JAPAN INTERNATIONAL COOPERATION AGENCY

THE DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

THE STUDY ON RISK MANAGEMENT FOR SEDIMENT-RELATED DISASTER ON SELECTED NATIONAL HIGHWAYS IN THE REPUBLIC OF THE PHILIPPINES

FINAL REPORT

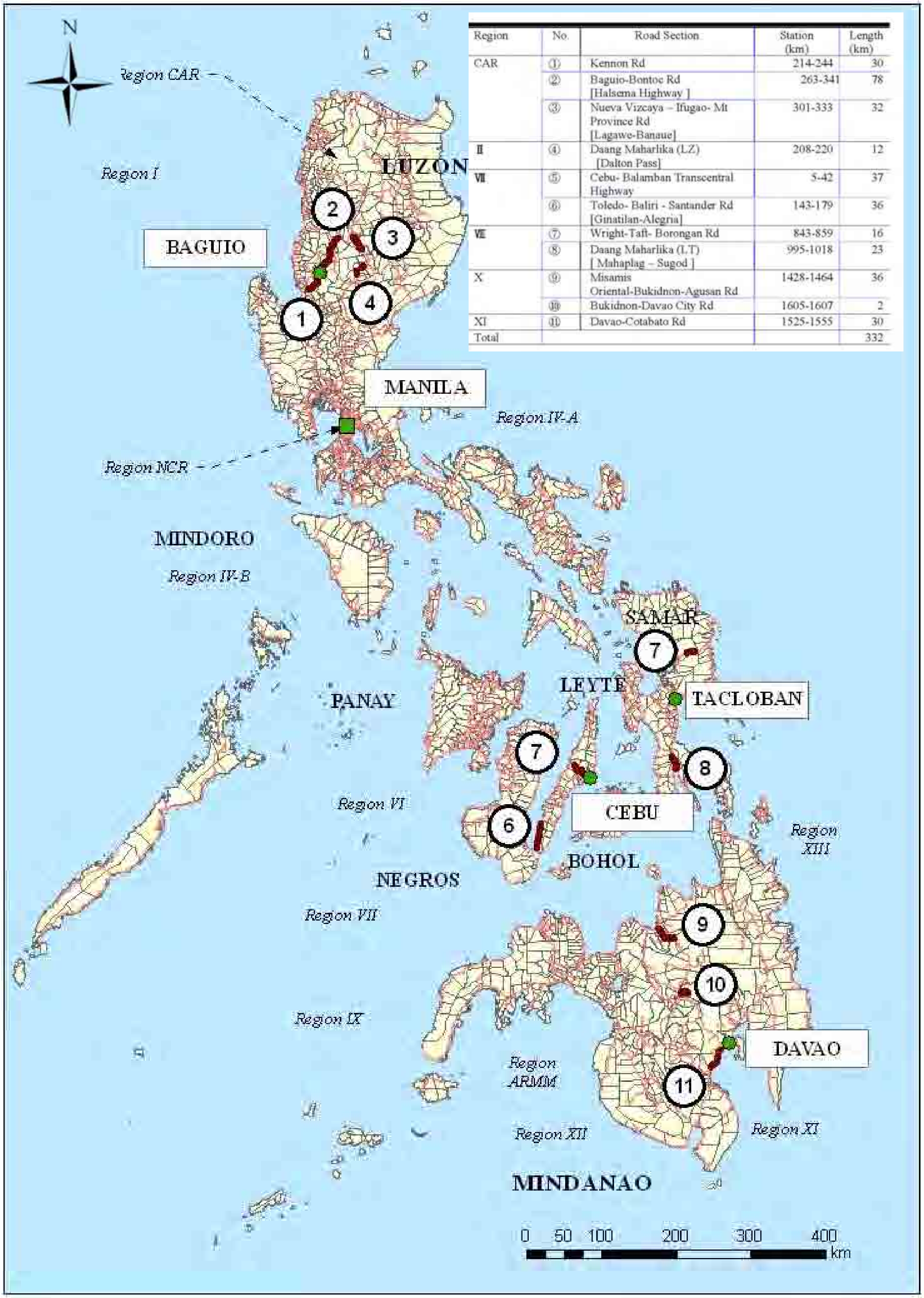
VOLUME II
MAIN REPORT

JUNE 2007

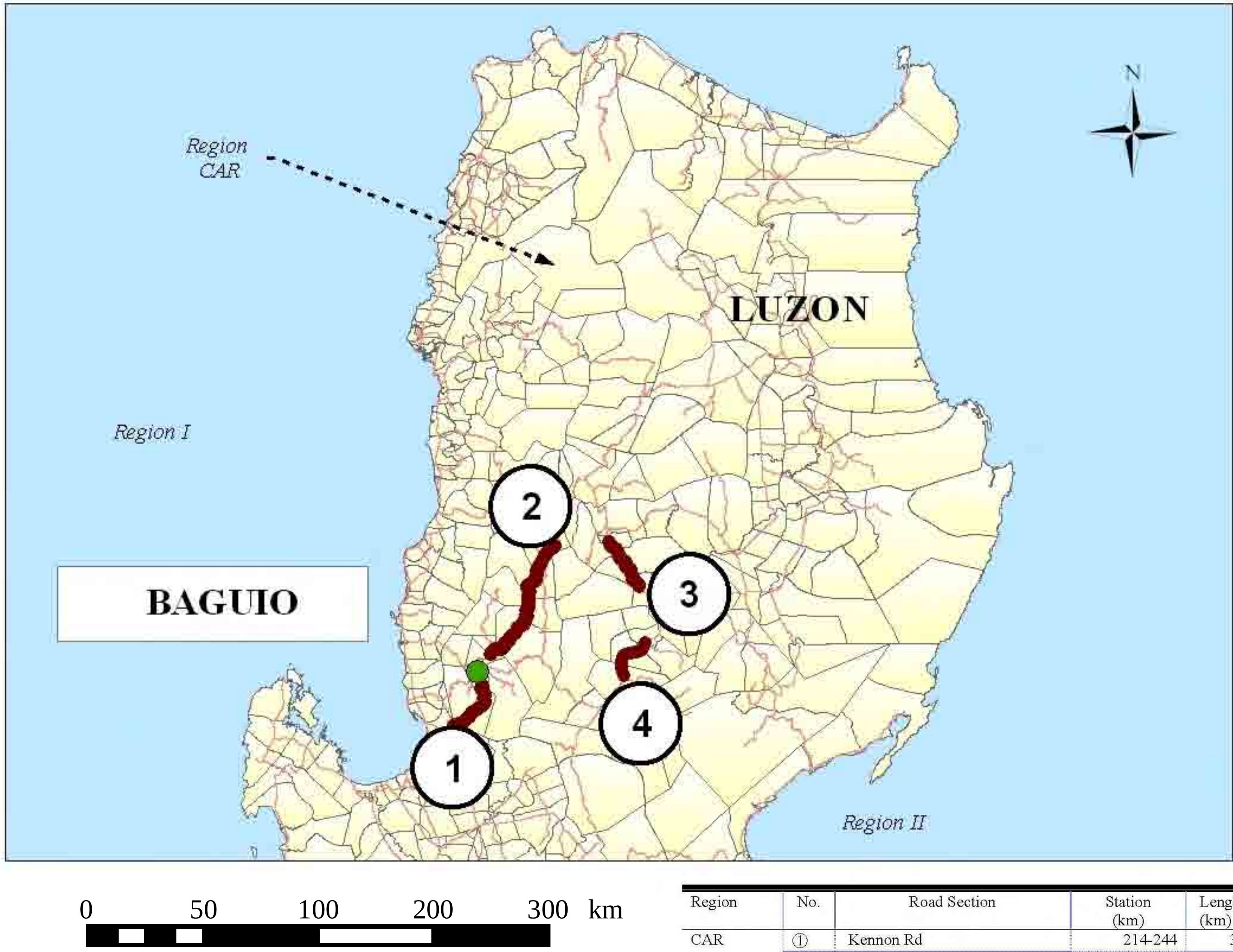
NIPPON KOEI CO., LTD.
OYO INTERNATIONAL CORPORATION

COMPOSITION OF THE FINAL REPORT

VOLUME	REPORT NAME	LANGUAGE
VOLUME I	SUMMARY	ENGLISH
VOLUME II	MAIN REPORT	ENGLISH
VOLUME III	SUMMARY	JAPANESE
GUIDE I	GUIDE TO RISK MANAGEMENT PLANNING ON ROAD SLOPES	ENGLISH
GUIDE II	GUIDE TO INVENTORY SURVEY AND RISK ASSESSMENT ON ROAD SLOPES	ENGLISH
GUIDE III	**GUIDE TO** ROAD SLOPE PROTECTION	ENGLISH



