacts that do not succeed in reducing vulnerability, but increase it instead.</p>
Operationalizing Adaptation: From Theory to Action	<p>Step1: Identifying current and future vulnerabilities and climate risks;  Step2: Identifying adaptation measures;  Step3: Evaluating and selecting adaptation options; and  Step4: Evaluating “success” of adaptation.</p>
Integrating Climate Change Adaptation at National, Sectoral and Project Level	<p>The report topic explains how we integrate the adaptation into development at national, sectoral and project level.</p>

### 2.3.2 UNDP

#### (1) Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures <sup>1</sup>

The key issue, especially for non-Annex I parties, is how to develop national strategies for adaptation to climate change that are easy to integrate into sustainable development plans. Most national vulnerability and adaptation studies to date have focused on the selection of climate change scenarios and impact studies. The main objective of the guidebook and the technical papers is to assist and provide guidance to developing countries in identifying, prioritizing, and shaping potential adaptation options into a coherent strategy that is consistent with their sustainable development and other national priorities.

In consideration of the objective above, the report explains each step of adaptation design process. Adaptation to climate change comprise of five consecutive processes for task identification, project formation and follow-up. It explains what to implement in each process. The four steps, excluding the implementation step, are as shown in Table 2.7.

<sup>1</sup> UNDP.(2004). Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures

**Table 2.7 Steps to Design Adaptation-related Project in “Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures”**

Step1: Scoping and designing an adaptation-related project	1)Identify scope of project and define the objectives -Prioritize key systems -Review policy process -Determine project objectives and outcomes 2) Establish the project team 3)Review and synthesize existing information on vulnerability and adaptation In this step, baseline project (vulnerability and adaptation without project) shall be clearly defined. -Develop indicators -Review and synthesize existing information 4) Design the adaptation project -Select approaches and methods -Develop synthesis plan -Develop monitoring and evaluation strategy -Develop the terms of reference
Step2: Assessing current vulnerability	1) Assess climate risks and potential impacts 2) Assess socio-economic conditions 3) Assess adaptation experience 4) Assess vulnerability
Step3: Assessing future climate risks	1) Characterize climate trends, risks and opportunities 2) Characterize socio-economic trends, risks and opportunities Characterize socio-economic trends with respect to both plan being executed and not being executed (baseline) 3) Characterize natural resource and environmental trends 4) Characterize adaptation barriers and opportunities
Step4: Formulating an adaptation strategy	1) Synthesize previous components/studies on potential adaptation options 2) Identify and formulate adaptation options 3) Prioritize and select adaptation options 4) Formulate the adaptation strategy

(2) Mapping Climate Change Vulnerability and Impact Scenarios – A Guidebook for Sub-National Planners<sup>1</sup>

This UNDP guidebook targets adaptation planning policy makers at sub-national scale for identifying adaptation and mapping vulnerability to climate change. In this guidebook, vulnerability assessment measure is coherently described in the order shown in Table 2.9. The definitions of “Vulnerability”, “Sensitivity” and “Adaptive Capacity” used in the guidebook are shown in Table 2.8.

<sup>1</sup> UNDP.(2010). Mapping Climate Change Vulnerability and Impact Scenarios – A Guidebook for Sub-National Planners

**Table 2.8 Definitions Related to Mapping Climate Change Vulnerability and Impact Scenarios**

Vulnerability	vulnerability = exposure to climate hazards and perturbations x sensitivity – adaptive capacity
Hazard	A physically defined source of potential harm, or a situation with a potential for causing harm, in terms of human injury, damage to health, property, environment, and other things of value, or some combination of these (CARICOM, 2003).
Perturbations	Small variations from the norm in the physical system, typically of lesser magnitude than a hazard, but possibly of longer duration. Perturbations may retrospectively be identified as incremental change.
Sensitivity	The extent to which a unit analysis reacts to stimuli. Climate terms, biomes, ecosystems, countries and sectors are all examples of units, which may have different levels of sensitivity exposed to the same climate hazard (depending on the scale of the analysis).
Adaptation	Adjustment in natural or human systems in response to actual or expected climate changes or their impacts, so as to reduce harm or exploit beneficial opportunities. (same as OECD 2009)
Adaptive Capacity	The potential or capability of a system to adjust its characteristics or behavior to anticipate, cope with and respond to climate variability and change.

**Table 2.9 Evaluation Steps of Mapping Climate Change Vulnerability and Impact Scenarios**

Evaluating Points	Vulnerability Assessment	<p>Step 1: Determine Project Hazards and Sensitivity</p> <ul style="list-style-type: none"> <li>-Assess past and present climate trends and risks</li> <li>-Assess past and present sensitivity by sector</li> <li>-Assess future exposure to climate hazards and perturbations</li> <li>-Assess future sensitivity to climate change</li> </ul> <p>STEP 2: Determine Project Adaptive Capacity</p> <ul style="list-style-type: none"> <li>-Identify proxies or indicators for adaptive capacity</li> <li>-Identify other stresses that can interact with climate change as driving forces of system change</li> </ul> <p>STEP 3: Integrate and Map Vulnerability</p> <ul style="list-style-type: none"> <li>-Use of geographic information systems</li> <li>-Use of expert judgment and tracing paper</li> </ul>
	Adaptation Formulation	<p>STEP 4: Identify, Assess, and Review Adaptation Options</p> <p>Identify adaptation options</p> <ul style="list-style-type: none"> <li>-Expert judgment</li> <li>-Spatial analogues</li> </ul> <p>Assess adaptation options</p> <ul style="list-style-type: none"> <li>-Cost-benefit analysis</li> <li>-Risk assessment</li> </ul> <p>Review vulnerability and adaptation options</p>

### 2.3.3 USAID

#### (1) Adapting to Climate Variability and Change – A Guidance Manual for Development Planning<sup>1</sup>

The USAID Global Climate Change Team developed this Adaptation Guidance Manual to assist missions and other partners to understand how climate change may affect their project outcomes, and

<sup>1</sup> USAID.(2007). Adapting to Climate Variability and Change – A Guidance Manual for Development Planning



identify adaptation options to be integrated into the design to implement more resilient projects.

Six necessary steps shown in Table 2.10 are defined for integration of adaptation into the planned project. Also, in conducting the adaptation analysis (Step 3), criteria for analyzing adaptations are provided based on the case study (Table 2.11).

**Table 2.10 Implementation Steps in Adapting to Climate Variability and Change**

Step 1	Screen for vulnerability Preliminary assessment of whether climate variability or change could compromise the integrity, effectiveness, or longevity of a project
Step 2	Identify adaptations Work with stakeholders to identify alternative designs or management practices
Step 3	Conduct analysis Examine the consequences of climate variability and change as well as the effectiveness, costs, and feasibility of adaptations
Step 4	Select course of action Meet with stakeholders to review results of the analysis. Determine if changes in a current project design are required, or if a proposed project should feature new adaptations.
Step 5	Implement adaptations
Step 6	Evaluate adaptations

**Table 2.11 Criteria for Analyzing Adaptations in Adapting to Climate Variability and Change**

Criteria for analyzing adaptations	Cost, effectiveness, ease of implementation, acceptability to local stakeholders, acceptability to USAID, endorsement by experts, timeframe for implementing the adaptation, institutional capacity, adequacy for current climate, size of beneficiaries group
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#### 2.3.4 GTZ (GIZ)

(1) Climate Change Information for Effective Adaptation – A Practitioner’s Manual<sup>1</sup>

This manual is developed to get climate change and related information necessary for practitioner’s decision-making in adaptation options by administrative organizations or NGOs.

It comprises Part I (Background) and Part II (Practical Steps) with an additional Annex. Part I discusses the cause of climate change, climate change scenario, outline of future projection model and vulnerability concept.

Part II discusses the practical steps for accessing climate change adaptation. Table 2.12 below shows some especially important concepts among these.

<sup>1</sup> GTZ(GIZ).(2009). Climate Change Information for Effective Adaptation – A Practitioner’s Manual

**Table 2.12 Outline of Points in Climate Change Information for Effective Adaptation**

Access to climate change information	<p>Important factors related to climate change are shown below:</p> <ul style="list-style-type: none"> <li>Increased temperature (including seasonal changes)</li> <li>More intensive and frequent storms</li> <li>Sea level rise</li> <li>More heat waves</li> <li>More cold spells</li> <li>More droughts</li> <li>More flooding, and more extreme floods</li> <li>More extreme rains (including seasonal changes)</li> <li>Change in annual or seasonal water availability</li> <li>Accelerated melting of glaciers</li> <li>Melting of permafrost</li> </ul>
	<p>Three methods in accessing information:</p> <p>1) Rapid literature assessment</p> <ul style="list-style-type: none"> <li>-Rather than generating your own climate change information, try to find existing materials on the internet or obtain them from resource persons or institutes.</li> <li>-Define your geographical, temporal and sectoral areas of interest. As the body of literature on climate change is overwhelming, your search should be as focused as possible.</li> <li>-Check literature and online databases; filter out what you need</li> <li>-Consult experts, government officials, scientists and consultants</li> <li>-Bring together the information gained in a comprehensive and transparent manner, and make it available to others.</li> </ul> <p>2) Using online data analysis tools</p> <p>For climate change data processing, the online tools below can be used.</p> <ul style="list-style-type: none"> <li>-SERVIR</li> <li>-Climate Change Explorer (weADAPT)</li> <li>-World Bank Climate Change Portal</li> <li>-CI: grasp</li> </ul> <p>3) Comprehensive assessment using climate change expertise</p> <p>If you cannot find the necessary climate change information for your needs, it is necessary to conduct analysis by yourself including requesting scientists to analyze regional climate change by RCM. The costs of such assessments can vary a lot. If new model runs are necessary, this can take months or even years, and can cost a five or six digit figure. You can also use the existing RCM tailored for developing countries.</p> <p>It is noted that the number of RCM for developing countries is increasing.</p>

Interpreting	<p>1) General rules</p> <ul style="list-style-type: none"> <li>-Use information about historic climate variability and change (especially extreme events), as well as adaptation experiences as a starting point</li> <li>-Bring together different stakeholders</li> <li>-Try to gather different regional scenarios</li> </ul> <p>2) Uncertainty and data interpretation</p> <ul style="list-style-type: none"> <li>-Differentiate between uncertainties of models and of the emission scenarios</li> <li>-Do not assume that uncertainty means there will be no change.</li> <li>-There will always be an inherent, irresolvable uncertainty involved in climate change projections. Uncertainty must be managed and should not overcome decision makers.</li> <li>-Rather than using a single model, try to use “possibility ranges”.</li> </ul> <p>3) Uncertainty and identification of adaptation measures</p> <ul style="list-style-type: none"> <li>-Be aware that adaptation to climate change is not the only area of planning affected by uncertainty.</li> <li>-Try to find “no regret” or “low regret” adaptation activities (ideally a “win-win-win” situation for mitigation, adaptation and sustainability).</li> <li>-Try to identify flexible and reversible options.</li> <li>-Take into account the time dimension of impacts, i.e., “when are the impacts expected?” or “is action necessary today?”</li> </ul>
Communication	<ul style="list-style-type: none"> <li>-Avoid alarmism – base your statements on sound scientific findings.</li> <li>-Stress the importance both of interpreting climate change and of managing uncertainty</li> <li>-Be exact about timescales</li> <li>-Get support from experts</li> </ul>

## (2) Climate Proofing for Development – Adapting to Climate Change, Reducing Risk<sup>1</sup>

Similar to section (1), this guide is designed to consider climate change adaptation in development planning at various levels – national, sectoral, local and project.

Especially, it covers climate change adaptation not just at the project level but also at planning level. It should be noted that climate change impact and planning time scale are specified in this guide as presented in Figure 2.1.

<sup>1</sup> GTZ(GIZ).(2010). Climate Proofing for Development – Adapting to Climate Change, Reducing Risk

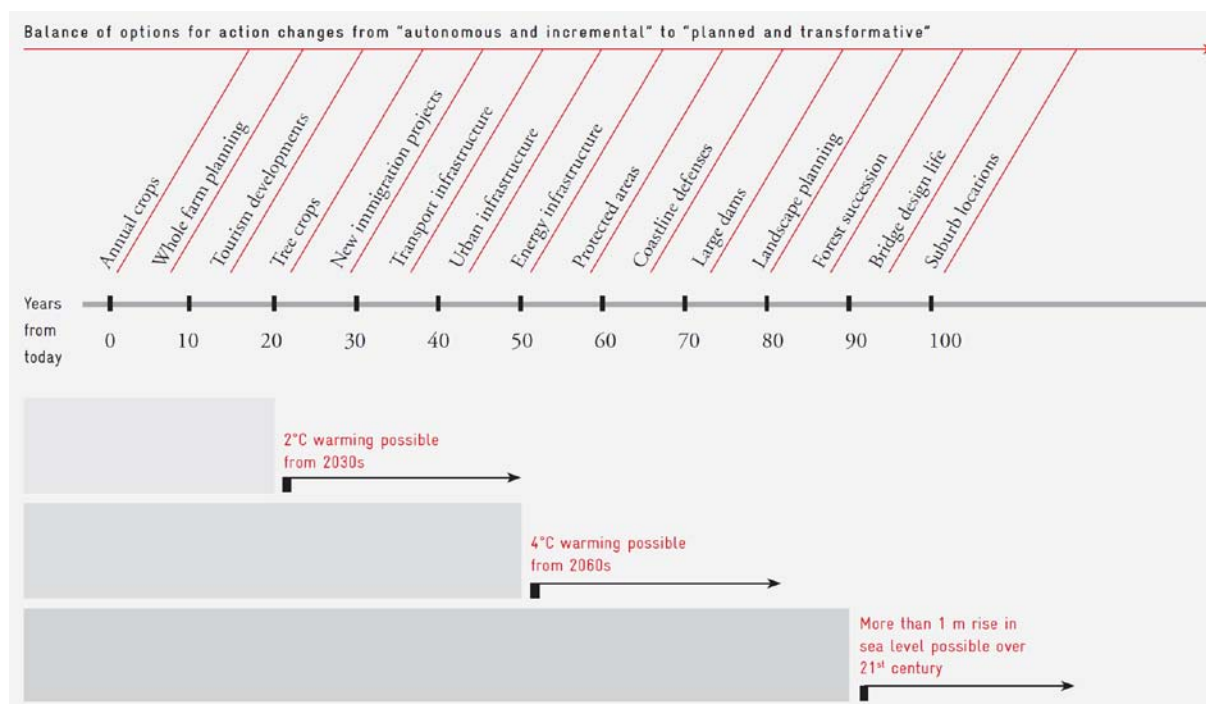


Figure 2.1 Planning Horizons - Today's Decisions Shape the Future<sup>1</sup>

### 2.3.5 Adaptation Fund

(1) Project Level Results Framework and Baseline Guideline Document (Mar. 2011)<sup>2</sup>

The document aims to show the indicators for performance measurement of the adaptation projects assisted by the fund. The results of the project should be analyzed in the following five steps, i.e., goal, impact, secondary outcomes (if applicable), outcome, and output. Expected results and measured indicators are shown in Table 2.13.

Table 2.13 Expected Results and Indicators in Adaptation Fund Results Framework

EXPECTED RESULTS	INDICATORS
<b>Goal:</b> Assist developing country parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change in meeting the costs of concrete adaptation projects and programs, in order to implement climate-resilient measures.	
<b>Impact:</b> Increased resiliency to climate variability and change at the community, national, and regional levels.	
<b>Outcome 1:</b> Reduced exposure at national level to climate-related hazards and threats	1. Relevant threat and hazard information generated and disseminated to stakeholders on a timely basis
<b>Output 1:</b> Risk and vulnerability assessments conducted and updated at a national level	1.1. Number and type of projects that conduct and update risk and vulnerability assessments
	1.2 Quality of relevant risk and vulnerability Assessments
	1.3 Early warning systems developed

<sup>1</sup> Stafford Smith et al. 2010 (GTZ, 2010, P.7 Figure 1)

<sup>2</sup> This survey does not refer to the new version of the document which was approved on 14<sup>th</sup> AFB meeting. Some of the "results" and "indicators" are amended and guidance for the evaluation of indicators is appended in the new version.