Region	No.	Road Section	Station (km)	Length (km)
CAR	①	Kennon Rd	214-244	30
	②	Baguio-Bontoc Rd [Halsema Highway]	263-341	78
	③	Nueva Vizcaya – Ifugao- Mt Province Rd [Lagawe-Banaue]	301-333	32
II	④	Daang Maharlika (LZ) [Dalton Pass]	208-220	12
VII	⑤	Cebu- Balamban Transcentral Highway	5-42	37
	⑥	Toledo- Baliri - Santander Rd [Ginatilan-Alegria]	143-179	36
VIII	⑦	Wright-Taft- Borongan Rd	843-859	16
	⑧	Daang Maharlika (LT) [Mahaplag – Sugod]	995-1018	23
X	⑨	Misamis Oriental-Bukidnon-Agusan Rd	1428-1464	36
	⑩	Bukidnon-Davao City Rd	1605-1607	2
XI	⑪	Davao-Cotabato Rd	1525-1555	30
Total				332



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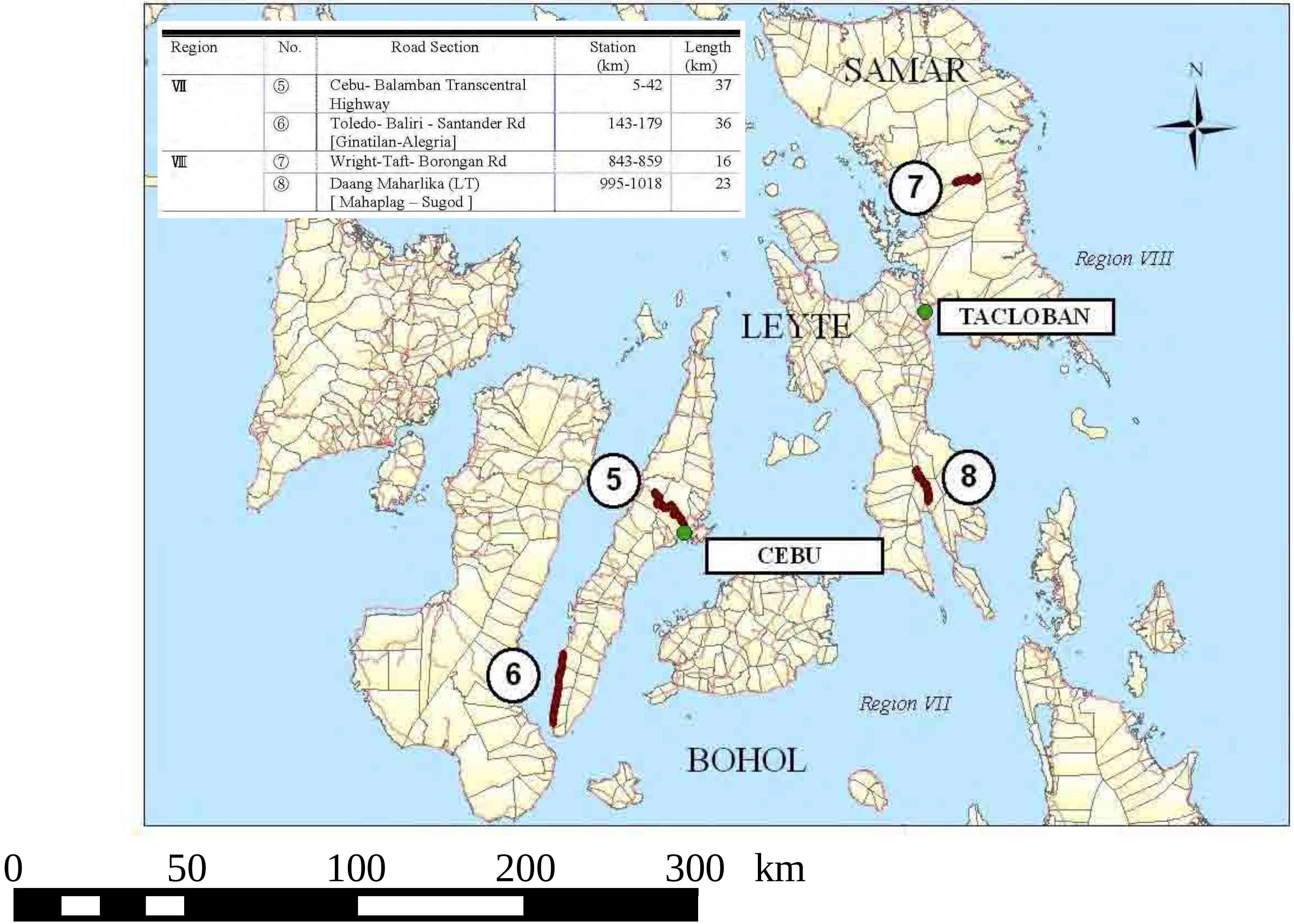

Region	No.	Road Section	Station (km)	Length (km)
VII	⑤	Cebu- Balamban Transcentral Highway	5-42	37
	⑥	Toledo- Baliri - Santander Rd [Ginatilan-Alegria]	143-179	36
VIII	⑦	Wright-Taft- Borongan Rd	843-859	16
	⑧	Daang Maharlika (LT) [Mahaplag – Sugod]	995-1018	23

Region	No.	Road Section	Station (km)	Length (km)
X	⑨	Misamis Oriental-Bukidnon-Agusan Rd	1428-1464	36
	⑩	Bukidnon-Davao City Rd	1605-1607	2
XI	⑪	Davao-Cotabato Rd	1525-1555	30

DEFINITION OF TERMS FOR RISK MANAGEMENT OF ROAD SLOPE DISASTERS (RSD)

Terms		Definitions
Disaster	:	A road slope failure, which could stop traffic flow and be dangerous to road users and inhabitants along the road.
Disturbance	:	Deformation of the slope and/or road structures or slope collapse which has not reached the road.
Visible Disturbance	:	Signs of potential disaster such as collapse, open cracks, depression, upheaval, or muddy spring water on the road or slope.
Road Closure Disaster [RCD]	:	A disaster which causes closure of the whole or partial width of the road Deformations and collapses that do not close the road are not necessarily regarded as a RCD but just as a 'Disturbance'.
Loss	:	Monetary amount of damage caused by a disaster, specifically defined as the sum of the reopening cost, human lives lost, and detour cost.
Risk	:	The total damage characterized by the potential frequency and magnitude of the disaster. Annual total loss is an expression of the risk. The risk is distinguished from the hazard, which could be defined, in the case of this Study, as the overt danger to the road and road users.
Frequency of Road Closure Disasters per Year [FRCD]	:	The number or RCD occurrences per year for a slope
Intensity of Road Closure Disasters of a Road Section [IRCD]	:	Average RCD occurrences per unit length per year for a road section, *i.e.* the total FRCD’s for the road section divided by its length

ACRONYMS/ABBREVIATIONS

AADT	Annual Average Daily Traffic
ADB	Asian Development Bank
-PMO- ADB	- Project Management Office - Asian Development Bank
AMMS	Administrative and Manpower Management Service
ASEC	Assistant Secretary
AVOC	Average Vehicle Operation Cost
AWP	Annual Work Programs
BCGS	Bureau of Coast and Geodetic Survey
BCR	Benefit Cost Ratio
BIIPs	Business Improvement Implementation Projects
BMS	Bridge Management System
BOC	Bureau of Construction
BOD	Bureau of Design
BOE	Bureau of Equipment
BOM	Bureau of Maintenance
BRS	Bureau of Research and Standards
CAR	Cordillera Administrative Region
-PMO- CARBDP	-Project Management Office - Cotabato-Agusan River Basin Development Project
CCE	Coefficient of Countermeasure Effectiveness for FRCDp
CDPCD	(DPWH'^s) Calamities and Disaster Preparedness Control Plan
CF	Calamity Fund
CFMS	Comptrollership & Financial Management Service
CMS	Contract Management System
DAO	DENR's Administrative Order
DBM	Department of Budget and Management
DBMS	Data Base Management System
DCBs	District/City Disaster Coordinating Bodies
DCC	Disaster Coordinating Council
DE	District Engineer (Head of District Engineering Office)
DENR	Department of Environment and Natural Resources
DEO	District Engineering Office
DIS	Detailed Inventory Survey

DO	Department Order
DND	Department of National Defense
DPD-PS	Development Planning Division-Planning Service
DPMP	Disaster Preparedness Management Plan
DPWH	Department of Public Works and Highways
ECC	Environmental Compliance Certificate
EGGA	Engineering, Geological and Geohazard Assessment (EGGA)
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMK	Equivalent Maintenance Kilometer
ENPV	Economic Net Present Value
EO	Executive Order
EPS	Expandable Polystyrene
ESSO	Environment & Social Safeguard Office
ExIS	Executive Information System
FAP	Foreign Assisted Projects
- PMO- FCSEC	- Project Management Office - Flood Control and Sabo Engineering Center
FRCD	Frequency of Road Closure Disaster
FRCDa	Actual Frequency of Road Closure Disaster
FRCDbc	Frequency of Road Closure Disaster before Countermeasure Period
FRCDp	Potential Frequency of Road Closure Disaster
FRCDpwc	Potential Frequency of Road Closure Disaster with Countermeasure
- PMO- FS	- Project Management Office - Feasibility Studies
GAA	General Appropriations Act
GIS	Geographic Information System
GOP	Government of the Republic of the Philippines
HMP	Highway Management Project (IBRD-financed)
I/A	Implementation Agreement
IBRD	International Bank for Reconstruction and Development
-PMO - IBRD	- Project Management Office- International Bank for Reconstruction and Development
IRF	Immediate Response Fund (of DPWH's Regional Office)
IROW	Infrastructure Right-of-Way

IRR	Implementing Rules and Regulations
IPRSD	Infrastructure Planning Research and Statistics Division
LAN	Local Area Network
LGU	Local Government Unit
LRS	Locational Referencing System
LRP	Locational Reference Point
LLO	Legislative Liaison Office
LTPBMC	Long Term Performance-Based Maintenance Contracts
LWUA	Local Water Utilities Administration
MGB	Mines and Geosciences Bureau
MBA	Maintenance by Administration
MBC	Maintenance by Contract
MDG	Millennium Development Goals
MIS	Monitoring and Information Service
MVUC	Motor Vehicle User’s Charge
MWP	Multi-Year Work Programs
MWSS	Metropolitan Waterworks Sewerage System
MYPS	Multi-Year Programming and Scheduling
NAMRIA	National Mapping & Resource Information Authority
NCA	Notice of Cash Allocation
NCR	National Capital Region
NDRB	Natural Disaster Reduction Branch
NDCC	National Disaster Coordinating Council
NDCB	(DPWH’s) National Disaster Coordinating Body of DPWH
NEDA	National Economic Development Authority
NFC	Notice of Funding Ceiling
NGA	National Government Agency
NRIMP	National Roads Improvement and Management Program
NSO	National Statistics Office
OP	Office of the President
OCC	Opportunity Cost of Capital
OCD	Office of Civil Defense under Department of National Defense
ODA	Overseas Development Assistance

PAGASA	Philippine Atmospheric, Geophysical & Astronomical Services Administration
PD	Presidential Degree
PDCA	Plan Do Check Action
PDD	Planning and Design Division (DPWH Regional Office)
PD-PS	Programming Division-Planning Service
PED-PS	Project Evaluation Division-Planning Service
PHIVOLCS	Philippine Institute of Volcanology & Seismology
-PMO- PJHL	-Project Management Office- Philippine-Japan Highway Loan
PIS	Preliminary Inventory Survey
PMO	Project Management Office
PMS	Pavement Management System
PS	Planning Service
QRF	Quick Response Fund (of DPWH'^{s} Central Office)
RA	Republic Act
RB	Road Board
RBIA	Road and Bridge Information Application
RBS	Road Board Secretariat
RCD	Road Closure Disaster
RDCBs	(DPWH's) Regional Disaster Coordinating Bodies
RDBMS	Relational Database Management System
RDCC	Regional Disaster Coordinating Council
RDBMS	Relational Database Management System
RES	Regional Equipment Services
RMMS	Routine Maintenance Management System
RO	Regional Office
RROW	Road Right of Way
RPO	Road Program Office
RIS	Road Information System
RSD	Road Slope Disaster
RSMS	Road Slope Management System
RTIA	Road Traffic Information Application
RIMSS	Road Information Management Support System
R/R	Request for Release

RRR	Risk Reduction Ratio
SONA	State of the Nation Address
SOPs	Standard Operation Procedures
SARO	Special Allotment Release Order
SQL	Structural Query Language
SRSaF	Special Road Safety Fund
SRSF	Special Road Support Fund
STRIDE	(PAGASA's team of) Special Tropical Cyclone Reconnaissance Information Dissemination and Damage Evaluation
TARAS	Traffic Accident Reporting and Analysis System
TATM	Thunder Storm
-PMO - URPO	-Project Management Office - Urban Roads Project Office
VOC	Vehicle Operating Cost
XSps	Cross-Sectional Positions
WAN	Wide Area Network

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

Over the last three decades, the Philippines has undertaken rapid development of its road network, the total length of which has reached more than 200,000 km, including 30,000 km of national highways.

With the development of the road network, road slope disasters have provoked wide public attention. These road slope disasters frequently destroy or block roads, particularly during the rainy season, due to steep topography, fragile geology, heavy rainfall and frequent earthquakes.

The Department of Public Works and Highways (DPWH) in the Republic of the Philippines is responding to the issue of slope disasters with available resources and expertise, as well as with the assistance of international funding agencies such as the International Bank for Reconstruction and Development (IBRD) and the Japan International Cooperation Agency (JICA). However, these efforts have been insufficient because of limited budgets, inadequate management systems and inappropriate technology to prevent or mitigate road slope disasters. Specifically, in the field of disaster management, the DPWH is facing technical difficulty as to how to effectively mitigate and control road slope disasters along the national highways. To improve this difficult situation, the DPWH decided to formulate a systematic procedure for road slope management with assistance from JICA.

In response to an official request from the Government of the Republic of the Philippines (GOP), JICA dispatched a preparatory study team, headed by Mr. Akira Nakamura, in September 2004. This team formulated a plan for a study for risk management for road slope disasters on the national highways. The plan was discussed and agreed upon between the DPWH and the JICA Preparatory Study Team on 23 September 2004 specifying the Scope of Work for the Study.