EXPECTED RESULTS	INDICATORS
<b>Outcome 2:</b> Strengthened institutional capacity to reduce risks associated with climate-induced socioeconomic and environmental losses	2.1 Number of targeted institutions with increased capacity to minimize exposure to climate variability risks
	2.2 Number of people subjected to reduced risk due to extreme weather events
<b>Output 2.1:</b> Strengthened capacity of national and regional centers and networks to rapidly respond to extreme weather events	2.1.1. Number of staff trained to respond to and mitigate impacts of climate-related events
	2.1.2. Capacity increase of staff from targeted institutions trained to respond to and mitigate impacts of climate related events
<b>Output 2.2:</b> Targeted population groups covered by adequate risk reduction systems	2.2.1. Percentage of population covered by adequate risk reduction systems
	2.2.2. Number of people affected by climate variability
<b>Outcome 3:</b> Strengthened awareness and ownership of adaptation and climate risk reduction processes at the local level	3.1. Percentage of targeted population aware of predicted adverse impacts of climate change, and of appropriate responses
	3.2. Modification in targeted population behavior
<b>Output 3:</b> Targeted population groups participating in adaptation and risk reduction awareness activities	3.1.1 Number and type of risk reduction actions or strategies introduced at local level
	3.1.2 Number of news outlets in the local press and media that have covered the topic
<b>Outcome 4:</b> Increased adaptive capacity within relevant development and natural resource sectors	4.1. Development sectors' services responsive to evolving needs from the changing and variable climate
	4.2. Physical infrastructure improved to withstand climate change and variability-induced stress
<b>Output 4:</b> Vulnerable physical, natural and social assets strengthened in response to climate change impacts, including variability	4.1.1. Number and type of health or social infrastructure developed or modified to respond to new conditions resulting from climate variability and change (by type)
	4.1.2. Number of physical assets strengthened or constructed to withstand conditions resulting from climate variability and change (by asset types)
<b>Outcome 5:</b> Increased ecosystem resilience in response to climate change and variability-induced stress	5. Ecosystem services and natural assets maintained or improved under climate change and variability-induced stress
<b>Output 5:</b> Vulnerable physical, natural and social assets strengthened in response to climate change impacts, including variability	5.1. Number and type of natural resource assets created, maintained or improved to withstand conditions resulting from climate variability and change (by type of assets)
<b>Outcome 6:</b> Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas	6.1 Percentage of households and communities having more secure (increased) access to livelihood assets
	6.2. Percentage of targeted population with sustained climate-resilient livelihoods
<b>Output 6:</b> Targeted individual and community livelihood strategies strengthened in relation to climate change impacts, including variability	6.1.1. Number and type of adaptation assets (physical as well as in terms of knowledge) created in support of individual or community livelihood strategies
	6.1.2. Type of income sources for households generated under climate change scenario
<b>Outcome 7:</b> Improved policies and regulations that promote and enforce resilience measures	7. Climate change priorities are integrated into national development strategy
<b>Output 7:</b> Improved integration of climate resilience strategies into country development plans	7.1. Number, type, and sector of policies introduced or adjusted to address climate change risks
	7.2. Number or targeted development strategies with incorporated climate change priorities enforced

Furthermore, during the preparation process of the document, it indicates in Annex A to adopt a set of indicators to assess the impact of and monitor the progress of adaptation actions proposed by implementing entities. Eventually, the proposed indicators seem not to be adopted by Adaptation Fund, however their general outlines are presented in Table 2.14.

**Table 2.14 General Outline of Impact Indicators proposed for the Project by Adaptation Fund**

Overview	<p>The following 3 indicators are proposed as objective method of determining impact effectiveness of adaptation actions under the Adaptation Fund.</p> <ol style="list-style-type: none"> <li>1) Saved Wealth</li> <li>2) Saved Health</li> <li>3) Environmental Benefits</li> </ol> <p>It is proposed that a set of indicators will both help to comparing several proposed projects and pre-estimating for budgeting purpose.</p>
1) Saved Wealth (SW)	<p>SW is the indicator that quantifies an economic value or vulnerability which would have saved or conserved by adaptation actions. It measures the economic values for assets (infrastructure or private property) that would have been damaged by the climate change impacts according to occurrence probability of the impacts.</p>
2) Saved Health (SH)	<p>SH measures impacts on people's health using DALYs (Disability Adjusted Life Years saved) which is an initially established method in the health sector. It quantifies how much of the health or life expectancy are saved by the project.</p> <p>DALYs = Years of life lost due to premature mortality (YLL) + Years lived with disability (YLD)</p> <p>YLL = Number of death x Average life expectancy;</p> <p>YLD = Number of incident cases x Disability weight x Average duration of disability.</p>
3) Environmental Benefits	<p>Environmental benefits are qualitative indicators to assess positive, negative, or neutral impacts on ecosystem in the project area.</p>
Combined Impact Indicator	<p>The following methods are suggested as indicators of comparative evaluation in project selection process.</p> <ol style="list-style-type: none"> <li>a) Divide SW and SH by project cost and obtain unit values as SW* and SH* per project cost.</li> <li>b) Compute SW*ave and SH*ave as the average value of SW* and SH* respectively, for the proposed each project.</li> <li>c) Combined impact indicator for each project = <math>(SW^* / SW^*_{ave}) + (SH^* / SH^*_{ave})</math></li> </ol> <p>Furthermore, it is proposed that budget from the fund be allocated to those indicating higher values of the above indicators</p>

## Chapter 3 Definitions and Steps in Adaptation Planning

### 3.1 Study Method

Related literatures reviewed in Chapter 2 show the concept for adaptation, definition of related terms, and basic analytical steps to formulate an adaptation project.

This chapter presents the definition, general steps and study items to be carried out in each step based on the reviewed information, which will be used in the project level guidelines for each sub-sector in Chapter 5.

### 3.2 Definitions

As reviewed in Chapter 2, the terms "adaptation", "vulnerability", etc. have different definitions. The definitions in this survey are examined as follows:

#### (1) Adaptation

Table 3.1 shows the various definitions for the term "Adaptation." Given that the adaptation projects studied in this survey is subject to OECD adaptation marker, the definition of OECD is adopted. According to the OECD's definition, adaptation is defined as "the activity to reduce vulnerability." Therefore, vulnerability assessment is crucial for determining adaptation measures.

**Table 3.1 Definition of Adaptation**

Agencies	Reference	Definition
JICA	JICA's Assistance for Adaptation to Climate Change <sup>1</sup>	Adaptation is not clearly defined but the definition in IPCC AR4 is introduced.
IPCC	IPCC AR4 <sup>2</sup>	Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.
OECD	Addendum on the Climate Change Adaptation Marker <sup>3</sup>	Activities which intends to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing adaptive capacity and resilience.
OECD	Integrating Climate Change Adaptation into Development Co-operation – Policy Guidance <sup>4</sup>	Adjustment in natural or human systems in response to actual or expected climate changes or their impacts, so as to reduce harm or exploit beneficial opportunities.
UNDP	Mapping Climate Change Vulnerability and Impact Scenarios <sup>5</sup>	Adjustment in natural or human systems in response to actual or expected climate changes or their impacts, so as to reduce harm or exploit beneficial opportunities. (same as OECD)
GTZ (Currently GIZ)	Climate Change Information for Effective Adaptation <sup>6</sup>	Adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. (same as IPCC)
MoE-J	Wise Adaptation to Climate Change <sup>7</sup>	In addition to the definition by IPCC AR4, the priority is given to adaptation that is intentionally implemented by humans. In other words, it emphasizes adaptation measure that is undertaken at the decision of policymakers in national and local governments, and/or that is intentionally undertaken by individuals or communities, etc.

## (2) Vulnerability

The term "vulnerability" has various definitions by many authorities as shown in Table 3.2. They commonly define "vulnerability" to be determined by several components comprising of climate change as an external forcing, sensitivity of the system and adaptive capacity of the system. Since none of the components are quantified for assessment by any development agency so far, the style or the formula has little importance in practice. However, this report adopts the UNDP definition that is well formalized using the terms adopted by OECD.

**Table 3.2 Definition of Vulnerability**

Agencies	Reference	Definition
JICA	JICA's Assistance for Adaptation to Climate Change	Vulnerability = almost equal External Force / [ Resistance (Adaptive capacity) – Sensitivity]
IPCC	IPCC AR4 <sup>8</sup>	Vulnerability is the degree to which a system is susceptible to or unable to cope with the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity.
OECD	Integrating Climate Change Adaptation into Development Cooperation–Policy Guidance	Vulnerability is the degree to which a system is susceptible to or unable to cope with the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. (same as IPCC AR4)
UNDP	Mapping Climate Change Vulnerability and Impact Scenarios	Vulnerability = Exposure to climate hazards and perturbations x Sensitivity – Adaptive capacity
UNDP	Adaptation Policy Frameworks for Climate Change : Developing Strategies, Policies and Measures <sup>9</sup>	Vulnerability = Risks (predicted adverse climate impacts) – Adaptation
MoE-J	Wise Adaptation to Climate Change	Vulnerability is the degree to which a system is susceptible to or unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity. (same as IPCC AR4)

## (3) Adaptive Capacity

Adaptive capacity is basically defined as the ability to reduce negative impacts of climate change as shown in Table 3.3. This survey adopts the definition of OECD which includes the ability to take advantage of opportunities.



**Table 3.3 Definition of Adaptive Capacity**

Agencies	Reference	Definition
JICA	JICA's Assistance for Adaptation to Climate Change	Not clearly defined.
OECD	Integrating Climate Change Adaptation into Development Cooperation–Policy Guidance	Adaptive capacity is a system's ability to adjust to climate change, including climate variability and extremes, to moderate potential damage, to take advantage of opportunities or to cope with consequences.
UNDP	Mapping Climate Change Vulnerability and Impact Scenarios	The potential or capability of a system to adjust its characteristics or behavior to anticipate, cope with and respond to climate variability and change.

### 3.2.2 Maladaptation

The definition of Maladaptation by OECD is adopted as presented in Table 3.4.

**Table 3.4 Definition of Maladaptation**

Agencies	Reference	Definition
OECD	Integrating Climate Change Adaptation into Development Cooperation–Policy Guidance	Business-as-usual developments which, by overlooking climate change impacts, inadvertently increases exposure and vulnerability to climate change. Actions undertaken to adapt to climate impacts that do not succeed in reducing vulnerability, but increase it instead.
UNDP	Mapping Climate Change Vulnerability and Impact Scenarios	Faulty or inadequate adaptation
MoE-J	Wise Adaptation to Climate Change	Inadequate study or consideration which result to insufficient effects of adaptation and impacts to other sustainable development

### 3.3 Vulnerability Assessment

The purpose of adaptation is to reduce the vulnerability to climate change. In this context, identification and assessment of the vulnerability on the target system is crucial in adaptation planning. Although there is no universal definition, it is considered that vulnerability is regarded as the relationship between a) the risk of the system in the context of climate change and b) its sensitivity and adaptive capacity against climate change.

UNDP (2010)<sup>5</sup> discusses the procedures for vulnerability assessment and adaptation planning applicable to local-level development. Table 3.5 shows steps in vulnerability assessment (Steps 1-3) and adaptation planning (Step 4).

The UNDP Guidebook aims to build regional master plan covering multiple sectors. To ensure the comprehensive process of vulnerability assessment at the regional level, cross-sectoral adaptation measures are considered.

In this survey, the emphasis is on adaptation measures at project level in target sectors. Therefore, the evaluation steps shown in the UNDP Guidebook have been integrated and revised to suit the purpose of this survey (Table 3.6).

**Table 3.5 Evaluation Steps of Mapping Climate Change Vulnerability and Impact Scenarios (Reprint)**

Items to be discussed	Vulnerability assessment	<p><b>STEP 1:DETERMINE AND PROJECT HAZARDS AND SENSITIVITY</b>  Assess Past and Present Climate Trends and Risks  Assess Past and Present Sensitivity by Sector  Assess Future Exposure to Climate Hazards and Perturbations  Assess Future Sensitivity to Climate Change</p> <p><b>STEP 2:DETERMINE AND PROJECT ADAPTIVE CAPACITY</b>  Identify Proxies and Indicators for Adaptive Capacity  Identify other Stresses that can Interact with Climate Change as Driving Forces of System Change</p> <p><b>STEP 3:INTEGRATE AND MAP VULNERABILITY</b>  Use of Geographic Information Systems  Use of Expert Judgment and Tracing Paper</p>
	Adaptation Formulation	<p><b>STEP 4:IDENTIFY, ASSESS, AND REVIEW ADAPTATION OPTIONS</b>  Identify Adaptation Options  Expert Judgment  Spatial Analogues  Assess Adaptation Options  Cost-Benefit Analysis  Risk Assessment  Review Vulnerability and Adaptation Options</p>

Source: Part of the report in UNDP (2010)

**Table 3.6 Steps and Summary of Evaluation for Vulnerability Assessment in Target Sectors (Adaptation Project)**

Step 1 Identification of the Hazards and Sensitivity to Climate Change	<p>1) Assess Past and Present Climate Trends and Risks  Identification of past and current conditions and changes with regard to climate parameters (weather, sea level, fire etc.) and impacts to each sector.  Research shall be done by analyzing past data and interviewing stakeholders.</p>
	<p>2) Assess Future Exposure to Climate Hazards and Perturbations  a) Study Future Weather Conditions  Identification of the future trends in climate change with regard to the climate parameters relating to the sensitivity of the target sector.  In assessment of climate change, review the climate change scenario, analysis model and target year in climate change adaptation policy of the target country and confirm with counterpart agencies.  In the absence of climate change adaptation policy, extract the necessary climate parameters from IPCC assessment models and process them with ensemble average or downscaling if necessary.</p> <p>b) Study Other Factors related to Socio-economic Changes  Review of development planning and regulations in the target country and area in order to identify the factors related to future socio-economic changes.</p>

	<p>3) Assess Future Sensitivity to Climate Change</p> <p>a) Study Past Damage Identification of past disasters in the target sector in relation to climate parameters.</p> <p>b) Study Present Condition of Facilities and Measures Description of the conditions of the existing facilities related to the project at target sectors or areas.</p> <p>c) Assess Future Sensitivity to Climate Change Identification of the future sensitivity to climate change of the target sector in consideration of socio-economic change variables based on past climate change related disasters, climate parameters, future climate change, presence and absence of facilities and their functions.</p>
<p>Step 2</p> <p>Identification of Adaptive Capacity to Climate Change</p>	<p>4) Assess Adaptive Capacity to Climate Change</p> <p>a) Identification of Adaptive Capacity Identification of the conditions of the facilities, organizations, information and education systems as the adaptive capacity to climate change.</p> <p>b) Clarify Exacerbating Factors for Climate Change Impacts Identification of the situation and degree of factors (poverty, education level, etc.), which increase future vulnerability if combined with climate change</p>
<p>Step3</p> <p>Assessment of Vulnerability</p>	<p>5) Assess Vulnerability Assessment of the vulnerability to climate change in the target area in consideration of factors in Steps 1 and 2. Identification of variations of vulnerability within the target area (in case there are substantial differences)</p>

### 3.4 Adaptation Project and Business-as-usual (BAU) Development Project

Adaptation-related projects can be classified into two types. One type is projects whose principal purpose is adaptation to climate change. The other type is the business-as-usual (BAU) development projects which take into account climate change aspects in designing and implementing the project. This Survey names the former as "Adaptation Project" and the latter as "BAU Development with Adaptation Options." Separate guidelines are prepared for each type of project in a single sector.

The definition of "Adaptation Project" and "BAU Development with Adaptation Options" is shown in Table 3.7. The basic concepts of the two types of adaptation are shown in Figures 3.1 to 3.4. Although conceptually separate, drawing a clear line between the two types is not realistic. A project which was not intended for adaptation may end up contributing entirely to adapting to climate change. For instance, implementation of irrigation project can result in reduction of climate change vulnerability if located in a region where the agriculture development sector faces high climate risks. The guidelines presented in this survey offer steps for typical projects for each of the two types. In the real world, it is possible that there are projects which may fall in-between the two types. In addition, only one of the two types may exist in some sub-sectors.