The Study entitled “The Study on Risk Management for Sediment-related Disaster on Selected National Highways in The Republic of The Philippines” is to be undertaken in accordance with the Scope of Work which was previously agreed upon. This Study Team hopes that the Study will help mitigate road slope disasters and improve the traffic function of the national highways in the Philippines.

1.2 Objectives of the Study

The ultimate goals of road slope management are the improvement of traffic function and to increase the level of safety on national highways against road slope disasters. To achieve these goals, as shown in Figure 1.1, the objectives adopted for the study were to:

a) Develop a road slope inventory survey system for national highways;
b) Create a road slope database system to continuously update the data;
c) Formulate a systematic plan to execute disaster management, taking into account the countermeasures to mitigate and prevent road slope disasters; and
d) Enhance the DPWH engineers in the assessment and management of road slope disasters on national highways through the transfer of technology and skills.

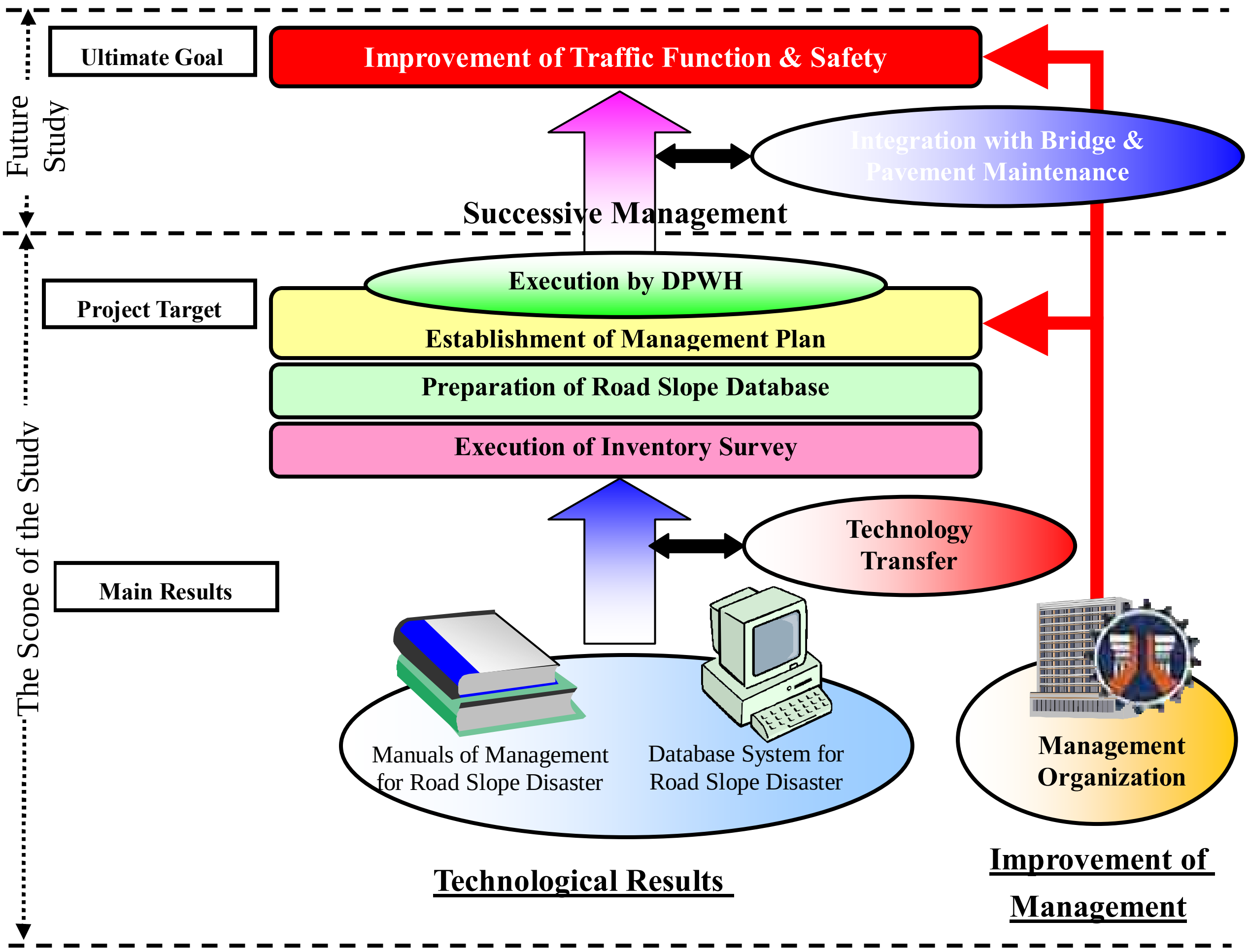


Figure 1.1 Ultimate Goals of Disaster Management and Outputs of the Study

1.3 Study Areas

The potential targets for the Study originally included twenty Road Sections with a total length of about 700 km, which had been suggested by the DPWH, based on past disaster records. The Road Sections actually selected for the preliminary inventory surveys (PIS) and their disaster types are listed in Table 1.1 (refer to location map). These sites were selected considering the following viewpoints based on the information from the preparatory study, preliminary field reconnaissance survey conducted by the Study Team together with the Counterpart Team and suggestions of the DPWH.

a) Security of the area
b) Accessibility
c) Covers all types of disaster
d) Equitable distribution of survey districts
e) Suggestions of the DPWH, and
f) Present condition of the road

There were 332 km of road sections selected for the PIS, of which 61 km have been prioritized. The priorities of the road sections for implementation of pilot detailed inventory surveys (DIS) were determined based on the PIS and are shown in Table 1.2.

Table 1.1 Selected Road Sections for Pilot PIS

No	Region	Road Section	Km	Disaster Type
1)	Region CAR	Kennon Rd	30	SC, RC, RE, DF, RS
		Baguio-Bontoc Rd [Halsema Highway]	78	SC, RC, LS, DF, RS
		Nueva Vizcaya – Ifugao- Mt Province Rd [Lagawe-Banaue]	32	SC, RC, LS, DF, RS
2)	Region Ⅱ	Daang Maharlika [Dalton Pass]	12	SC, RC, RS, DF, RE
3)	Region Ⅶ	Cebu- Balamban Transcentral Highway	37	SC, RC, RS, DF
		Toledo- Baliri - Santander Rd [Ginatilan-Alegria]	36	SC, RC, RS, RE, CE
4)	Region Ⅷ	Wright-Taft- Borongan Rd	16	SC, RC, RS, DF
		Daang Maharlika (LT) [Mahaplag – Sugod]	23	SC, RC, LS, RE, RS, DF
5)	Region X	Misamis Oriental-Bukidnon-Agusan	36	SC, RC, RS, RE
		Bukidnon-Davao City Rd	2	SC, RC, RS
6)	Region XI	Davao-Cotabato Rd	30	SC, RS, RE
	Total		332	

Soil Collapse: SC, Rock Collapse: RC, Landslide: LS, Road Slip: RS, Debris Flow: DF, River Erosion: RE, Coastal Erosion: CE

Table 1.2 Prioritized Road Sections for Pilot DIS

No	Region	Road Section	Km	Number of Slopes
1)	Region CAR	Kennon Rd	10	42
		Baguio-Bontoc Rd [Halsema Highway]	5	43
		Nueva Vizcaya - Ifugao- Mt Province Rd [Lagawe-Banaue]	10	33
2)	Region Ⅱ	Daang Maharlika [Dalton Pass]	5	27
3)	Region Ⅶ	Cebu- Balamban Transcentral Highway	7	47
		Toledo- Baliri - Santander Rd [Ginatilan-Alegria]	4	4
4)	Region Ⅷ	Wright-Taft- Borongan Rd	3	13
		Daang Maharlika (LT) [Mahaplag – Sugod]	7	35
5)	Region X	Sayre Highway [Misamis Oriental-Bukidnon-Agusan]	5	33
		Bukidnon-Davao City Rd	2	9
6)	Region XI	Davao-Cotabato Rd	3	4
	Total		61	290

Further, five sites for pilot feasibility studies have been selected, as shown in Table 1.3 Selection of the study areas is shown schematically in Figure 1.2.