**Table 3.7 Definition of the Two Types of Adaptation-related Projects**

	Adaptation Project	BAU Development with Adaptation Options
Definition	Projects formed to reduce the climate change vulnerability in the existing system such as projects to improve existing facility to cope with the increased vulnerability caused by the change of external forcing due to climate change.	Projects which is not mainly aimed to reduce the vulnerability, but is designed to adapt to the impacts of the climate change in achieving its main objective, such as development and rehabilitation of infrastructure projects that are planned or designed with consideration to increasing external forcing stemming from climate change.
Example	<ul style="list-style-type: none"> <li>- Drainage of the glacial lake with the risk of collapse by global warming</li> <li>- Extension of existing irrigation system to address the crop damage caused by the increase of frequency and intensity of drought.</li> <li>- Disaster prevention project to strengthen the resilience against potential hazards concerned when inundation of road network is anticipated due to increased flood risk by climate change.</li> </ul>	<ul style="list-style-type: none"> <li>- Mangrove afforestation project with consideration to the sea level rise for coastal protection and ecosystem conservation.</li> <li>-Flood control project whose main purpose is to contribute to economic development, but with consideration to external forcing caused by increased frequency of extreme events and rainfall.</li> <li>- Road construction project which takes into account potential flood damage caused by climate change to design the route and related facilities.</li> </ul>

### 3.5 Evaluation and Monitoring of Adaptation Measures

#### 3.5.1 Evaluation (Project Evaluation)

Similar to the evaluation of BAU development project, evaluation (economic evaluation) based on cost-benefit analysis can be applied to adaptation measures, if the adaptation measures bring benefit to the system under the current climate conditions. For adaptation measures specialized in coping with climate change or those whose benefits are different from those of BAU development, it is necessary to identify other evaluation items and indicators which allow assessment of improvements in the sensitivity of the system or adaptive capacity.

#### 3.5.2 Monitoring and Review

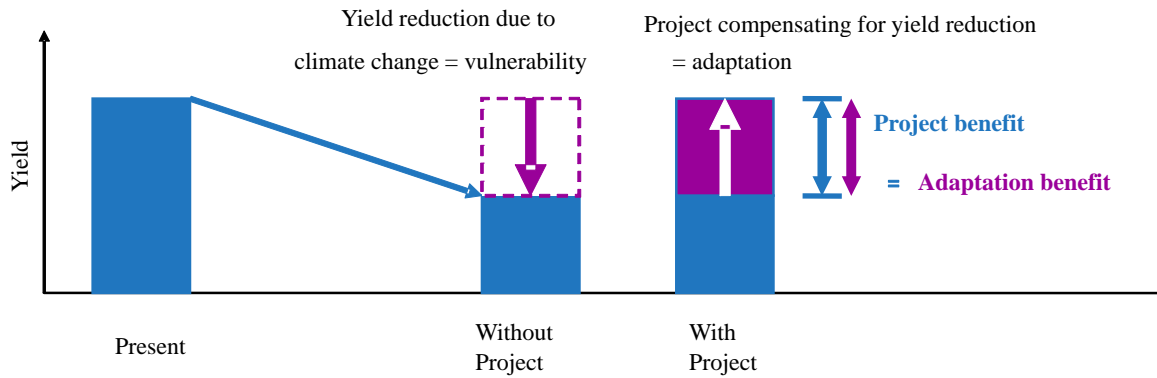
If the same items and indicators in Section 3.5.1 above are applicable during the monitoring and review stage, then these can be used. In the case of a project that addresses long-term change and extreme events caused by climate change, it may be difficult to measure impacts of climate change and benefits of adaptation measures using the items and indicators described in Section 3.5.1 above. In such cases, alternative indicators are needed to evaluate the improvement in sensitivity and adaptive capacity.

For instance, the performance and achievement of adaptation activities can be evaluated by some indicators that measure progress towards adaptation objectives. Such alternatives include: the number of projects adjusted to incorporate climate change risks; the number of stakeholders involved in capacity building activities for vulnerability reduction; and the number of stakeholders served by new or expanded climate information management systems such as early warning systems and forecasting

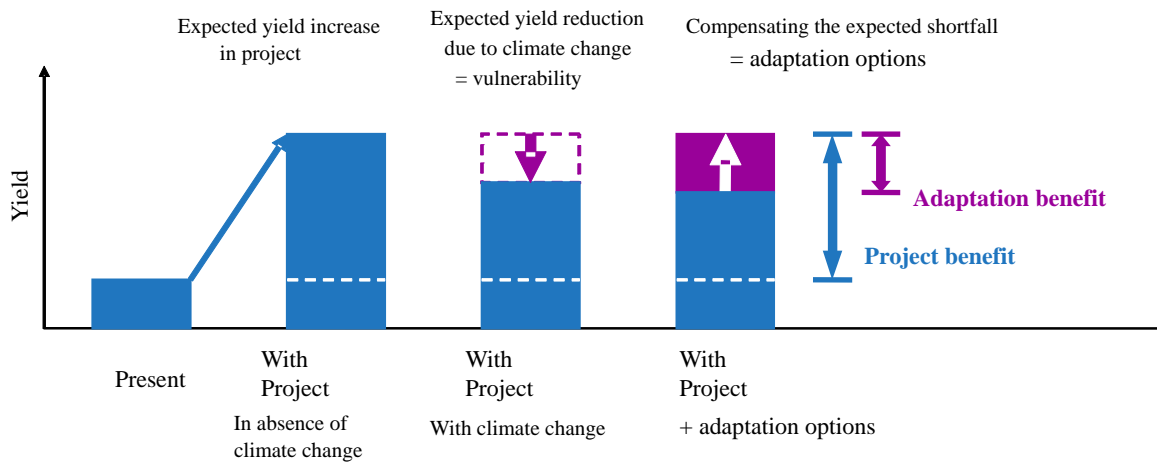
(Brooks & Frankel-Reed 2008, cited in OECD 2009, p.129).

In this survey, possible alternative indicators for monitoring are presented for each type of project.

Figures 3.1 and 3.2 show the basic concepts for “Adaptation Project” and “BAU Development with Adaptation Options” in the irrigation sector. Figures 3.3 and 3.4 illustrate the basic concepts of the types of adaptation projects in the flood control sector.



**Figure 3.1 Basic Concept of “Adaptation Project” in the Irrigation Sector**



**Figure 3.2 Basic Concept of “BAU Development with Adaptation Options” in the Irrigation Sector**

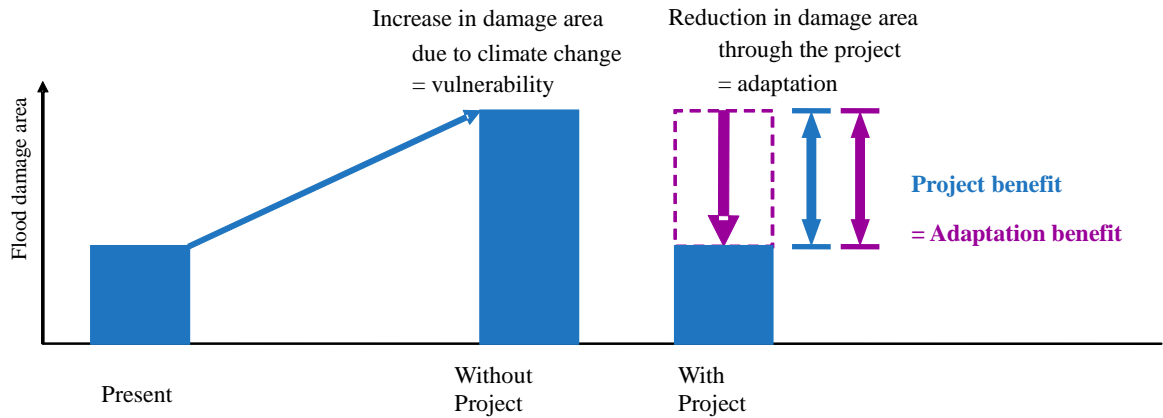


Figure 3.3 Basic Concept of “Adaptation Project” in the Flood Control Sector

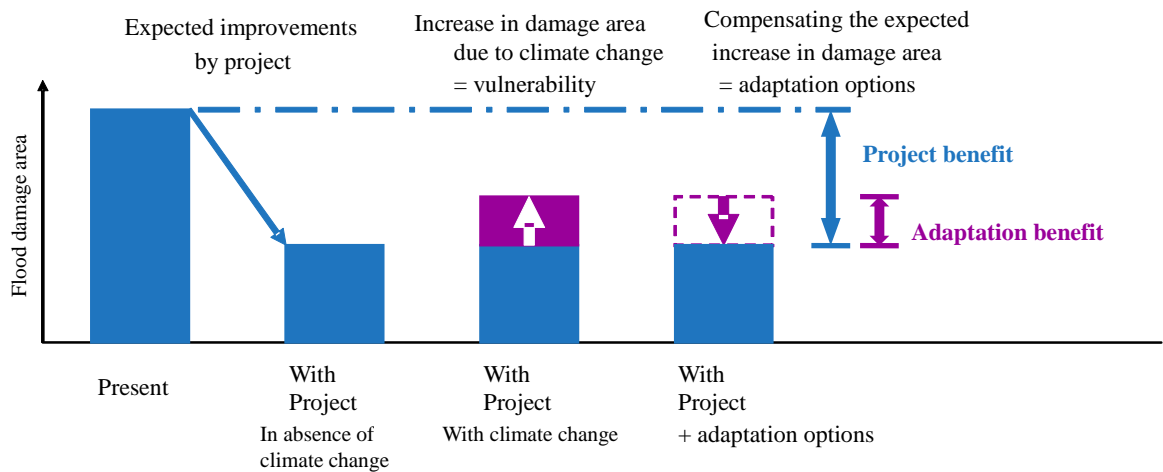


Figure 3.4 Basic Concept of “BAU Development with Adaptation Options” in the Flood Control Sector

<sup>1</sup> JICA. (2007). JICA's Assistance for Adaptation to Climate Change

<sup>2</sup> IPCC. Glossary of Terms used in the IPCC Fourth Assessment Report WGII. <http://www.ipcc.ch/pdf/glossary/ar4-wg2.pdf>

<sup>3</sup> OECD/DAC. (2010). ADDENDUM ON THE CLIMATE CHANGE ADAPTATION MARKER

<sup>4</sup> OECD/DAC. (2009). Integrating Climate Change Adaptation into Development Co-operation – Policy Guidance

<sup>5</sup> UNDP. (2010). Mapping Climate Change Vulnerability and Impact Scenarios

<sup>6</sup> GTZ(GIZ). (2009). Climate Change Information for Effective Adaptation

<sup>7</sup> MoE-J. (2008). Kikouhendou heno Kashikoi Tekiou (in Japanese)

<sup>8</sup> IPCC. (2007). WG2 Summary for Policymakers. E. Systematic observing and research needs

[http://www.ipcc.ch/publications\\_and\\_data/ar4/wg2/en/spmssp-e.html](http://www.ipcc.ch/publications_and_data/ar4/wg2/en/spmssp-e.html)

<sup>9</sup> UNDP. (2004). Adaptation Policy Frameworks for Climate Change : Developing Strategies, Policies and Measures

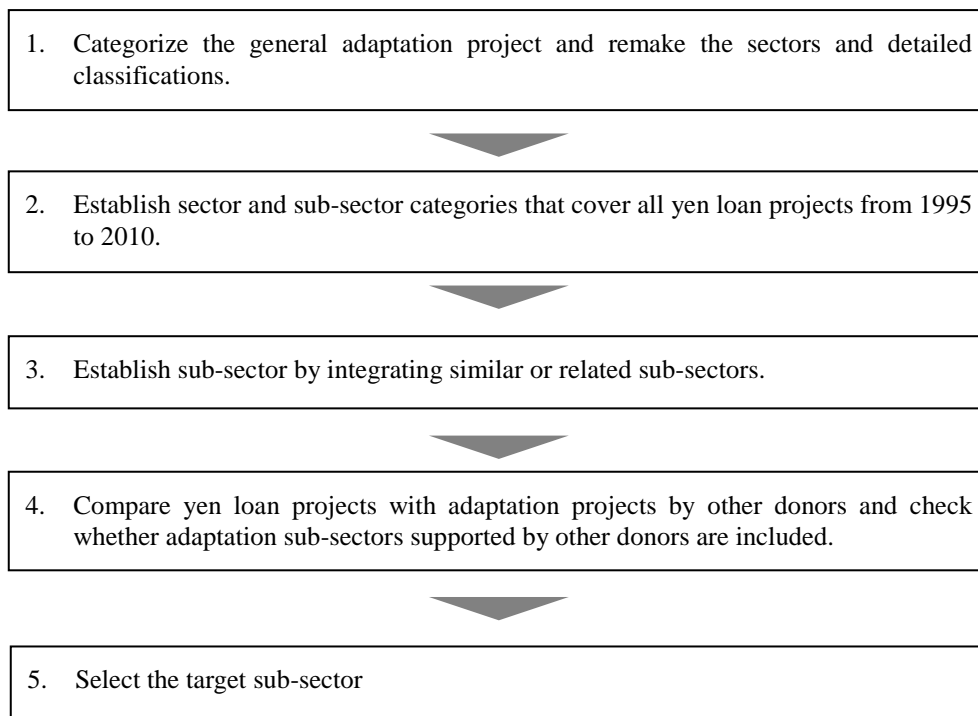
## Chapter 4 Selection of Target Sub-Sectors

In this chapter, target sub-sectors are selected for discussion in Chapter 5. The following items were considered for selection of the sub-sectors.

- Past JICA ODA loan projects
- Potential for formulating future adaptation projects

The process of selection is as shown in Figure 4.1.

The segmentation unit described as “detailed classification” in the process is equivalent to the concept of “sub-sector”. In order to avoid confusing “sub-sectors” used to categorize the typical adaptation measures studied in this report, it is named as “detailed classification”.



**Figure 4.1 Selection Process of Sub-sectors**

#### 4.1 Categorization of Sectors and Detailed Classifications based on Typical Adaptation Measures

First of all, in order to categorize based on past JICA ODA Loan projects, the sectors or sub-sectors to be tentatively classified should be established. Then the adaptation projects shown below are extracted and the sectors or detailed classifications to include these projects are established.

- a) JICA's Assistance for Adaptation to Climate Change<sup>1</sup>
- b) IPCC AR4 WGII Technical Summary<sup>2</sup>
- c) Reports by Ministry of the Environment Japan, Global Warming and Adaptation<sup>3</sup>, 2009
- d) Principle on Climate Change Adaptation, Ministry of the Environment Japan<sup>4</sup>, 2010.11

#### 4.2 Identification of Sectors and Detailed Classifications based on Past JICA ODA Loan Projects

Further, past JICA ODA loan projects from 1995-2010 was categorized into detailed classification. New classification was created for those projects which did not fall into existing classification. In addition, adaptations measures not described in any of the above a)-d) have been allocated to one of the detailed classification. As a result, several detailed classifications (shaded areas in the table), did not have any adaptation projects allocated. These classifications were excluded from consideration in this survey in principle. Although some detailed classifications did not include any JICA ODA loan projects in the past, these were not extracted since these may become potential sub-sectors of future JICA ODA loan project when these detailed classifications are integrated with other classifications to formulate a single sub-sector.

The summary is shown in Table 4.1. Some adaptation projects are counted in multiple classifications. Therefore, the total number of projects adds up to 1,293.