Table 1.3 Selected Sites for Feasibility Study on Countermeasures

Site	Region	Route/Section	Location
Site 1	Region CAR	Kennon Road	Km 232
Site 2	Region CAR	Lagawe-Banaue Road	Km 301
Site 3	Region Ⅱ	Dalton Pass	Km 211
Site 4	Region Ⅶ	Ginatilan-Alegria	Km 172
Site 5	Region Ⅷ	Wright-Taft Road	Km 846

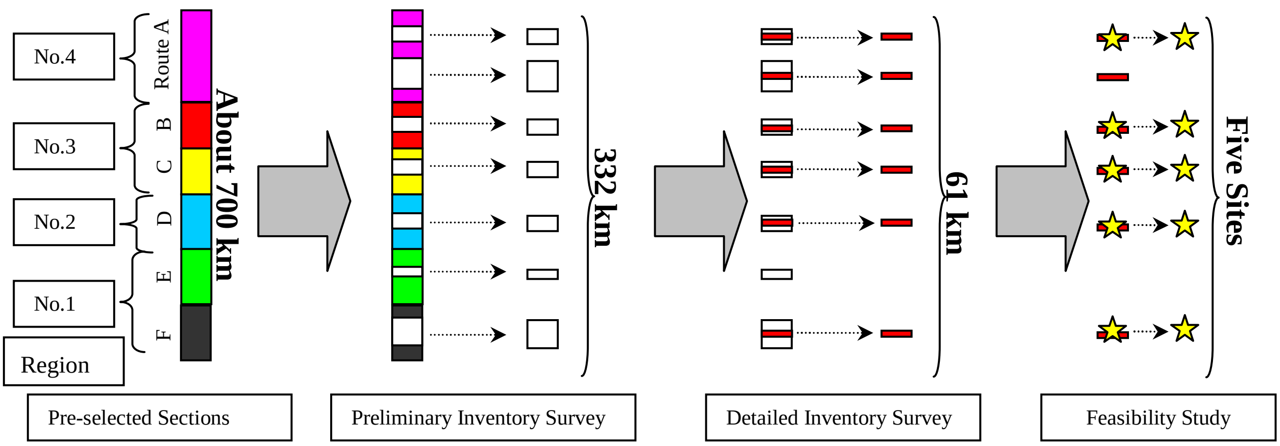


Figure 1.2 Process of Selection of Model Sections in Each Stage

1.4 Process of the Study

The Study has been implemented in two phases from 14 March 2006 to June 2007, as shown in Figure 1.3. The detailed work schedule is given in Table 1.4.

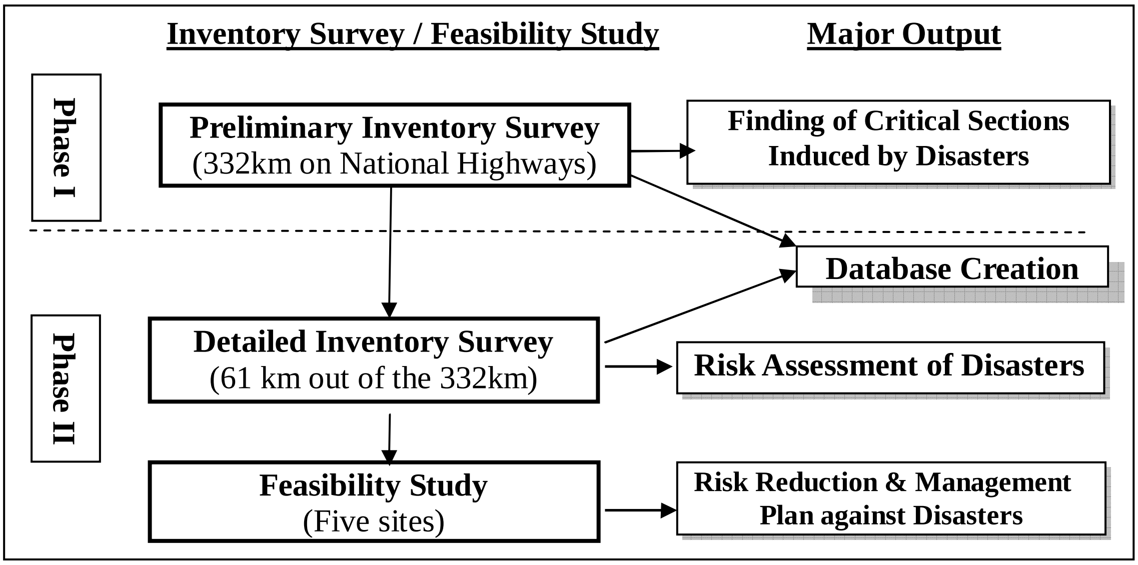


Figure 1.3 Outline of the Study

Since the commencement on 14 March 2006, the Study has progressed as smoothly as originally intended. Firstly, efforts were made for smooth and efficient implementation of the preliminary inventory surveys (PIS) on disaster-prone road slopes. The first stage of the PIS was successfully completed in May 2006. Also, the preparatory work has been done for the development of the Road Slope Management System (RSMS) and the formulation of technical guides for the road slope management. A set of these outcomes was compiled by mid-June and was submitted to JICA and DPWH as a Progress Report on 14 June 2006. The seminars/workshops for the PIS were held on 15th and 16th of June in Baguio and 22nd and 23rd of June 2006 in Cebu City.

The remaining second stage of the PIS was subsequently implemented from July to September, 2006 by DPWH with the assistance of the Study Team. A total length of 332 km has been covered by the PIS. A statistical analysis of the factors affecting the occurrence of road slope disasters was undertaken based on the data obtained from the PIS producing the relative weight score for each category of impacts.

The procedures and methods for the detailed inventory surveys (DIS) on the slopes that were selected from the output of the PIS were formulated in August and September, and actual implementation of the DIS on a portion of the above-selected slopes with total length of 60 km was started in mid-October and completed by January 2007. The methodology for the DIS was the main subject of the second seminar/workshop held from the 15th to the 17th of November 2006 in Cebu City.

For review and analysis of the past and present conditions of the road slopes, the Study Team, with assistance of DPWH, tried to collect the information and historical records on road slope disasters on national highways through a questionnaire given to all District Engineering Offices. Processing and statistical analysis of the collected data was conducted and reflected in the relevant parts of the guides.

The detailed database system design and programming of the RSMS were initiated in July 2006, and, through the delivery test and manipulation training for DPWH and the Study Team, completed by mid-November. The RSMS has been finalized through experimental usage for database formulation.

As technical guides for road slope management, the following three documents were produced in this Study;

① Guide to Risk Management Planning on Road Slopes,
② Guide to Inventory Survey and Risk Assessment on Road Slopes, and
③ Guide for Prevention of Road Slope Disaster.

Five feasibility studies (F/S) on promising countermeasures against slope disasters, which included actual experimentation, were carried out in the last period of this Study.

Table 1.4 Detailed Work Schedule

Period: 2006 (months 3–12) – 2007 (months 1–6). Phase I: 2006 months 3–9; Phase II: 2006 month 10 – 2007 month 6.

[1]	**Preparatory Work in Japan**	
[2]	**Preparatory Work in Philippines**	
[2-1]	Preliminary Reconnaissance	4/4-4/12
[2-2]	Historical Review & Analysis of Present Situation	1st stage (interview and questionnaire survey); 2nd stage (Data analysis and review)
[2-3]	Decision on Study Model Area	
[3]	**Inventory Survey**	
[3-1]	Selection of Preliminary Inventory Survey Road	
[3-2]	Formulation of Procedures for Inventory Survey	Draft of PIS; Draft of DIS; Finalize
[3-3]	Execution of Preliminary Inventory Survey (PIS) Stage I :Collaborative Work of the Study Team and the DPWH	5/1 - 5/25
[3-4]	Execution of Preliminary Inventory Survey (PIS) Stage II :DPWH Work with Assistance of the Study Team	
[3-5]	Evaluation of Preliminary Inventory Survey	Statistical Analysis
[3-6]	Execution of Detailed Inventory Survey (DIS)	
[3-7]	Planning of Risk Management on RSD	
[4]	**Feasibility Study**	
[4-1]	Planning of Feasibility Study Sites	
[4-2]	Investigation for Feasibility Study	Tender
[4-3]	Design, Construction Planning, Cost Estimates	
[4-4]	Economical Analysis and Recommendation	
[5]	**Formulation of Management System**	
[5-1]	Formulation of Road Disaster Management Database System	
[5-2]	Formulation of Guides to Road Disaster Management	
[6]	**Preparation of Final Report & Seminar/Workshop**	
Report		Inception; Progress; Interim; Draft Final; Final
Guidelines, Guides, Database System	Guideline on Road Slope Management	Draft; Finalize
	Guide to Inventory Survey	Draft of PIS Portion; Draft of DIS Portion
	Guide to Planning and Design of Countermeasures	Planning; Draft; Finalize
	Database System on Road Slope Management	Basic System Design; Tender; Detailed System Design and Programming; Database Formulation/ Usage/ Finalize
Seminar/ Workshop		Seminar/ workshop for PIS Baguio 6/15 - 6/16, Cebu 6/22-6/23; Seminar/ Workshop for DIS Cebu 11/15-11/17; Seminar/Workshop for Risk Management
Technical Working Group		5/9 Manila; 6/14 Baguio; 12/4 Manila; 3/7 Manila
Steering Committee		5/10 Manila; 6/21 Manila; 12/6 Manila; 3/9 Manila

1.5 Organization and Members of the Study

In accordance with the Minutes of Meeting on the Scope of Work of the Study dated 23rd September, 2004, the implementation organization for the Study is composed of the JICA Philippine Office as the client, the DPWH as the GOP counterpart, and the JICA Study Team. The Study was carried out under a three-layer management structure consisting of the Steering Committee, the Technical Working Group and the JICA Study Team in joint cooperation with the DPWH Counterpart Team, as shown in Figure 1.5.

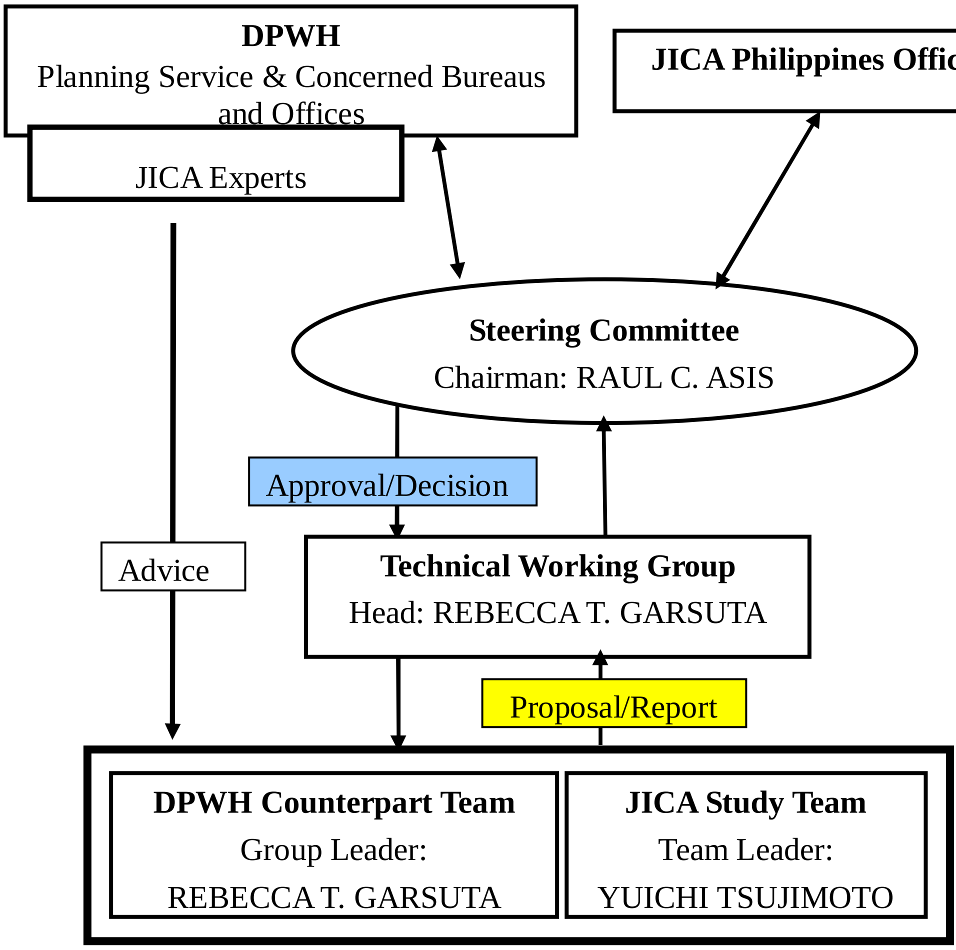


Figure 1.4 Implementation Organization for the Study

The members of the Steering Committee, Technical Working Group, DPWH Counterpart Team and JICA Study Team are shown in Tables 1.5 through 1.8

Table 1.5 Members of the Steering Committee

Name	Position	Title / Office
(1) Raul C. ASIS	Chairperson	Assistant Secretary for Planning, DPWH
(2) Maria Catalina E. CABRAL	Vice-Chairperson	OIC-Director, Planning Service, DPWH
(3) Resito V. DAVID	Co-Vice Chairperson	Project Director, PMO-FCSEC, DPWH
(4) Glenn J. RABONZA	Member	Administrator, OCD and Executive Office, NDCC
(5) Rolu P. ENCARNACION	Member	Weather Service Chief, PAGASA
(6) Rolando G. TUNGPALAN	Member	Assistant Director General, NEDA
(7) Fernandino Y. CONCEPCION	Member	OIC-Director, EMB-DENR
(8) Dr. Renato U. SOLIDUM	Member	Director, PHIVOLCS
(9) Eugenio R. PIPO, Jr.	Member	Regional Director, Region II, DPWH
(10) Mariano R. ALQUIZA	Member	Regional Director, CAR, DPWH
(11) Robert G. LALA	Member	Regional Director, Region VII, DPWH
(12) Jaime A. PACANAN	Member	Regional Director, Region VIII, DPWH

DPWH: Department of Public Works and Highways
PMO-FCSEC: Project Management Office - Flood Control and Sabo Engineering Center
NEDA: National Economic & Development Agency
PAGASA: Philippine Atmospheric, Geophysical and Astronomical Services Administration
DENR: Department of Environment and Natural Resources
OCD: Office of Civil Defense
NDCC: National Disaster Coordinating Council
PHIVOLCS: Philippine Institute of Volcanology and Seismology