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<sup>1</sup> JICA.(2007). JICA's Assistance for Adaptation to Climate Change

<sup>2</sup> [http://www.ipcc.ch/publications\\_and\\_data/ar4/wg2/en/ts.html](http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ts.html)

<sup>3</sup> [http://www.env.go.jp/earth/ondanka/knowledge.html#03\\_ondankenkyu](http://www.env.go.jp/earth/ondanka/knowledge.html#03_ondankenkyu)

<sup>4</sup> <http://www.env.go.jp/press/press.php?serial=13167>



**Table 4.1 Adaptation Cases and JICA Loan Projects Implemented in Each Small Classification**

Sector	Small Classification	Adaptation Cases	Projects
1 Water resources	01 Proper management of water resources	Introduction of the system accommodating water distribution within an area in a dry spell, dissemination of drought information, water demand management through measuring and pricing, capacity building for sustainable water utilization, water level observation, and water regulating dam	2
	02 Water resources development, facility improvement	Construction of water intake structure, development of water storage facilities, desalination of seawater, rainwater harvesting, rehabilitation of dam, and construction of headrace	14
	03 Utilization of water resources	Utilization of recycled wastewater, reclaimed water and rainwater, raising awareness for water-saving, diffusion of water-saving equipment, and leakage reduction	2
	04 Water and sanitary improvement	Development of safe drinking water and public health, development/enhancement of private electric generator in purification plant, selection of consolidated evaluation on raw water quality characteristic and its suitable purification process, and eutrophication prevention	0
2 Agriculture and rural development	01 Irrigation and drainage	Improvement of reclaimed land and drainage, irrigation and hydroponic culture, water-saving irrigation, development and improvement of irrigation facilities, and irrigation with recycled wastewater	56
	02 Cultivation management (assistance in farmland management), enhancement of water users association	Conservation of soil moisture by mulching, pest control and crop monitoring, intercropping, change of farming timing, facility introduction to avoid high temperature injury, change of cropping season, retention of crop residues, sericulture, crop diversification, agricultural extension, and strengthening of water users association	13
	03 Crop variety development	Switching to heat resistant varieties, development of drought-tolerant varieties, development and promotion of alternative crops, and development of wind-resistant varieties	3
	04 Information system	Providing weather forecast information	0
	05 Livestock	Change in stock raising density, technique development for infertile breeder during summer, impact assessment for heat stress on infertility, development of mitigation technique to reduce genital function stress, environmental control for animal housing, change in rangeland and grass field rotation, and biogas plant construction	1
	06 Fisheries	Fishing port rehabilitation, fishery resource management, and technical support	4
	07 Agro-economy	Utilization of mutual aid system, grain storage and development of emergency food service facilities, establishment of grain bank, debt relief, and income diversification	1

Sector	Small Classification		Adaptation Cases	Projects
2 Agriculture and rural development	08	Development of sustainable agriculture	Land development with soil conservation, soil conservation, development of small-scale irrigation facilities, and afforestation and forest conservation	2
	09	Development/improvement of farmland		1
	10	Agricultural processing		1
3 Forestry/natural resource conservation	01	Forest conservation and afforestation	Conservation/restoration of tropical forest, afforestation, and water resource conservation	37
	02	Land conservation	Erosion control works of the slope, relief work for sediment discharge, sand dune fixation work for anti-desertification, grassland improvement by seeding grasses, construction of sabo dam and riverbank protection as conservation measures to prevent soil erosion, and soil conservation	15
	03	Mangrove conservation	Mangrove conservation	0
	04	Lakefront/ coastal protection/restoration	Lakefront /coastal protection/restoration, and prevention work for shore erosion/sedimentation	3
	05	Ecosystem (biodiversity) integrity/restoration	Conservation of coral reef and rare species	5
4 Disaster management	01	Coastal protection	Development/improvement of coastal protection facilities, preparation of contingency plan for sea level rise and forecast and warning system, swamp protection, hazard mapping for tsunami, storm surge and inland waters, development of evacuation space, and procurement of disaster prevention ships	3
	02	River disaster prevention (flood control)	Dike construction, dike reinforcement in hazard area (flood prone area), utilization and life extension of existing facilities, understanding the current protection level, improvement and development of flood protection infrastructure, development of retarding basin and regulating pond, measures for riverbed degradation, river improvement, rehabilitation of embankment, and development of pumping station, flood gate, drainage and floodway	35
	03	Disaster-relief		1
	04	Information system	Upgrading of monitoring system (long-term, on a real-time basis), and precautions for emergency including early-warning system	1
	05	Development of human resources, environmental management ability	Capacity building of community organizations, information service for disaster risk, assessment of disaster risk, development of maintenance ability for facility managers, information system for hazard mapping and information service for flood disaster history, and maritime training	4
	06	Urban disaster prevention	“Flood tolerance” building, development of sewerage system, and change in building style	0
	07	Forest disaster prevention		0

Sector	Small Classification		Adaptation Cases	Projects
4 Disaster management	08	Sediment management	Development of soil conservation facilities (same as 302)	0
	09	Land use management		0
5 Urban-regional development	01	Rural development	Basic infrastructure of water supply and sanitation facilities, production facilities, health-related facilities, and educational facilities	38
	02	Urban development	Water supply facilities, drainage facilities, wastewater disposal facilities, housing	2
6 Transportation	01	Road and bridge	Improvement and rehabilitation of road, construction and rehabilitation of bridge and tunnel, and road disaster management	164
	02	Airport		35
	03	Port	Development, improvement, expansion, upgrading, rehabilitation, and dredging of port	36
	04	Railway	Improvement of tracks and rehabilitation of facilities	83
	05	Marine transportation	Development of marine safety facilities, study and improvement of sea ship, development of canal, and dredging of river	7
	06	Others		1
	07	Logistic facilities		1
7 Medical and health care	01	Development of Basic adaptive capacity	Awareness raising on health control, and preparation and diffusion of health guidance manual for heat disorder	0
	02	Measures for high risk area	Study on the outbreak and distribution condition of vectors	0
	03	Heat prevention	Adjustment of clothing and activity level, temperature warning system in national and local regions, increase in fluid intake, development of shelter for heat disorder prevention, and mitigation of heat island effect by afforestation	0
	04	Malaria control	Vaccination, study on the emergence of insecticide resistance, development of human resources to plan vector mosquito control, vector control (mosquito, etc. ), and providing information for vector control	0
	05	Waterborne infectious disease control	Improvement of sanitary facilities, development of new vaccine for infectious disease, and development of water supply and sewage system	1
	06	Medical care	Rotating medical care system, and medical equipment	15
8 Architecture	01	Architecture		31
9 Mining and manufacturing	01	Manufacturing		4
	02	Factory and plant		6
	03	Mining		3
10 Government administration	01	Finance		25
	02	Environmental issues		50
	03	Topographic survey and mapping		1
	04	General government		5

Sector	Small Classification	Adaptation Cases	Projects	
10 Government administration	05	Assistance in policy-making system	57	
	06	Assistance for rehabilitation and reconstruction	0	
11 Energy	01	Energy saving	2	
	02	Energy supply	18	
	03	Electric power generation and supply	195	
	04	Renewable energy	14	
	05	Energy facilities	2	
12 Human resources	01	Education	Education, educational equipment, personnel development, scholarship offers, overseas education, education continuance, and training	42
	02	Medical education	Training	13
13 Public works	01	Water supply	Water supply, water service, and raw water transmission	95
	02	Urban health		9
	03	Sewerage and drainage	Sewerage, municipal effluent, and regional drainage	79
14 Commerce	01	Tourism		7
15 Communications and broadcasting	01	Telecommunications		17
	02	Broadcasting		11
99 Others	01	Instauration		1
	02	Poverty program, improvement of livelihood	Community development, microcredit, rural finance, social development program, improvement of livelihood, and participatory development	19

### 4.3 Integration of Detailed Classifications into Target Sub-sectors

Similar or related detailed classifications used in the above process were integrated into 8 sectors and 20 sub-sectors shown in Table 4.2. Table 4.3 shows the integration process into sub-sectors.

**Table 4.2 Integrated Sub-sectors**

Sector	Sub-sector
Water resources	Water resources management
	Water resources development
	Water resources utilization
Agriculture and rural development	Irrigation, drainage
	Enhancement of agricultural management (cultivation management, breed, irrigation association)
	Livestock and fisheries
Forestry/natural resource conservation	Forest conservation, afforestation (planting grass seeds)
	Ecosystem integrity
Disaster management	Flood control
	Coastal protection
	Sediment-related disaster prevention
	Information system
Urban-regional development	Rural community improvement
	Urban community improvement
Transportation	Transportation infrastructure
Sanitary improvement	Water supply
	Sewerage, drainage
	Medical, health care
Others	Village development, enhancement of local community
	Development of human resources

**Table 4.3 Integration into Sub-sectors**

Sector	Suggested Sub-sector	Adaptation Cases	JICA Loan Category			
			Small Classification		Projects	
Water resources	Water resources management	Introduction of the system accommodating water distribution within an area in a dry spell, dissemination of drought information, water demand management through measuring and pricing, capacity building for sustainable water utilization, water level observation, and water regulating dam	101	Proper management of water resources	2	2
	Water resources development	Construction of water intake structure, development of water storage facilities, desalination of seawater, rainwater harvesting, rehabilitation of dam, and construction of headrace	102	Water resources development, facility improvement	14	14
	Water resources utilization	Utilization of recycled wastewater, reclaimed water and rainwater, raising awareness for water-saving, diffusion of water-saving equipment, and leakage reduction	103	Utilization of water resources	2	2
Agriculture and rural development	Irrigation and drainage	Improvement of reclaimed land and drainage, irrigation and hydroponic culture, water-saving irrigation, development and improvement of irrigation facilities, and irrigation with recycled wastewater	201	Irrigation and drainage	56	56
	Farmland management enhancement (cultivation management, varieties, water users association)	Conservation of soil moisture by mulching, pest control and crop monitoring, intercrops, change of farming timing, facility introduction to avoid high temperature injury, change of cropping season, retention of crop residues, sericulture, crop diversification, agricultural extension, and strengthening of water users association	202	Cultivation management (assistance in farmland management), enhancement of water users association	13	18
		Switching to heat resistant varieties, development of drought-tolerant varieties, development and promotion of alternative crops, and development of wind-resistant varieties	203	Crop variety development	3	
		Providing weather forecast information	204	Information system	0	
		Land development with soil conservation, soil conservation, development of small-scale irrigation facilities, and afforestation and forest conservation	208	Development of sustainable agriculture	2	
	Livestock and fishery	Change in stock raising density, technique development for infertile breeder during summer, impact assessment for heat stress on infertility, development of mitigation technique to reduce genital function stress, environmental control for animal housing, change in rangeland and grass field rotation, and biogas plant construction	205	Livestock	1	5
		Fishing port rehabilitation, fishery resource management, and technical support	206	Fisheries	4	

Sector	Suggested Sub-sector	Adaptation Cases	JICA Loan Category			
			Small Classification		Projects	
Forestry/ natural resource conservation	Forest conservation/ afforestation (planting grass seeds)	Conservation/restoration of tropical forest, afforestation, and water resource conservation	301	Forest preservation and afforestation	37	37
		-	407	Forest disaster prevention	0	
	Ecosystem integrity	Mangrove conservation	303	Mangrove conservation	0	5
		Conservation of coral reef and rare species	305	Ecosystem (biodiversity) integrity/restoration	5	
Disaster management	Flood control	Dike construction, dike reinforcement in hazard area (flood prone area), utilization and life extension of existing facilities, understanding the current protection level, improvement and development of flood protection infrastructure, development of retarding basin and regulating pond, measures for riverbed degradation, river improvement, rehabilitation of embankment, and development of pumping station, flood gate, drainage and floodway	402	River disaster prevention (flood control)	35	35
		Coastal protection	Lakefront /coastal protection/restoration, and prevention work for shore erosion/sedimentation	304	Lakefront/coastal protection/restoration	3
	Development/improvement of coastal protection facilities, preparation of contingency plan for sea level rise and forecast and warning system, swamp protection, hazard mapping for tsunami, storm surge and inland waters, development of evacuation space, and procurement of disaster prevention ships		401	Coastal protection	3	
	Sediment-related disaster prevention	Prevention work for erosion of the slope, relief work for sediment discharge, sand dune fixation work for anti-desertification, grassland improvement by seeding grasses, construction of sabo dam and riverbank protection as conservation measures to prevent soil erosion, and soil conservation	302	Land conservation	15	15
		Development of soil conservation facilities (same as 302)	408	Sediment management	0	
	Information system	Providing weather forecast information	204	Information system	0	1
			Upgrading of monitoring system (long-term, on a real-time basis), and precautions for emergency including early-warning system	404	Information system	

Sector	Suggested Sub-sector	Adaptation Cases	JICA Loan Category				
			Small Classification		Projects		
Urban-regional development	Rural development	Basic infrastructure of water supply and sanitation facilities, production facilities, health-related facilities, and educational facilities	501	Rural development	38	38	
	Urban development	“Flood tolerance” building, development of sewerage system, and change in building style	406	Urban disaster prevention	0	2	
		Water supply facilities, drainage facilities, wastewater disposal facilities, housing	502	Urban development	2		
Transportation	Transportation infrastructure	Improvement and rehabilitation of road, construction and rehabilitation of bridge and tunnel, and road disaster management	601	Road and bridge	164	290	
		Development, improvement, expansion, upgrading, rehabilitation, and dredging of port	603	Port	36		
		Improvement of tracks and rehabilitation of facilities	604	Railway	83		
		Development of marine safety facilities, study and improvement of sea ship, development of canal, and dredging of river	605	Marine transportation	7		
Sanitary improvement	Water supply	Development of safe drinking water and public health, development/enhancement of private electric generator in purification plant, selection of consolidated evaluation on raw water quality characteristic and its suitable purification process, and eutrophication prevention	104	Water and sanitary improvement	0	95	
		Water supply, water service, and raw water transmission	1301	Water supply	95		
	Sewerage and drainage	Sewerage, municipal effluent, and regional drainage	1303	Sewerage and drainage	79	79	
	Medical/ health care	Awareness raising on health control, and preparation and diffusion of health guidance manual for heat disorder	Study on the outbreak and distribution condition of vectors	701	Development of Basic adaptive capacity	0	16
			Adjustment of clothing and activity level, temperature warning system in national and local regions, increase in fluid intake, development of shelter for heat disorder prevention, and mitigation of heat island effect by afforestation	702	Measures for high risk area	0	
			Vaccination, study on the emergence of insecticide resistance, development of human resources to plan vector mosquito control, vector control (mosquito, etc.), and providing information for vector control	703	Heat prevention	0	
			Improvement of sanitary facilities, development of new vaccine for infectious disease, and development of water supply and sewage system	704	Malaria control	0	
			Rotating medical care system, and medical equipment	705	Waterborne infectious disease control	1	
				706	Medical care	15	



Sector	Suggested Sub-sector	Adaptation Cases	JICA Loan Category			
			Small Classification		Projects	
Others	Village development, enhancement of local community	Community development, microcredit, rural finance, social development program, improvement of livelihood, and participatory development	9902	Poverty program, improvement of livelihood	19	19
	Human resources development	Capacity building of community organizations, information service for disaster risk, assessment of disaster risk, development of maintenance ability for facility managers, information system for hazard mapping and information service for flood disaster history, and maritime training	405	Development of human resources, environmental management ability	4	59
		Education, educational equipment, personnel development, scholarship offers, overseas education, education continuance, and training	1201	Education	42	
		Training	1202	Medical education	13	

#### **4.4 Trends of Projects by Other Donors**

The trend of adaptation measure projects for climate change implemented by other donors is investigated and verified as to whether the adaptation projects not in the suggested sub-sector were implemented, then summarize the differences in trends between JICA projects and other projects.

##### **4.4.1 World Bank**

In the World Bank database<sup>1</sup>, 143 projects are considered as adaptation measures as a result of screening the 635 of climate change-related projects (as of the end of February 2011) through excluding those seemingly-related projects to mitigation measure such as energy and industrial development sectors. Finally, the remaining 143 projects are classified into each target sub-sector in this survey. Table 4.4 presents the result of the screening and classification.

Many of the World Bank projects tend to fall into the forest or transportation sectors, of which projects are possibly classified into mitigation measures, while its assistance trend for adaptation measures is unclear.

##### **4.4.2 GEF**

From GEF's database<sup>2</sup>, 645 projects whose focal area is climate change and implemented after 2000 are extracted. Among these, 88 adaptation related projects are extracted based on the project name and explanations and classified into the suggested sub-sectors in accordance of each project explanation shown in Table 4.4.

GEF projects seem to focus on water resources, agriculture, disaster management, government, and human resources. In the sectors of disaster management, government, and human resources, many adaptation projects aim at moderating the vulnerability of the government or community and other stakeholders.

##### **4.4.3 ADB**

From ADB's database<sup>3</sup>, 23 loan projects related to adaptation measures are extracted. These 23 projects are classified into the suggested sub-sectors in accordance with each project explanation shown in Table 4.4.

ADB projects seem to focus on disaster management and the government sectors. Similar to GEF, many adaptation projects are awareness programs for climate change or capacity enhancement. In the agriculture, water resource, and rural development sectors, indirect support is provided by increasing adaptive capacity through enhancement of research institutes.

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<sup>1</sup> <http://www.worldbank.org/>

<sup>2</sup> <http://www.gefonline.org/>

<sup>3</sup> <http://www.adb.org/Climate-Change/projects.asp#promoting>

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**Table 4.4 Comparison of Suggested Sub-sectors with Sub-sectors of WB, GEF, ADB Projects**

Sector	Suggested Sub-sector	World Bank		GEF		ADB		
	Sub-sector	Sub-sector	Nos.	Sub-sector	Nos.	Sub-sector	Nos.	
Water resources	Water resources management			Water resources management	8	Water resources management	3	
	Water resources development			Water resources development	1	Water resources development	1	
	Water resources utilization							
Agriculture and rural development	Irrigation and drainage	Irrigation and drainage	5					
	Farmland management enhancement (cultivation management, varieties, water users association)			Farming support	10	Farming support	2	
				Sustainable agriculture	2			
	Livestock and fishery	Livestock	Livestock	3	Livestock	3		
		Agriculture administration	Agriculture administration	3				
						Others	1	
Forestry/natural resource conservation	Forest conservation/afforestation (planting grass seeds)	Forest	47	Forest conservation/afforestation	1			
				Forest disaster prevention	1			
	Ecosystem integrity					Coastal protection	3	
					Development of human resources, Environmental management ability	24	Development of human resources, Environmental management ability	3
Disaster management	Flood control	Flood control	6	Flood control	1			
	Coastal protection			Coastal protection	2			
	Sediment-related disaster prevention							
	Information system			Information system	4	Information system	1	
						Land use management	1	
Urban-regional development	Rural development	Housing	1					
	Urban development							

Sector	Suggested Sub-sector	World Bank		GEF		ADB	
	Sub-sector	Sub-sector	Nos.	Sub-sector	Nos.	Sub-sector	Nos.
Transportation	Transportation infrastructure	Transportation by ship, port	4			Port	1
		Railway	4				
		Road	6				
		General transportation	15				
		Transportation administration	5				
Sanitary improvement	Water supply	Water supply	3				
	Sewerage and drainage	Sewerage	2				
	Medical/ health care	Sanitary	1				
Others	Village development, enhancement of local community						
	Human resources development	Primary education	1	Education	10		
		Vocational training	1				
Government administration				Environmental issues	13		
				General administration	1		
Energy				Renewable energy	1		
Finance		Finance	2				
Overall water resources management (water resource, sewage water, flood control)		Overall water resources management	14				
		Government administration	1				

#### 4.5 Selection of Target Sub-sectors

Based on the classification conducted above, and clarification of the potential of adaptation measures in each sub-sector, the following 15 sub-sectors shown in Table 4.5 were selected.

**Table 4.5 Sub-sectors for Adaptation Measures**

Sub-sector
1. Water Resources
2. Irrigation and Drainage
3. Farmland Management Enhancement
4. Forest Conservation/ Afforestation
5. Ecosystem Integrity
6. Flood Control
7. Coastal Protection
8. Sediment-related Disaster Prevention
9. Disaster Prevention Information System
10. Rural / Urban Development
11. Bridge, Road and Railway
12. Port and Airport
13. Water Supply
14. Sewerage / Urban Drainage
15. Medical / Health Care

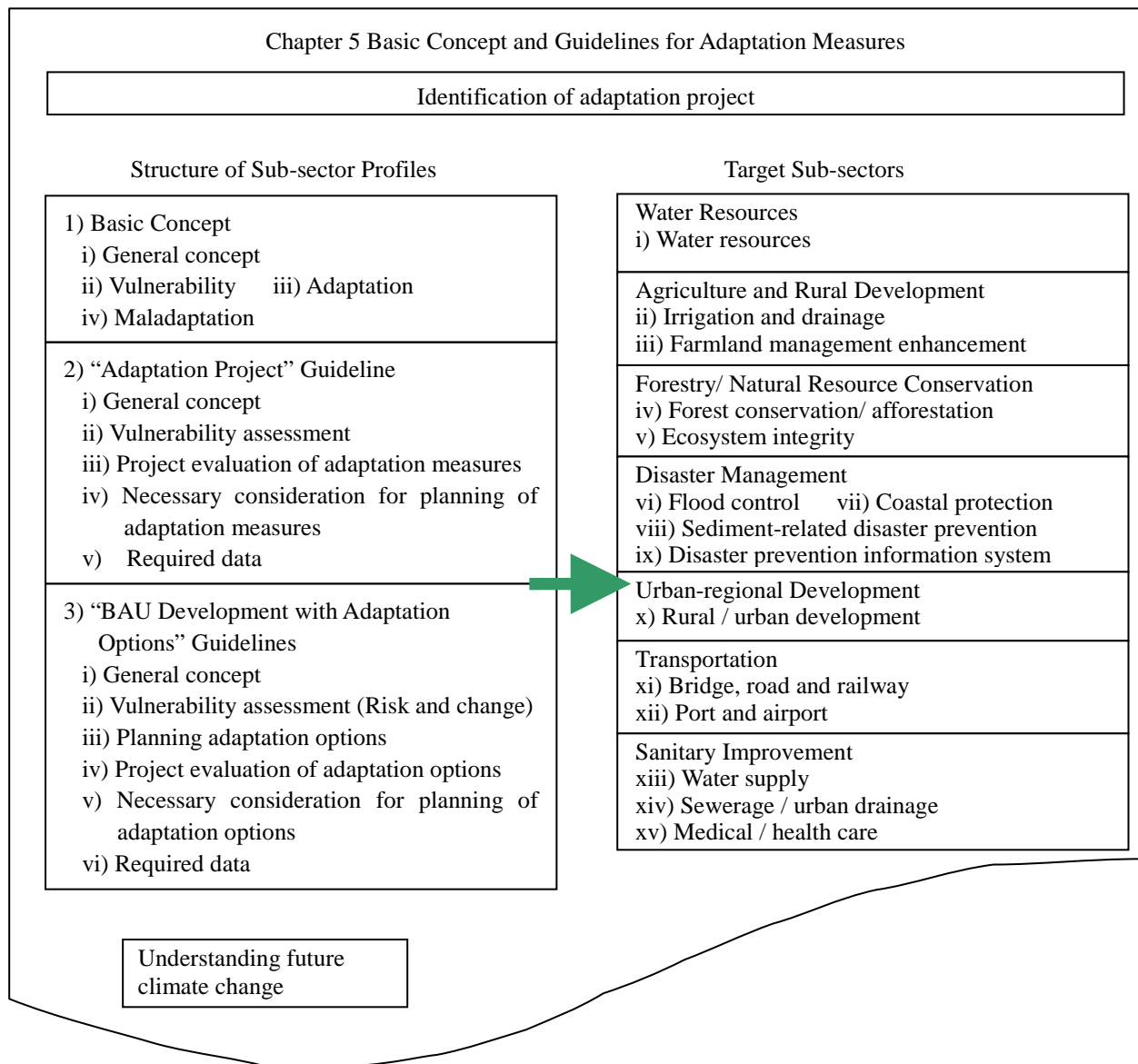
## Chapter 5 Basic Concept and Guidelines for Adaptation Measures

This chapter shows how to formulate the adaptation measures.

In Figure 5.1, a workflow shows how to identify an adaptation project. If it is identified as an adaptation project, the project is classified as either “Adaptation Project” or “BAU Development with Adaptation Options”, and how it should be further examined during project preparatory survey.

Subsequently, the section on “Basic Concept,” summarizes vulnerability to climate change in each sub-sector as well as adaptation measures to cope with such vulnerability and maladaptation.

The sections about “guidelines” summarizes the direction of project preparatory survey, etc. for typical adaptation projects examined in this survey, with due consideration to future potential of formulating JICA ODA loan project in the target sub-sector.



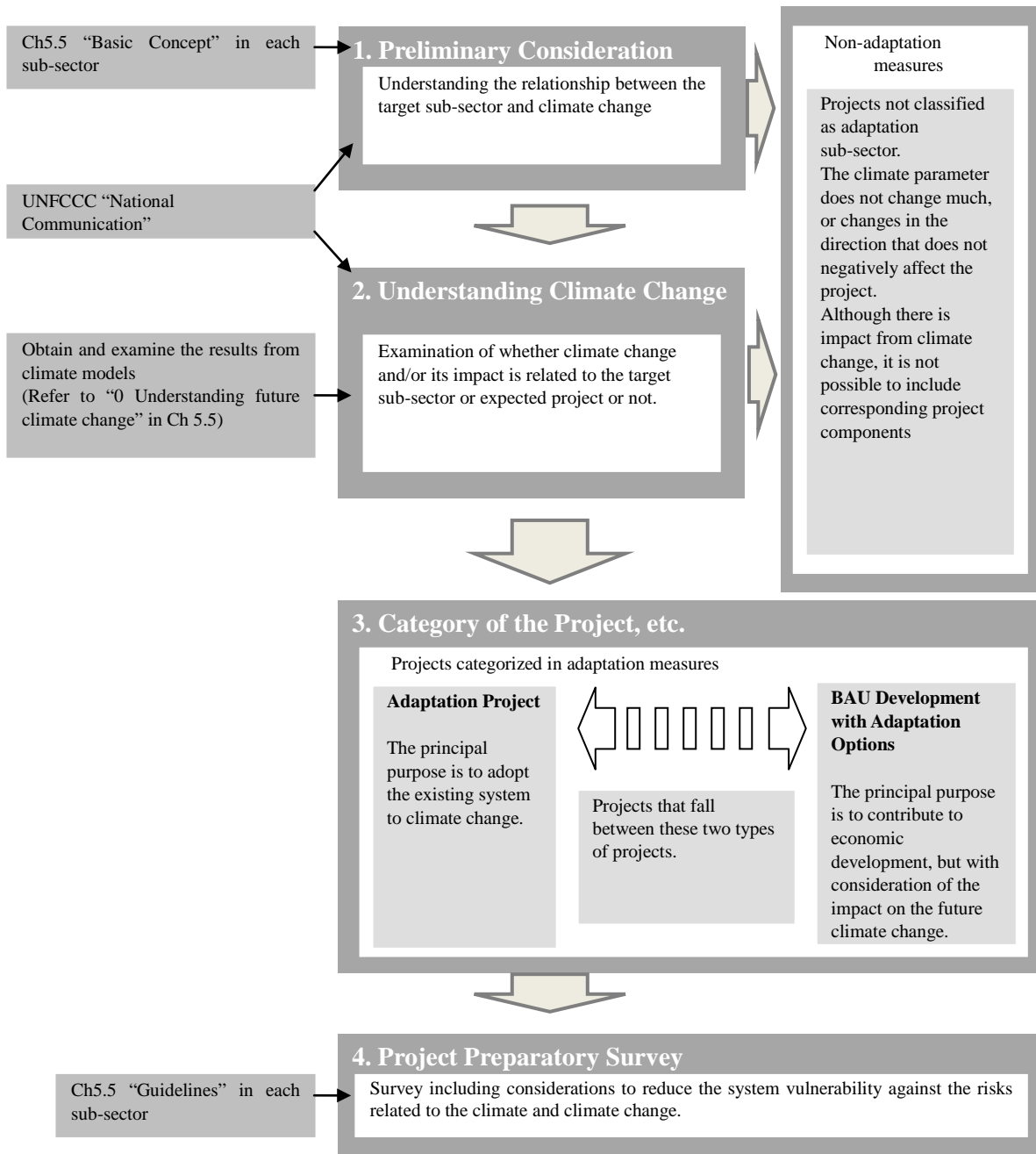


Figure 5.1 Process of Formulating Adaptation Measures

## 5.1 Basic Concept

Table 5.1 summarizes the structure and the contents of the adaptation concept in each sub-sector.

**Table 5.1 Structure of the Adaptation Concept**

A. General Concept	General description and introductions for climate change impact and adaptation in the target sub-sector
B. Vulnerability	<p>As defined in the Section 3.2, the vulnerability to climate change in this report is shown below:</p> <p><b>Vulnerability</b>  = Exposure to climate hazards and perturbations x Sensitivity  – Adaptive capacity</p> <p>The expected vulnerability to climate change in the target sub-sector is summarized below:</p> <p>1) Major Climate Change Impacts on the Target Sub-sector  This shows the climate parameters related to the target sub-sector and how climate change influences said sub-sector. In this report, both change of external force related to the target sub-sector caused by climate change, and its probability of impact to the target sub-sector (sensitivity) are explained.</p> <p>2) Other Factors that Influence the Target Sub-sector Associated with Climate Change Impacts  When socio-economies as well as climate dynamically change, the impacts on the target sub-sector could increase with the synergy effects. Thus, these socio-economic factors are mentioned here.</p> <p>3) Adaptive Capacity to Climate Change  It shows the adaptive capacities such as organization, ability and budget for combating climate change. When the adaptive capacity is high, the vulnerability becomes low.</p> <p>4) Spatial Distribution of Vulnerability  Vulnerability factors are heterogeneously distributed in the target system. It examines the spatial distribution of vulnerability, because some area is much more influenced by climate change.</p>
C. Adaptation Measures	It mainly shows the major structural and non-structural measures, which are expected to be applied in the loan assistance.
D. Maladaptation	<p>Maladaptation is defined as the project activities which increase the vulnerability.</p> <p>1) Business-as-usual development, which by overlooking climate change impacts, inadvertently increases exposure and/or vulnerability to climate change.  2) Actions undertaken to adapt to climate impacts that do not succeed in reducing vulnerability, but increase it instead.</p> <p>In this step, it shows the related maladaptation in the target sub-sector, which requires attention.</p>



## 5.2 Guidelines

Respective guidelines on “Adaptation Project” and “BAU Development with Adaptation Options” are shown for each sub-sector. As explained in Chapter 3, it is difficult to clearly distinguish these types in actual projects. The guidelines in this survey correspond to typical example for each type in each sub-sector.

As defined in Section 3.2, the adaptation in this survey is defined as “reducing vulnerability”. Thus, vulnerability assessment becomes crucial for examination of adaptation measures. This report presents the vulnerability assessment in detail for “Adaptation Project”, while also presenting minimum considerations that should be given to vulnerability for the “BAU Development with Adaptation Options”. Among the parameters influencing vulnerability, the “Assess Future Exposure to Climate Hazards and Perturbations”, which means the change of external force, is solely examined for “BAU Development with Adaptation Options”. Table 5.2 presents comparison of both concepts.

**Table 5.2 Concept Comparison between “Adaptation Project” and “BAU Development with Adaptation Options”**

Adaptation Project	BAU Development with Adaptation Options
Projects formed to reduce the climate change vulnerability in the existing system such as projects to improve existing facility to cope with the increased vulnerability caused by the change of external forcing due to climate change.	Projects which is not mainly aimed to reduce the vulnerability, but is designed to adapt to the impacts of the climate change in achieving its main objective, such as development and rehabilitation of infrastructure projects that are planned or designed with consideration to increasing external forcing stemming from climate change.

### 5.2.1 Adaptation Project

The process for formulating “Adaptation Project” is shown in Figure 5.2.