Table 1.6 Members of the Technical Working Group

Name	Position	Title / Office
(1) Rebecca T. GARSUTA	Chairperson	Chief, DPD-PS, DPWH
(2) Dolores HIPOLITO	Co-Chairperson	Project Manager, PMO-FCSEC, DPWH
(3) Zoisimo BALISI	Member	Chief, PDD, Region II, DPWH
(4) Santiago WOODEN	Member	Chief, PDD, CAR, DPWH
(5) Luis A. GALANG	Member	Chief, PDD, Region VII, DPWH
(6) Andres M. SEVILLA	Member	Chief, PDD, Region VIII, DPWH
(7) Perla J. Delos REYES	Member	OIC-GGRD, Researcher, PHIVOLCS
(8) Florentino R. SISON	Member	Civil Defense Officer-I, OCD-NDCC
(9) Representative	Member	PAGASA
(10)Dr. Ramon D. Quebral	Member	Spvg. Science Research Specialist, MGB, DENR

DPD-PS: Development Planning Division, Planning Service
PDD: Planning and Design Division (DPWH Regional Office)
MGB: Mines and Geosciences Bureau

Table 1.7 Members of the DPWH Counterpart Team

Name	Designation/Office	Counterpart
(1) Rebecca T. GARSUTA	Engineer V, DPD-PS	Team Leader/ Road Administration
(2) Elmo F. ATILLANO	Engineer III, DPD-PS	Co-Leader/ Road Disasters Protection Planning
(3) Estelita M. LEONADO	Economist III, DPD-PS	Socio-Economic Analysis/ Organization and Institution
(4) Pelita V. GALVEZ	Engineer II, DPD-PS	Sediment Disaster Expert
(5) Diana J. PARUBRUB	GIS/CAD Operator DPD-PS	Information System Design
(6) Marcelino G. TOLENTINO, Jr.	Engineer III, DPD-PS	Natural Conditions
(7) Silverio D. AUXTERO	Draftsman I, DPD-PS	Construction Planning /Cost Estimate
(8) Orlando A. LADDRAN, Jr.	Legislative Liaison Specialist DPD-PS	Coordinator/ Guidelines for Road Slope Protection
(9) Carina B. DIAZ	Engineer III, Highways Division, BOD	Countermeasure Planning /Designing
(10) Guillerma Jayne T. ATIENZA	Sr. Geologist, Surveys and Investigation Division, BOD	Natural Conditions

BOD: Bureau of Design

Table 1.8 Members of the JICA Study Team

Name	Position	Specialty
(1) Yuichi TSUJIMOTO	Team Leader/ Road Administration	- Basic policy of the study - General management of the study - Coordination with counterpart
(2) Masatoshi ETO	Vice-Leader / Road Disaster Protection Planning	- Proxy for the leader - Planning disaster management - Evaluation/analysis of related data - preparation of technical manuals
(3) Joselito P. SUPANGCO	Socio Economic Analysis/Organization and Institution	-Review and plan of organization /institution/ legal condition -Review and plan of financial condition of disaster management
(4) Mikihiro MORI	Sediment Disaster Expert I	- Planning field investigation - Evaluation/analysis of related data - Preparation of technical manuals
(5) Komei OZAKI	Sediment Disaster Expert II	- Planning field investigation - Evaluation/analysis of related data - Preparation of technical manuals
(6) Hisatoshi NAITO	Countermeasure Planning/ Designing	- Countermeasure planning / design / - Preparation of design manual
(7) Takashi OGAWA	Information System Design	- Database system designing - Building-up disaster database
(8) Ryo MIYAZAKI	Natural Condition I (Field Survey Specialist)	- Planning/supervision of field survey - Preparation of technical manuals
(9) Itaru MORITA	Natural Condition II (Numerical Analysis)	- Numerical analysis on risk evaluation - Preparation of risk evaluation manuals
(10) Ippei IWAMOTO	Construction Planning/ Cost Estimate	-Planning construction, cost estimate - Preparation of design manual
(11) Pucai YANG	Project Coordinator / Preparation of Manuals	- Collection/analysis of existing data - Preparation of design manual

1.6 Technical Transfer

Joint activities involving both the JICA Study Team and its DPWH counterpart as stipulated in the Implementation Agreement between JICA and DPWH for the Study, (such as the activities necessary to carry out the Study, as well as to master the results of the Study) is the focus of the technical transfer from the Study Team to DPWH. For that purpose, in addition to the DPWH Counterpart Team, DPWH set up the Steering Committee and the Technical Working Group as the inter- and intra-Departmental supporting bodies to facilitate the technical transfer of the Study.

It was the Study Team's plan to promote the technical transfer during the Study period in three ways, including:

1) Joint work between the JICA Study Team and DPWH personnel,
2) On-the-job training for DPWH personnel, and
3) Seminars/Workshops for DPWH personnel.

Actually, the preliminary and detailed Inventory Surveys of the slopes along the selected routes and sections of the national highways were mostly executed by DEO engineers with the assistance of the JICA Study Team and/or DPWH Counterpart Team members as on-the-job training. Also, in the process of developing the RSMS database system, some of the DPWH engineers at the head office were engaged in the delivery test and manipulation training for the system.

During the period of the Study, three Seminars/Workshops were planned in order to disseminate the methodology of road slope management. Around 50 to 60 engineers from concerned Regional and District Engineering Offices participated in each of the two Seminars/Workshops held in Baguio and Cebu City. The last one will be held around the time of submission of the Final Report of the Study.

One of the remarkable features in the implementation of the Study is the highly effective joint work with the DPWH Counterpart Team as well as its engineers at Regional and District Engineering Offices, which was done through close cooperation between the Study Team and DPWH. The Study Team wishes this favorable joint work will result in the useful utilization of the RSMS in the activities of DPWH.

1.7 Main Events during the Study

The main events relevant to the Study are as follows;

Date	Event
14 March 2006	Commencement of the Study in Tokyo
20 March 2006	Briefing on the basic study policy to JICA headquarters
27 March 2006	Pre-kick-off meeting with JICA
30 March 2006	Kick-off meeting with JICA
4-6 April 2006	Site reconnaissance of Baguio, Bontoc, Banaue and Dalton Pass
10-12 April 2006	Site reconnaissance of Tacloban, Catbalogan, Wright-Taff Road, Mahaplag-Sogod Road, Cebu City, Balamban, Toledo and Naga
19 April 2006	Submission of Inception Report to JICA and DPWH
2-4, 8-10, 15 and 16 May, 2006	PIS (Stage 1) in Region CAR
9 May 2006	First Technical Working Group meeting
10 May 2006	First Steering Committee meeting
17 May 2006	PIS (Stage 1) in Region II
22 and 23 May 2006	PIS (Stage 1) in Region VII
24 and 25 May 2006	PIS (Stage 1) in Region VIII
14 June 2006	Second Technical Working Group meeting in Baguio Submission of Progress Report to JICA and DPWH
15-16 June 2006	First Seminar/Workshop 1 (for PIS) in Baguio
21 June 2006	Second Steering Committee meeting
22 -23 June 2006	First Seminar/Workshop 2 (for PIS) in Cebu City
July to October 2006	PIS(Stage 2) in Regions CAR, II, VII, VIII, X and XI
16-19 October 2006	Demonstrative DIS in Region VII
23-25 October 2006	Demonstrative DIS in Region CAR
26-27 October, 2006	Site reconnaissance of Baguio, Lagawe and Dalton Pass
15-17 November, 2006	Second Seminar/Workshop (for DIS) in Cebu City
21 November, 2006	Submission of Interim Report to JICA and DPWH
4 December, 2006	Third Technical Working Group meeting
6 December, 2006	Third Steering Committee meeting
November, 2006 to February, 2007	DIS in Regions CAR, II, VII, VIII, X and XI
27 February, 2007	Submission of Draft Final Report to JICA and DPWH
7 March, 2007	Third Technical Working Group meeting
8 March, 2007	Workshop for Technical Guides
9 March, 2007	Forth Steering Committee meeting

CHAPTER 2

OVERVIEW OF SLOPE DISASTERS ON NATIONAL HIGHWAYS

The development of the road network in the Philippines was followed by frequent road slope disasters beginning in the early 1980s. The DPWH has been implementing various preventive measures for critical slopes, especially along major highways prone to slope disasters such as Dalton Pass and Marcos Highway. However, these measures have been in limited areas, and road slope disasters are still occurring every year on national highways affecting economic activities in the areas which become isolated by the disruption of traffic flow due to road closures.