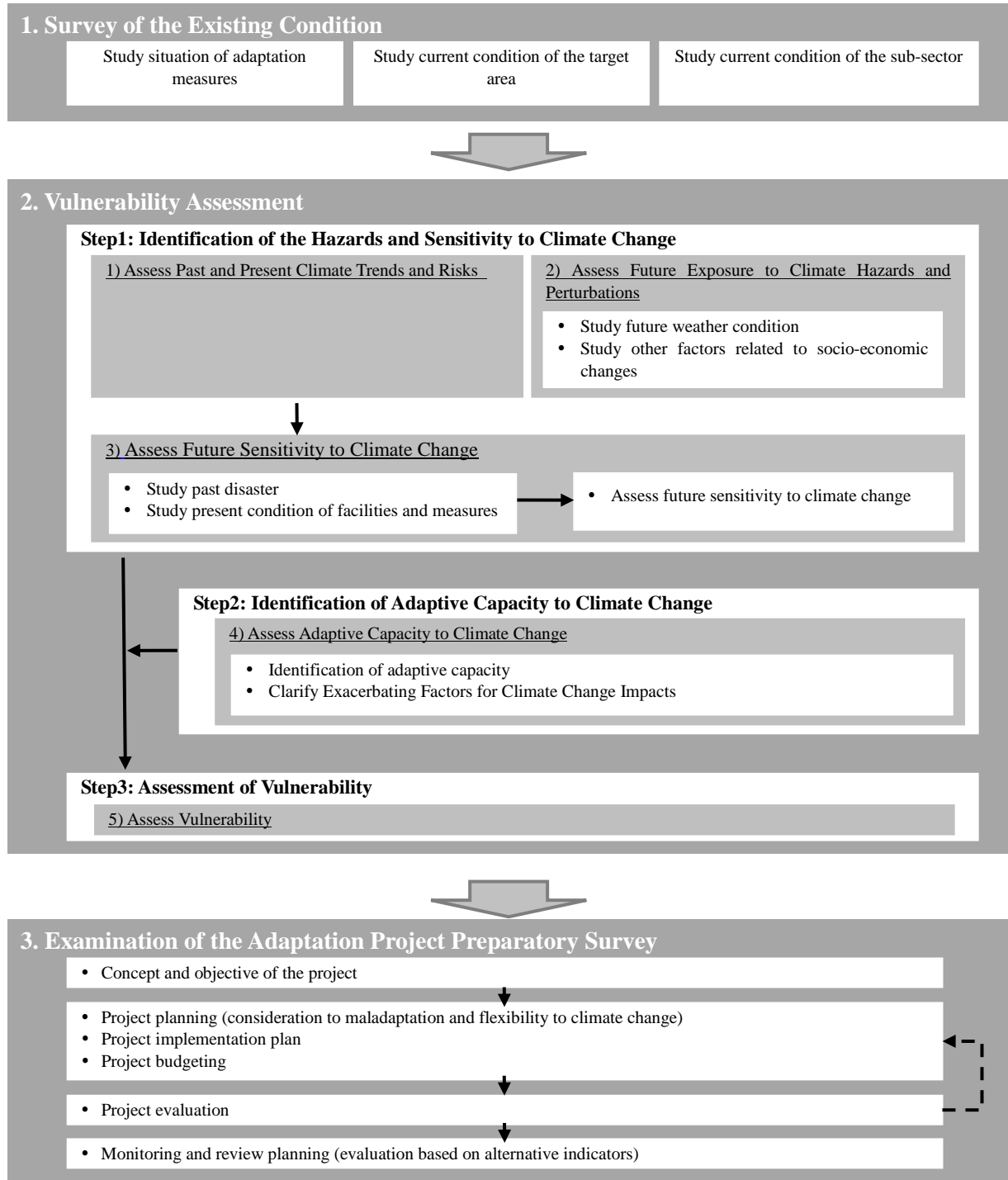


Figure 5.2 Formulation Process for “Adaptation Project”

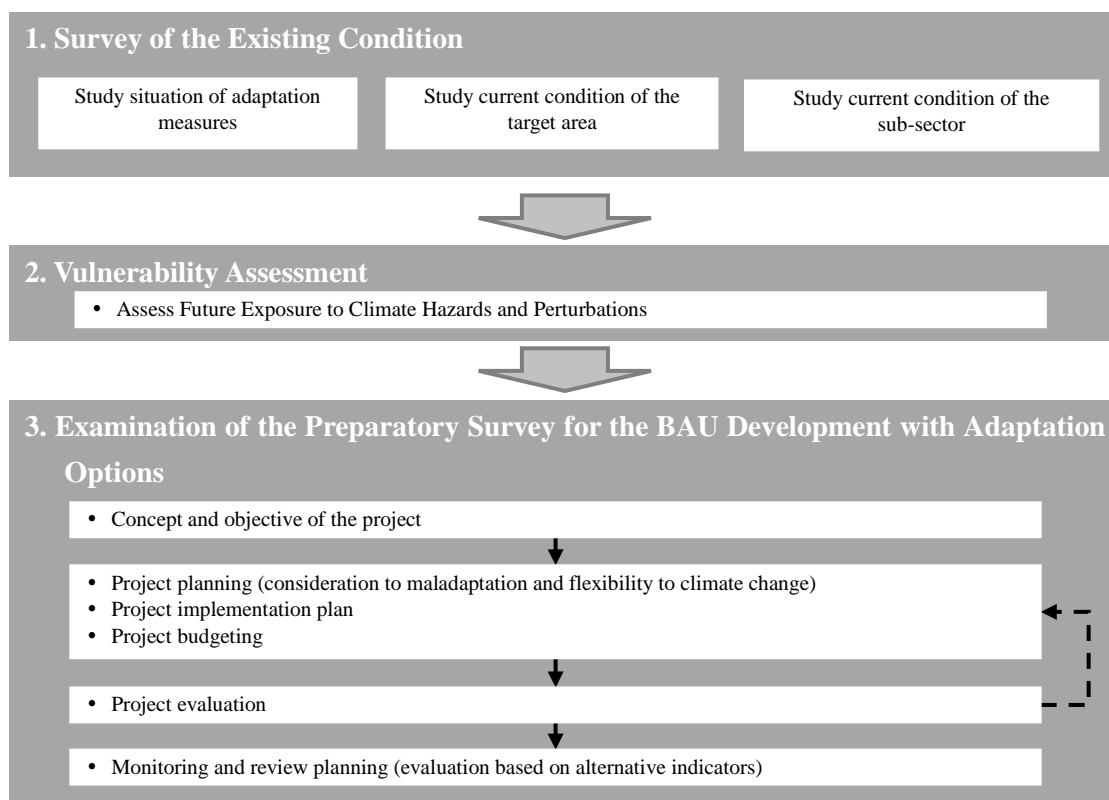
Guidelines in each sub-sector summarizes the items (overall vulnerability assessment, flexibility in adaptation examination, maladaptation consideration, evaluation items for project evaluation and monitoring) which require examination in addition to those considered in business-as-usual development projects. The guidelines on “Adaptation Project” include the following items shown in Table 5.3.

**Table 5.3 Evaluation Items for Guidelines on “Adaptation Project”**

A. General	The necessity, description and impact of the adaptation project in the target sub-sector
B. Vulnerability Assessment	<p>STEP 1:</p> <ol style="list-style-type: none"> <li>1) Assess past and present climate trends and risks</li> <li>2) Assess future exposure to climate hazards and perturbations               <ol style="list-style-type: none"> <li>a) Study future weather conditions</li> <li>b) Study other Factors related to socio-economic changes</li> </ol> </li> <li>3) Assess future sensitivity to climate change               <ol style="list-style-type: none"> <li>a) Study past damage</li> <li>b) Study present condition of facilities and measures</li> <li>c) Assess future sensitivity to climate change</li> </ol> </li> </ol> <p>STEP 2:</p> <ol style="list-style-type: none"> <li>4) Assess adaptive capacity to climate change               <ol style="list-style-type: none"> <li>a) Identification of adaptive capacity</li> <li>b) Clarify exacerbating factors for climate change impacts</li> </ol> </li> </ol> <p>STEP 3:</p> <ol style="list-style-type: none"> <li>5) Assess Vulnerability</li> </ol>
C. Project Evaluation of Adaptation Measures	<p>Project evaluation</p> <p>Major alternative indicators used during monitoring and review</p>
D. Necessary Consideration for Planning of Adaptation Measures	<ol style="list-style-type: none"> <li>1) Monitoring and review</li> <li>2) Flexibility to climate change</li> <li>3) Consideration to Maladaptation</li> </ol>
E. Required Data	Required data for the vulnerability assessment and project evaluation, which are additional when compared to business-as-usual development project evaluation

### 5.2.2 BAU Development with Adaptation Options

The process for formulating “BAU Development with Adaptation Options” is shown in Figure 5.3. Vulnerability assessment is simplified compared to the procedure for “Adaptation Project” as shown in the chart below.



**Figure 5.3 Formulation Process for “BAU Development with Adaptation Options”**

The following additional actions are required for “BAU Development with Adaptation Options” as compared to the “Business-As-Usual Development”:

- Vulnerability assessments
- Planning adaptation options
- Consideration of flexibility to climate change and maladaptation
- Project evaluation (additional cost and effect for the adaptation options)
- Monitoring and review planning (evaluation based on alternative indicator)

Based on the above discussion, additional considerations for BAU Development with Adaptation Options are summarized in guidelines for each sub-sector (see Table 5.4) the section related to the policy in sub-sector. Other general considerations for “BAU Development” projects are omitted.

**Table 5.4 Evaluation Items for Guidelines on “BAU Development with Adaptation Options”**

A. General	The necessity, description and impact of the BAU Development with Adaptation Options in the target sub-sector
B. Vulnerability Assessment (Risk and Change)	Assess future exposure to climate risk and change
C. Planning Adaptation Options	Develop the adaptation options in consideration of climate change
D. Project Evaluation of Adaptation Options	Project evaluation Major alternative indicators used during monitoring and review
E. Necessary Consideration for Planning of Adaptation Options	1) Monitoring and Review 2) Flexibility to climate change 3) Consideration to Maladaptation
F. Required Data	Required data for the vulnerability assessment and project evaluation, which are additional when compared to business-as-usual development project evaluation

### 5.3 Reviewed Documents for Each Target Sub-sector

Table 5.5 summarizes the reference documents for policy making in each sub-sector. Details are classified for each sub-sector.

**Table 5.5 Reference Documents for Each Sub-sector**

Sector	Sub-sector	Reference Documents
Water resources	1 Water resources	<ul style="list-style-type: none"> <li>• IPCC. (2007). AR4 WGII Report</li> <li>• JICA. (2010). Handbook on Climate Change Adaptation in the Water Sector: A Resilient Approach that Integrates Water Management and Community Development</li> <li>• GTZ. (2008). Water and Adaptation to Climate Change: Consequences for Developing Countries</li> <li>• Ministry of Land, Infrastructure, Transport and Tourism, Japan. (2008). Integrated Water Resource Management addressing Climate Change and Other Risks (Interim Report)</li> </ul>
	2 Irrigation and drainage	<ul style="list-style-type: none"> <li>• GTZ. (2008). Climate Change and Agriculture: Threats and Opportunities</li> <li>• Ministry of Agriculture, Forestry and Fisheries, Japan. (2008). Nogyo Noson ni okeru Chikyu Ondanka Taiousaku no Arikata (in Japanese)</li> </ul>
Agriculture and rural development	3 Farmland management enhancement	<ul style="list-style-type: none"> <li>• GTZ. (2008). Climate Change and Agriculture: Threats and Opportunities.</li> <li>• Ministry of Agriculture, Forestry and Fisheries, Japan. (2008). Nourinsuisan-sho Chikyu Ondanka Taisaku Sogo Senryaku (in Japanese)</li> </ul>
	4 Forest conservation/afforestation	<ul style="list-style-type: none"> <li>• Ministry of the Environment, Japan.(2008). Kikouhendou heno Kashikoi Tekiou (in Japanese), Chapter 4 Natural Ecosystem</li> <li>• IPCC. (2007).AR4 WGII Report</li> <li>• David L. Spittlehouse, Robert B. Stewart. (2003). Adaptation to Climate Change in Forest Management. BC Journal of Ecosystems and Management. Vol. 4. No.1</li> <li>• FAO / Intercooperation (Swiss). (2005).Adaptation of Forest Ecosystems and the Forest Sector to Climate Change</li> <li>• UNDP.(2010). Mapping Climate Change Vulnerability and Impact Scenarios - A Guidebook for Sub-National Planners</li> </ul>
Forestry/natural resource conservation	5 Ecosystem integrity	<ul style="list-style-type: none"> <li>• Ministry of the Environment, Japan. (2008). Kikouhendou heno Kashikoi Tekiou (in Japanese), Chapter 4 Natural Ecosystem</li> <li>• IPCC. (2007).AR4 WGII Report</li> <li>• The Ramsar Convention on Wetland (2002) Climate Change and Wetlands: Impacts, Adaptation, and Mitigation (Resolution VIII.3)</li> <li>• Secretariat of Convention of Biological Diversity. (2009). Connecting Biodiversity and Climate Change - Mitigation and Adaptation-. CBD Technical Series No.41</li> <li>• IBRD / WB. (2008). Climate Change, and Adaptation - Nature-Based Solutions from the World Bank Portfolio</li> </ul>

Sector	Sub-sector	Reference Documents
Disaster management	6 Flood control	<ul style="list-style-type: none"> <li>JICA. (2010). Handbook on Climate Change Adaptation in the Water Sector: A Resilient Approach that Integrates Water Management and Community Development</li> <li>Ministry of Land, Infrastructure, Transport and Tourism, Japan. (2010). Practical Guidelines on Strategic Climate Change Adaptation Planning -Flood Disasters-</li> </ul>
	7 Coastal protection	<ul style="list-style-type: none"> <li>JICA. (2010). Handbook on Climate Change Adaptation in the Water Sector: A Resilient Approach that Integrates Water Management and Community Development</li> <li>USAID. (2009). Adapting to Coastal Climate Change: A Guidebook for Development Planners</li> </ul>
	8 Sediment-related disaster prevention	<ul style="list-style-type: none"> <li>Ministry of Land, Infrastructure, Transport and Tourism, Japan. (2008). Climate Change Adaptation Strategies to Cope with Water-related Disasters due to Global Warming (Policy Report)</li> </ul>
	9 Disaster prevention information system	<ul style="list-style-type: none"> <li>WMO, the Earth Institute, Global Humanitarian Forum, Zain, and Ericsson. (2008). Weather Info for All Initiative 2008-2012.</li> </ul>
Urban-regional development	10 Rural / urban development	<ul style="list-style-type: none"> <li>Japan Society of Civil Engineers, (2009). Chikyu Ondanka ni Idomu Doboku Kougaku - Dai 4 pen: Chikyu Ondanka ni taisuru Tekiousaku. (in Japanese).</li> <li>Ministry of the Environment, Japan. (2008). Kikouhendou heno Kashikoi Tekiou - Chapter 7 Kokumin Seikatsu / Toshi Seikatsu Bunya. (in Japanese).</li> </ul>
Transportation	11 Bridge, road and railway	<ul style="list-style-type: none"> <li>Highway Agency. (2010), The Highway Agency's Interim Climate Change Risk Assessment</li> <li>Network Rail. (2010), Network Rail Interim Climate Change Adaptation Report</li> <li>Rail Safety &amp; Standards Board. (2008). Assessing the Impact of Climate Change on Transport Infrastructure</li> </ul>
	12 Port and airport	<ul style="list-style-type: none"> <li>Ministry of Land, Infrastructure, Transport and Tourism, Japan. (2009). Chikyu-Ondanka ni Kiinsuru Kiko-Hendo ni Taisuru Kowan-Seisaku no Arikata: Toshin (in Japanese).</li> </ul>
Sanitary improvement	13 Water supply	<ul style="list-style-type: none"> <li>Ministry of the Environment, Japan. (2008). Kikouhendou heno Kashikoi Tekiou: Chapter 3 Mizu Kankyo / Mizu Shigen Bunya (in Japanese).</li> <li>UNEP (1998) Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies; Chapter 6.</li> </ul>
	14 Sewerage / urban drainage	<ul style="list-style-type: none"> <li>Ministry of the Environment, Japan. (2008). Kikouhendou heno Kashikoi Tekiou - Chapter 3 Mizu Kankyo / Mizu Shigen Bunya. (in Japanese).</li> <li>JICA (2010) Handbook for Climate Change Adaptation in Water Sector.</li> <li>National Geographic official website (Japanese). (2011). Chikyu Ondanka ga Umidasu Mittsu no Igaina Heigai - Gesui niyoru Inryousui no Osen (in Japanese): <a href="http://www.nationalgeographic.co.jp/news/news_article.php?file_id=20110302002">http://www.nationalgeographic.co.jp/news/news_article.php?file_id=20110302002</a></li> <li>Ministry of the Environment, Japan. (2008). Kikouhendou heno Kashikoi Tekiou - Chapter 3 Mizu Kankyo / Mizu Shigen Bunya. (in Japanese)</li> </ul>
	15 Medical / health care	<ul style="list-style-type: none"> <li>WHO. (2003). Methods of Assessing Human Health Vulnerability and Public Health Adaptation to Climate Change.</li> <li>Ministry of the Environment, Japan. (2008). Kikouhendou heno Kashikoi Tekiou - Chapter 6 Kenkou Bunya. (in Japanese).</li> </ul>

#### 5.4 Assumptions for Preparing Guidelines for Target Sub-sectors

During preparation of the guidelines in each sub-sector, typical project outline for “Adaptation Project” and for “BAU Development with Adaptation Options” with future potential of becoming JICA ODA loan project has been presented. Table 5.6 summarizes the description of the assumed projects.

Some sub-sectors have either one of, “Adaptation Project” or “BAU Development with Adaptation Options”.

**Table 5.6 Assumed Project of Each Sub-sector**

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
1. Water Resources	Adaptation Project	Climate change will bring imbalance between water supply and demand for existing water resources facilities, due to change in precipitation and its pattern, increase of water demand due to temperature rise, etc. In addition, the intensification of flood would damage the facilities.	Adaptation measures against water shortage include: to increase the active capacity of reservoir by structural measures such as raising dam height, excavating reservoir, etc.; to increase water resources by reduction of water leakage, new water resources development and water conveyance; and to reallocate and utilize water resources by improvement of dam management or integrated water resources management. Reinforcement of intake facility will be a countermeasure against flood intensification.	The impacts of climate change on the water resources sub-sector will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Flexibility of water supplier side</li> <li>• Flexibility of water user side</li> <li>• Flexibility of water supply and demand adjustment</li> <li>• Disaster resilience capacity of regulatory agency</li> <li>• Existence and ability of research and development</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period by expanded facilities</li> <li>• Improvement of target return period in the target area by new facility development</li> <li>• Improvement of target return period in the target area by water management improvement</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in the awareness of stakeholders on water supply and water use</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
	BAU Development with Adaptation Options	It is necessary to develop water resources since future water demand will exceed the existing water supply from water resources, such as dam reservoir, water intake at river, groundwater, etc., in association with economic growth. Future climate change impacts such as reduction of water availability due to rainfall change, increase of water demand due to temperature rise, and intensification of the flood scale, shall be considered.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	The expected water supply will be maintained in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period of expanded facilities</li> <li>• Improvement of target return period in the target area by new facility development</li> <li>• Improvement of target return period in the target area by water management improvement</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in stakeholders' awareness of water supply and water use</li> </ul>



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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
2. Irrigation and Drainage	Irrigation Project	Climate change impacts, such as decrease in precipitation, change of precipitation patterns, and prolongation of drought, are likely to increase crop damage.	To reduce drought damage by means of development/ expansion/ improvement of irrigation facilities, installation of water saving irrigation, etc.	Crop damage in the event of drought, which will be exacerbated by climate change, will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Activity of agricultural extension office and NGOs</li> <li>• Disaster resilience capacity of regulatory agency</li> <li>• Existence and ability of research and development</li> <li>• Compensation for crop and structural damage by climate disaster</li> <li>• Financial scheme to farmers</li> <li>• Socio-economic condition of farmers</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Expansion of irrigated area, improvement of target return period</li> <li>• Improvement of water management</li> <li>• Implementation situation of participatory irrigated agriculture development</li> <li>• Changes in the awareness of stakeholders</li> </ul>
	BAU Development with Adaptation Options	New irrigation facilities will be constructed, or existing ones will be rehabilitated or expanded in order to improve agricultural productivity. Potential risks of reduction in irrigation efficiency because of water shortage are likely to increase due to climate change impacts.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	The expected irrigated farming will be maintained in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Expansion of irrigated area, improvement of target return period</li> <li>• Improvement of water management</li> <li>• Implementation situation of participatory irrigated agriculture development</li> <li>• Changes in the awareness of stakeholders</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
Drainage	Adaptation Project	Climate change will increase frequency and intensity of flood, hence the flood damages on crops will increase.	To reduce flood damage on crops by means of development, expansion, and improvement of drainage facilities.	Crop damage in the event of flood, which will be exacerbated by climate change, will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Activity of agricultural extension office and NGOs</li> <li>• Disaster resilience capacity of regulatory agency</li> <li>• Existence and ability of research and development</li> <li>• Compensation for crop and structural damage by climate disaster</li> <li>• Financial scheme to farmers</li> <li>• Socio-economic condition of farmers</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Expansion of area covered by drainage facilities, improvement of target return period for drainage</li> <li>• Improvement of drainage management</li> <li>• Implementation situation of participatory irrigated agriculture development</li> <li>• Changes in the awareness of stakeholders</li> </ul>
	BAU Development with Adaptation Options	New drainage facilities will be constructed, or existing ones will be rehabilitated or expanded in order to reduce flood damage and insufficient drainage. Potential risks of reduction of drainage function because of discharge increase in natural drainage, and intensification and increase frequency of flood, are likely to increase due to climate change impacts.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	Crop damages due to flood will be reduced in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Expansion of area covered by drainage facilities, improvement of target return period for drainage</li> <li>• Improvement of drainage management</li> <li>• Implementation situation of participatory irrigated agriculture development</li> <li>• Changes in the awareness of stakeholders</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
3. Farmland Management Enhancement	Adaptation Project	Climate change impacts, such as conventional farm crops becoming unsuitable to agricultural condition, change of cropping season, exacerbation of quality deterioration after harvesting, are likely to be caused.	To enhance farmland management through alternation/ development of varieties, improvement of cultivation and post harvesting, strengthening of farmers organization, etc.	Crop damage by climate change will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Condition of development and operation of irrigation and drainage facilities</li> <li>• Activity of agricultural extension office and NGOs</li> <li>• Existence and ability of research and development</li> <li>• Compensation for crop and structural damage by climate disaster</li> <li>• Financial scheme to farmers</li> <li>• Socio-economic condition of farmers</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of cultivation (review of cropping pattern, condition of farming guidance and dissemination of agricultural knowledge and technology)</li> <li>• Improvement of cultivation (installation of greenhouse and precision agriculture, agricultural input)</li> <li>• Condition of development and introduction of new crop varieties</li> <li>• Strengthening post harvesting (condition of facility installation and operation)</li> <li>• Condition of other agricultural support (farmers organization, financial scheme)</li> <li>• Changes in the awareness of stakeholders</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
	BAU Development with Adaptation Options	Projects for farmland management enhancement will be implemented. Climate change impacts, such as conventional farm crops becoming unsuitable to change in agricultural condition, change of cropping season, and exacerbation of quality deterioration after harvesting, are necessary to be considered.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	Farming practice will be maintained in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of cultivation (review of cropping pattern, condition of farming guidance and dissemination of agricultural knowledge and technology)</li> <li>• Improvement of cultivation (Installation of greenhouse and precision agriculture, agricultural input)</li> <li>• Condition of development and introduction of new crop varieties</li> <li>• Strengthening post harvesting (condition of facility installation and operation)</li> <li>• Condition of other agricultural support (farmers organization, financial scheme)</li> <li>• Changes in the awareness of stakeholders</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
4. Forest Conservation/ Afforestation	Forest Conservation/ Afforestation BAU Development with Adaptation Options	In regions where forests are devastated due to human activities such as grazing and fuel woods collection, efforts including reforestation, restoration, and forestry management should be intensified. Such efforts should also include construction of seedling production facilities, distribution of seedlings, and improvement of infrastructure for forestry activities. Changes in temperature and precipitation need to be considered as elements causing impacts on vegetation. Aggravated frequency and severity of forest fire and pest damages may be associated with future climate change.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	Even under climate change impacts, forest areas can still be expanded and forest quality may be increased as expected.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Sensitivity to climate change</li> <li>• Adaptive capacity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Forest road length, progress in the introduction of fire extinguishing equipments</li> <li>• Length of fireproof belts and pest control belts</li> <li>• Frequency of fire prevention patrol</li> <li>• Changes in the awareness of stakeholders</li> </ul>

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Mangrove Reforestation	BAU Development with Adaptation Options	<p>Mangrove forests have been significantly deforested for fuel woods production, or paddy field and aquafarm development. In order to restore and conserve the mangrove forests, replanting, construction of seedling production facilities of mangroves, and assistance to sustainable fishery, agriculture and eco tourism for livelihood will be implemented. As future climate change impacts, changes in inundation areas due to sea level rise as well as in tidal current and water temperature should be considered.</p> <p>If sediment inflow from upstream greatly affects mangrove growth, sediment supply volumes need to be considered in association with changes in precipitation or rainfall patterns.</p>	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	Even under climate change impacts, planted mangroves can take roots and grow as expected.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Maintenance of planted mangrove area</li> <li>• Capacity building of the bureau responsible for reforestation</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
5. Ecosystem Integrity	Wetland Conservation Adaptation Project	<p>Ecosystem in lakes and wetlands may be affected by changes in precipitation, rainfall patterns and others resulted in future climate change, which might cause water quality deterioration and physical water area shrinkage associated with change in freshwater inflow, increase in sediment and nutrients inflow, increased secondary products and stratification due to temperature rise.</p> <p>Ecosystem in coastal wetlands may be further affected by sea level rise and associated changes in water depth, tidal level, salinity and tidal current conditions.</p>	<p>In order to reduce nutrients inflow, introduce waste water treatment facilities, plant trees and manage farmlands in the whole catchment area. Also in order to reduce loads such as sediment inflow in the catchment area, plant trees, construct sediment control facilities such as hillside works and sediment dams, and control soil erosion in farmlands.</p> <p>In addition to the above efforts, establish the conservation zones as well as buffer zones to alleviate stresses to ecosystem.</p>	<p>Climate change impacts to ecosystem will be reduced.</p>	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Sensitivity to future climate change</li> <li>• Risks associated with climate change</li> <li>• Ecosystem conservation activities</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Water quality, sediment load volume</li> <li>• Installation of watershed management facility</li> <li>• Changes in the awareness of stakeholders related to ecosystem</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
	BAU Development with Adaptation Options	<p>The target wetland faces impacts to ecosystem due to water quality deterioration, and shrinkage in wetland area, which resulted from land development in the catchment area, nutrients inflow due to urbanization, increase in sediment inflow, unsustainable fishery, and coastal development.</p> <p>In order to conserve wetland ecosystem, requirements include reduction of inflowing load volume by proper management of the catchment area, introduction of sustainable use, and protection of important zones.</p> <p>Among future climate change impacts, change in precipitation, increase in inflowing load volume due to changed rainfall patterns, and water quality deterioration due to temperature rise need to be considered.</p> <p>For coastal wetlands, changes in water depth, tidal level, and salinity associated with sea level rise, and physical damages due to increased disasters such as cyclones should also be considered.</p>	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	Even under climate change impacts, wetlands can still be conserved as expected.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Sensitivity to future climate change</li> <li>• Risks associated with climate change</li> <li>• Ecosystem conservation activities</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Water quality, sediment load volume</li> <li>• Installation of watershed management facility</li> <li>• Changes in the awareness of stakeholders related to ecosystem</li> </ul>



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6. Flood Control	Adaptation Project	The target river had been developed with flood control facilities. However, climate change would change precipitation patterns, increase extreme events, and cause backwater effect by sea level rise. Hence, flood frequency will increase and intensify in the target river basin.	The flood control capacity in the target area shall be strengthened by structural measures such as development of flood control facilities, and non-structural measures such as evacuation.	Flood damage increased by climate change will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Risk of priority protection area</li> <li>• Community- based disaster management and crisis management</li> <li>• Disaster resilience capacity of regulatory agency</li> <li>• Existence and ability of research and development</li> <li>• Compensation for flood damage</li> <li>• Land use and land use regulation</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period in the whole river basin or the target area</li> <li>• Improvement of target return period in priority protection area</li> <li>• Quantity and quality of land area for storage, infiltration and retarding</li> <li>• Changes in the number of inhabitants and economical activities in the whole river basin, priority protection area, and flood prone area</li> <li>• Changes in the awareness of stakeholders on flood disaster</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
	BAU Development with Adaptation Options	It is necessary to increase flood control capacity of the target river, in association with economic growth and land development. Potential risks of flood disasters in larger areas, or in greater magnitudes, are likely to occur in the target river basin and areas. The climate change impacts are expected to increase the amount of precipitation, change rainfall patterns, increase frequency and scale of extreme events, and increase backwater effects due to sea level rise.	Appropriate measures will be implemented within the project with consideration of the increased flood damage associated with climate change.	The expected damages from the flood disaster will be reduced in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Risk of priority protection area</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period in the whole river basin or the target area</li> <li>• Improvement of target return period in priority protection area</li> <li>• Quantity and quality of land area for storage, infiltration and retarding</li> <li>• Changes in the number of inhabitants and economical activities in the whole river basin, priority protection area, and flood prone area</li> <li>• Changes in the awareness of stakeholders on flood disaster</li> </ul>
7. Coastal Protection	Adaptation Project	Climate change will raise the sea water level and increase frequency and intensity of cyclones, which translates to inundation, coastal erosion, storm surge-related damage, and tidal waves at coastal areas. Groundwater level increase associated with sea level rise will exacerbate the risk of ground uplift, buoyancy increase of buried pipes and manholes, and soil liquefaction in coastal areas. Other concerns are coral bleaching and fish death due to sea temperature rise, and decline of preventive measures for coastal areas against coastal erosion and environmental deterioration.	To take countermeasures for inundation, coastal erosion and groundwater level rise; strengthen disaster management; and promote conservation of coastal environment by means of structural and non-structural measures.	Damages due to inundation, coastal erosion, groundwater level increase, storm surges, and tidal waves, induced by climate change will be reduced. Coastal environment will be conserved and coral reefs will be protected against wave forces.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Community-based disaster management and crisis management</li> <li>• Disaster resilience capacity of regulatory agency</li> <li>• Existence and ability of research and development</li> <li>• Compensation for storm surge and high wave damage</li> <li>• Land use and land use regulation</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period/ safety factor of facilities</li> <li>• Implementation record of projects, such as beach nourishment, mangrove afforestation, transplanting of coral reef.</li> <li>• Changes in the awareness of stakeholders on coastal protection</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
	BAU Development with Adaptation Options	It is necessary to increase coastal protection capacity, in association with land development in the coastal area due to economic growth. Potential risks of flood inundation, coastal erosion, storm surge and high wave damage are likely to increase in the target coastal areas due to climate change impacts, such as sea level rise and increase of frequency and intensification of cyclones.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	The expected coastal protection function will be maintained in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period/ safety factor of facilities</li> <li>• Implementation record of projects, such as beach nourishment, mangrove afforestation, transplanting of coral reef.</li> <li>• Changes in the awareness of stakeholders on coastal protection</li> </ul>
8. Sediment-related Disaster Prevention	Adaptation Project	Climate change will increase short-term rainfall and continuous precipitation. The change of temporal and spatial distribution in rainfall will change the frequency, scale, and timing of sediment-related disaster, expand the collapse area, and increase the probability for multiple disasters occurring. Direct damage from a sediment-related disaster will increase mainly in the upstream area, while consequential damage due to debris flow will increase in the downstream area. Hence, there are anxieties on land degradation and desertification in the upstream area, and adverse effects to the downstream dams, river channels and estuaries.	In order to strengthen the responsiveness of the target area on sediment-related disaster, appropriate measures shall be implemented. The measures include structure construction, and non-structural approaches such as forecasting, warning, and evacuation, etc.	Sediment-related disaster by climate change will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Risk of priority protection area</li> <li>• Community-based disaster management and crisis management</li> <li>• Organizational structure and disaster resilience capacity of regulatory agency</li> <li>• Existence and ability of research and development</li> <li>• Compensation for sediment-related disaster</li> <li>• Land use and land use regulation</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target safety factor of the target section and facilities</li> <li>• Changes in the awareness of stakeholders on sediment-related disaster</li> </ul>

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		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
	BAU Development with Adaptation Options	It is necessary to plan or reconsider sediment-related disaster prevention works, in association with economic growth and land development. Potential risks of sediment-related disasters in larger areas, and in greater magnitudes, are likely arising in the target river basin and areas due to climate change. The anticipated climate change impacts are considered to increase the amount of precipitation, change rainfall patterns, and increase the frequency and scale of extreme events such as torrential rainfall and tropical cyclones.	Appropriate measures will be implemented within the project with consideration of the increased sediment-related disaster damage associated with climate change.	The expected damages from the sediment-related disaster will be controlled or reduced in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Risk of priority protection area</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target safety factor of the target section and facilities</li> <li>• Changes in the awareness of stakeholders on sediment-related disaster</li> </ul>

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9. Disaster Prevention Information System	Adaptation Project	It is highly possible that the frequency and intensity of natural disasters associated with climate change will increase. The target area is very vulnerable since reliable or properly functioning observation systems for natural phenomenon are not available. The adaptation project for the sub-sector will need to establish observation systems for natural phenomenon which disseminate early warning for evacuation, thereby, minimizing human casualties caused by disasters and reducing overall vulnerability to natural disasters.	Enabling the dissemination of early warning through development and proper operation of observation and monitoring systems for natural phenomenon.	Human casualties due to natural disasters that are associated with climate change will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• The past damages on observation and measurement facilities</li> <li>• Development level of observation and measurement facilities</li> <li>• Development level of early warning system</li> <li>• Present budget level related to observation system for natural phenomenon</li> <li>• Present conditions of human resources and organizational capacity</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Conditions of O&amp;M (number of measurement instruments properly functioning, and number of locations for those installed)</li> <li>• Number of early warnings performed in fact</li> </ul>

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10. Rural / Urban Development	Rural Development Adaptation Project	Maintaining basic human needs (BHN) in rural areas are exposed to the risk of climate change impacts, which can potentially worsen living environment that would have been achieved without climate change.	Rural infrastructure development and support of rural livelihood will improve and maintain primary living environment in rural areas.	Climate change vulnerability of rural areas will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change (conditions of rural infrastructures and their functional validities)</li> <li>• Conditions of rural infrastructures and their functional validities</li> <li>• Organizational capacity and conditions of residents</li> <li>• Involvement of the regional / local government department and NGOs concerned</li> <li>• Socio-economic conditions of rural residents</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and newly developed facilities</li> <li>• Improvement of the target return period of target areas by O&amp;M improvement</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in stakeholders' awareness on climate change</li> </ul>
	BAU Development with Adaptation Options	BAU infrastructure project will be implemented for rural development. However, the anticipated climate change will cause difficulty in maintaining the expected livelihood and living environment in the rural areas, which requires considering the adaptation options to climate change impacts.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	In case the target areas are exposed to climate change, the rural system will function properly and the area can sustain living environment.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and/or newly developed facilities</li> <li>• Improvement of the target return period in target area by O&amp;M improvement</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in stakeholders' awareness on climate change</li> </ul>

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Urban Development	Adaptation Project	Climate change will affect on regular functions of cities / urban areas, and make it difficult to maintain ordinary livelihood.	The development of urban infrastructure will improve and sustain primary conditions of urban livelihood.	Vulnerability of urban areas will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change (conditions of urban infrastructures and their functional validities)</li> <li>• Conditions of urban infrastructures and their functional validities</li> <li>• Involvement of the municipal government department and NGOs concerned</li> <li>• Socio-economic conditions of urban residents</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and/or newly developed facilities</li> <li>• Improvement of the target return period in target area by O&amp;M improvement</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in stakeholders' awareness on climate change</li> </ul>
	BAU Development with Adaptation Options	BAU infrastructure project will be implemented for urban infrastructure development. However, the anticipated climate change will cause difficulty in maintaining the expected living environment in the urban areas, which requires considering the adaptation options to climate change impacts.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	In case the target areas are exposed to climate change, the urban system will function properly and the area can sustain living environment.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and newly developed facilities</li> <li>• Improvement of the target return period of target areas by O&amp;M improvement</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in stakeholders' awareness on climate change</li> </ul>

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
11. Bridge, Road and Railway	Adaptation Project	Climate change would intensify flood, which can cause inundation, slope failures and landslides, affecting roads, railways, and subways. There are certain risks in road and railway functions that are adversely affected or lost due to climate change impacts.	In order to enhance the disaster prevention capacity of bridges, roads and railways, countermeasures such as realignment of route, slope stabilization, enhancement of drainage capacity and flood prevention, and raising, reinforcement or replacement of bridges are required.	The impacts of climate change related to structural damage, traffic restriction and interruption, as well as damage on related facilities and users will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Alternative transportation means and detour</li> <li>• Crisis management of regulatory agency and management body</li> <li>• Disaster resilience capacity of regulatory agency and management body</li> <li>• Existence and ability of research and development</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period and safety factor of facilities</li> <li>• Situation of preparation and recognition of hazard map</li> <li>• Reduction of time for damage detection and suspension of traffic</li> <li>• Reduction of time for evacuation guidance</li> <li>• Reduction of time for leading to detour or alternative traffic</li> <li>• Changes in the awareness of stakeholders</li> </ul>
	BAU Development with Adaptation Options	New bridges, roads and railways will be constructed, or existing facilities will be replaced or extended. Potential risks such as the reduction of safety of bridges, inundation damage on roads and railways, slope failure and landslides, and flooding in underground space such as subway are likely to increase due to climate change impacts.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	The safety of facilities and traffic will be maintained in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period and safety factor of facilities</li> <li>• Situation of preparation and recognition of hazard map</li> <li>• Reduction of time for damage detection and suspension of traffic</li> <li>• Reduction of time for evacuation guidance</li> <li>• Reduction of time for leading to detour or alternative traffic</li> <li>• Changes in the awareness of stakeholders</li> </ul>



Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
12. Port and Airport	Port Adaptation Project	Climate change will raise sea water level and increase and intensify cyclones, which increase the damage to revetments and port structures, inundation at apron, and damage to buildings, containers, machinery and materials on the apron. Sea level rise will increase buoyancy of buried pipes and manholes, and cause ground uplift of the reclaimed land area. The risk of ground liquefaction will increase.	To strengthen the disaster mitigation capacity of port facilities by development, reinforcement, and raising of revetments and port structures, etc.	The impacts of climate change such as damage to structures, equipment and materials, and inundation, will be reduced, and port function will also be maintained.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Alternative transportation means</li> <li>• Disaster resilience capacity of regulatory agency and management body</li> <li>• Existence and ability of research and development</li> <li>• Compensation for storm surge and high wave damage</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period and safety factor of facilities</li> <li>• Implementation records of projects, such as dredging.</li> <li>• Changes in the awareness of stakeholders</li> </ul>
	BAU Development with Adaptation Options	New ports will be constructed, or existing ports will be expanded for the development in maritime trade. Potential risks of damages on revetments and port structures by sea level rise and extreme events, damages by storm surge and high waves, and ground uplift and buoyancy increase of buried pipes and manholes by sea level rise, are likely to increase in the target port due to climate change impacts.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	Port functions will be maintained in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Alternative transportation means</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period and safety factor of facilities</li> <li>• Implementation records of projects, such as dredging.</li> <li>• Changes in the awareness of stakeholders</li> </ul>

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
Airport	Adaptation Project	Climate change will increase precipitation, cloud amount and wind speed, and change the bird ecosystem. These conditions are likely to adversely affect the safety of flight operation especially during take-off and landing and cause damage to the airport.	To secure safety during take-off and landing of planes, and structure safety of the airport by mainly development and improvement of airport facilities.	The impacts of climate change on flight operations and structure safety will be reduced.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Alternative transportation means</li> <li>• Disaster resilience capacity of regulatory agency and management body</li> <li>• Existence and ability of research and development</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period and safety factor of facilities</li> <li>• Changes in the awareness of stakeholders</li> </ul>
	BAU Development with Adaptation Options	New airports will be constructed, or existing ones will be expanded or improved. Potential risks of structural damages and decline of safety in take-off and landing by increase of rainfall, cloud amount and wind speed, and change of avian ecosystem, are likely to increase in the target airport by climate change impacts.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	The safety of flight operation and airport function will be maintained in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Alternative transportation means</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period and safety factor of facilities</li> <li>• Changes in the awareness of stakeholders</li> </ul>

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
13. Water Supply	Adaptation Project	In an existing watery supply system, its stable operation in the future will be at risk due to anticipated changes in rainfall intensity and patterns brought by climate change. This will reduce the available amount of water from the sources, and the rising temperature will affect the water quality at the source as well as increase per capita water consumption.	It will be necessary to increase water supply capacity through the development / expansion of alternative water sources, reduction of water leakages and the rate of unaccounted-for-water (UFW), and improvement of water treatment capability.	The adaptation measures will be able to prevent or reduce climate change impacts on water supply quantity and quality.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Organizational capacity and operation conditions of water service providers</li> <li>• Available water volume and quality at alternative water sources</li> <li>• Awareness of water conservation</li> <li>• Socio-economic conditions of the target areas</li> <li>• Budget related to climate change impacts on the Water Supply Sub-sector</li> <li>• Climate change-related activities of NGO for the Water Supply Sub-sector</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period of expanded and/or newly developed facilities</li> <li>• Changes in beneficiaries' awareness on water conservation</li> <li>• Changes in the number of beneficiaries</li> </ul>
	BAU Development with Adaptation Options	Due to the anticipated climate change impacts, there will be increased possibility of reduced water supply volume at intake site, poor water quality, and increased water demand caused by the rise of average temperatures.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	This will enable supply of safe and sufficient water to the population in the event of climate change.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Conditions of water balance</li> <li>• Conditions of water sources</li> <li>• O&amp;M system and capacity of water service providers</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of target return period of expanded and/or newly developed facilities</li> <li>• Changes in beneficiaries' awareness on water conservation</li> <li>• Changes in the number of beneficiaries</li> </ul>

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
14. Sewerage / Urban Drainage	Sewerage Adaptation Project	Increase in intensity and frequency of rainfall, and temperature rise due to climate change will cause inundation and exacerbated hygienic conditions in urban areas. If areas possess ineffective or insufficient sewerage and urban drainage systems, it will potentially cause outbreaks of infectious diseases such as cholera, typhoid, and diarrhea due to the exacerbated hygienic conditions.	The development of sewerage systems (sewerage treatment plant, installation of sewerage network and pump stations, etc.) will improve the hygiene and living conditions of the environment in the target areas.	Risks of which will worsen the hygiene and living conditions of the environment due to climate change will be reduced, and the morbidity rate of infectious diseases will improve.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Condition of preventive activities against infectious diseases by residents in the target areas</li> <li>• Geographical distribution of existing medical institutions and healthcare centers</li> <li>• Present conditions and functional validity of the existing sewerage system</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and/or newly developed facilities</li> <li>• Changes in the number of the patients of infectious diseases</li> <li>• Changes in number of beneficiaries</li> <li>• Changes in beneficiaries' awareness on hygiene</li> </ul>
	BAU Development with Adaptation Options	In order to improve the hygiene and living conditions in the environment of the target areas or city, the project for development, expansion, and rehabilitation of sewerage and drainage systems will be implemented. Due to the anticipated climate change impacts, increased rainfall intensity is likely to cause inundation damages coupled with increased storm water in drainage systems, and it is highly concerned that hygienic conditions will deteriorate.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	In the event of climate change, the developed sewerage system will function properly.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Morbidity and mortality rates of infectious diseases</li> <li>• Present conditions of sewerage and rainwater discharge</li> <li>• Water quality</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and/or newly developed facilities</li> <li>• Changes in the number of the patients with infectious diseases</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in beneficiaries' awareness on hygiene</li> </ul>

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
Urban Drainage	Adaptation Project	Increase in intensity and frequency of rainfall, and temperature rise due to climate change will cause inundation and exacerbated hygienic conditions in urban areas. If areas possess drainage systems that are malfunctioning or have insufficient capacity, it will potentially cause outbreaks of infectious diseases such as cholera, typhoid, and diarrhea. Storm water contaminated with solid waste and chemical materials will flow into the surrounding bodies of water, therefore seriously affecting water quality.	The development of urban drainage systems (open and closed drainage channels, pump stations, etc.) will improve drainage capacity and hygienic conditions, reduce the risk of floods, and enhance socio-economic activities in the target areas.	Risks of flooding and inundation due to malfunctioning drainage systems will be reduced, and socio-economic activities and the morbidity rate of infectious diseases will be improved.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Condition of preventive activities against infectious diseases by residents in the target areas</li> <li>• Geographical distribution of existing medical institutions and healthcare centers</li> <li>• Present conditions and functional validity of existing drainage system</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and/or newly developed facilities</li> <li>• Changes in number of the patients with infectious diseases</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in beneficiaries' awareness on hygiene</li> </ul>
	BAU Development with Adaptation Options	In order to improve the hygiene and living conditions in the environment of the target areas or city, the project for development/expansion/rehabilitation of urban drainage systems will be implemented. Due to the anticipated climate change impacts, increased rainfall intensity is likely to cause inundation damages coupled with increased storm water drainage, and it is highly concerned that hygienic conditions will deteriorate.	Appropriate measures will be implemented within the project with consideration of the climate change impacts.	In the event of climate change, the developed drainage system in urban areas will function properly.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Morbidity and mortality rates of infectious diseases</li> <li>• Conditions of flood and inundation damages</li> <li>• Water quality</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Improvement of the target return period by expanded and/or newly developed facilities</li> <li>• Changes in the number of the patients with infectious diseases</li> <li>• Changes in the number of beneficiaries</li> <li>• Changes in beneficiaries' awareness on hygiene</li> </ul>

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
15. Medical / Health Care	Adaptation Project	Temperature rise due to climate change is likely to shift or expand habitat areas of disease-carrying vectors for infectious diseases. Climate-induced changes in locations and seasons will likely trigger an epidemic of infectious diseases such as malaria and dengue fever. Flood, drought, and crop failure associated with change in rainfall intensities and patterns will increase risks of water- and food-borne diseases. Particularly in the areas with poor healthcare services and facilities as well as poor hygienic conditions, risks of exposure to these infectious diseases are considerably high, which will be exacerbated by climate change impacts.	The adaptation measures will strengthen preventive and responsive actions against infectious diseases and improve health conditions of people in the target areas by developing clinics or general hospitals, upgrading equipment, and strengthening capacity of healthcare personnel.	The framework for treatment will be strengthened for patients whose numbers are increasing due to climate change impacts, and corresponding preventive measures will be undertaken.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Future sensitivity to climate change</li> <li>• Population shares of socially-vulnerable groups</li> <li>• Number of doctors per population</li> <li>• Number of existing medical institutions / healthcare centers</li> <li>• Conditions of preventive activities against infectious diseases</li> <li>• National / regional budgets for medical care and infectious diseases</li> <li>• Activities by NGOs</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Trend of the budgets for disease prevention</li> <li>• Number of patients</li> </ul>

Sub-sector	Project Type	Assumption at Guidelines			Items for Assessment in Project Formulation & Alternative Items for Assessment in Monitoring and Review
		Necessity of Adaptation	Adaptation Measures/Options	Outcome of Adaptation Measures/Options	
	BAU Development with Adaptation Options	It is necessary to upgrade and expand medical / healthcare facilities and equipment in order to provide better healthcare services in the target areas. Climate change impacts are expected to increase infectious disease cases which would have been a minor issue in the target areas.	In the development under the business-as-usual condition, the project may focus on capacity-building for the areas of cardiac and brain surgeries, other internal medicine, trauma care, adult disease, and HIV. In addition to these, adaptation measures to climate change will require preparation for the increasing concern on water and vector-borne diseases.	In case there are serious climate change impacts, sufficient medical or healthcare services will be provided.	<p>[Assessment Items]</p> <ul style="list-style-type: none"> <li>• Morbidity rates for infectious diseases</li> <li>• Mortality rates for infectious diseases</li> <li>• Conditions of preventive activities against infectious diseases</li> </ul> <p>[Alternative Items]</p> <ul style="list-style-type: none"> <li>• Trend of the budgets size for disease prevention</li> <li>• Number of patients</li> </ul>

### **5.5 Basic Concept and Guidelines for Each Sub-sector**

“Basic Concept” was prepared for the each sub-sector selected in Chapter 4 and “Guidelines” were prepared for assumed projects as shown in Section 5.4. “Understanding Future Climate Change”, which is common to each sub-sector, is also prepared.

0. Understanding Future Climate Change
1. Water Resources
2. Irrigation and Drainage
3. Farmland Management Enhancement
4. Forest Conservation/ Afforestation
5. Ecosystem Integrity
6. Flood Control
7. Coastal Protection
8. Sediment-related Disaster Prevention
9. Disaster Prevention Information System
10. Rural / Urban Development
11. Bridge, Road and Railway
12. Port and Airport
13. Water Supply
14. Sewerage / Urban Drainage
15. Medical / Health Care