Slope disasters on national highways are induced mainly by the following two causes:

- Adverse natural conditions such as fragile geology and heavy rainfall; and
- Inappropriate selection of slope failure countermeasures, poor maintenance of road drainage systems and defective construction.

2.1 Natural Conditions Related to Slope Disasters in the Philippines

2.1.1 Topography and Geology

The islands of the Philippines emerged from the sea due to the activity of the Philippines' Sea Plate in the late Cretaceous period. This plate activity continues today. In the process of these series of geo-dynamic movements, mountain ranges were formed in the islands and alluvial plains have developed around the mouths of rivers and along coastlines.

The basement complex of the islands is formed by dynamo-metamorphic rocks such as amphibolites, mica-schist, and phyllites, which are frequently associated with quartz and marbles, and granite, which has been presumed to have been made up in the pre-Jurassic periods.

Most of the islands on the basement complex consist of soft sedimentary rocks such as sandstone, mudstone, conglomerate and limestone that had been deposited in the late Cretaceous to Neogene Tertiary periods. At the same time, the volcanic rocks such as andesites, basalt and tuffs have been produced by repeated volcanic activity.

These rocks are sheared and fractured in many places by the Philippine Fault and its related faults that pass from NNW to SSE through the center of the Philippine islands. Rocks in the mountainous areas are subject to fault activity in many places and are often fractured. This is one of the characteristics of base rocks of the Philippines that results in collapses and slides (refer to Figure 2.1)

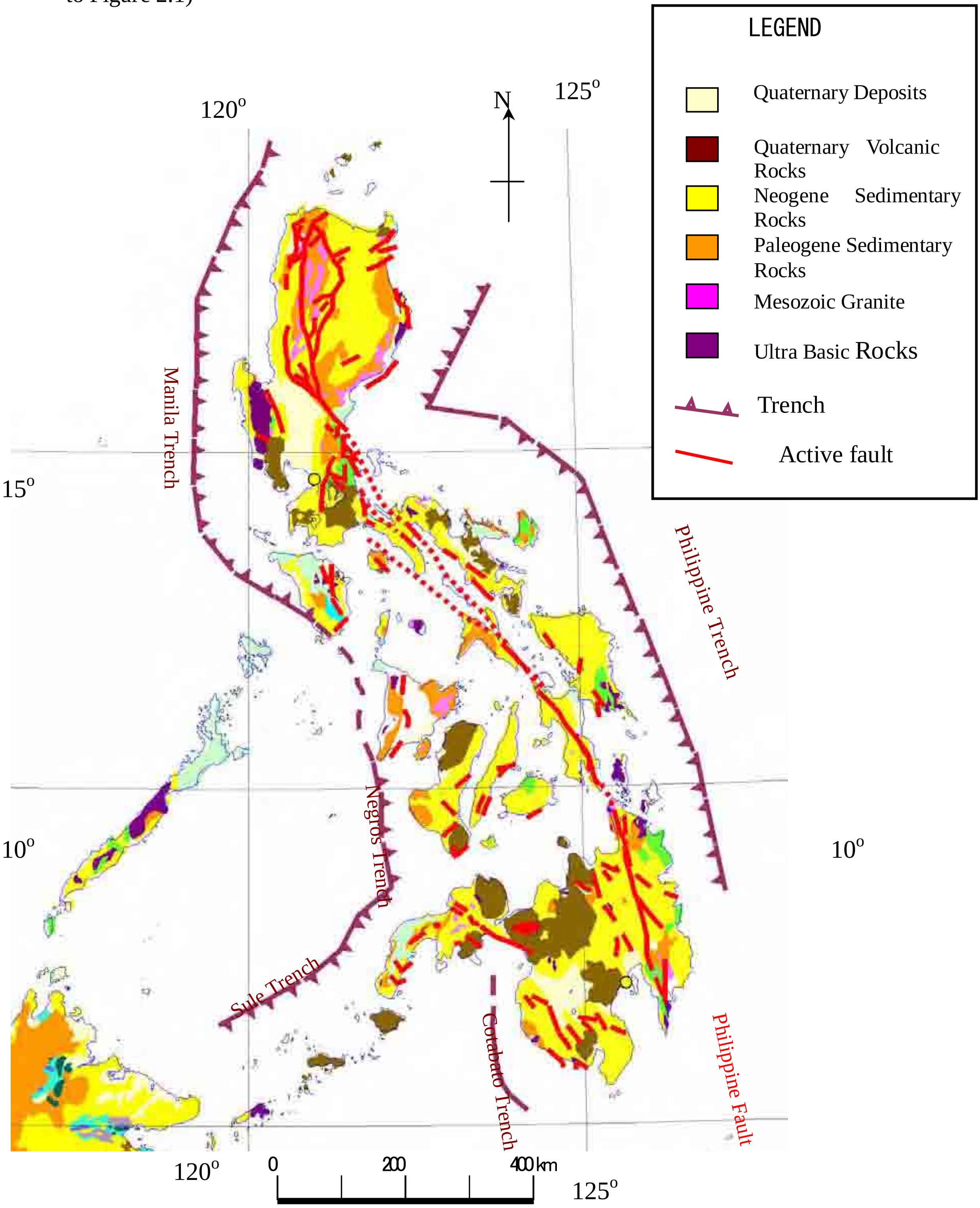


Figure 2.1 Simplified Geotectonic Schematic Distribution of Geological Systems

2.1.2 Climate

The climate of the Philippines features uniform temperature, high humidity and much rainfall in the tropical monsoon zone that arises mainly due to the maritime exposure of the country.

Climate in the Philippines is classified into four types as given below:

(1) Dry/Rainy: Western Luzon, Mindoro, and Palawan
(2) No Dry Season with a very pronounced maximum rainfall from November to January: Eastern Mindanao and Southeastern Luzon
(3) Obscure Dry/Rainy: Northern-Central of Luzon
(4) Rainy throughout the Year: Easternmost Luzon and Central Mindanao

Annual average rainfall varies in the regions from 960 mm to 4,600 mm, with half the rain brought about by typhoons, a major cause of road disasters.

For example, in 2006, two catastrophic sediment-related disasters occurred: On February 17, in the northernmost part of Leyte, huge debris flow was triggered by a 674 mm rainfall, which accumulated from February 8 - 17 and wiped out Barangay Guinsaugon, St. Bernard with thousands of casualties. From November 30 to December 1, a typhoon brought heavy rainfall to Mt. Mayon and surrounding areas, and caused huge damage in many areas of Albay, and Camarines Sur provinces. Another disaster occurred in Marinduque province.

The results of questionnaire surveys on road closure disasters (RCDs) on national highways in 2004 and 2005 show an annual average of about 2700 RCDs occurrence mainly caused by heavy rains.

2.2 Types of Slope Disasters along National Highways

2.2.1 General

The Study Team undertook a reconnaissance in April 2006. From that reconnaissance, the Study Team, together with the Counterpart Team found that due to the above-mentioned natural conditions, the potential types of slope disasters that could occur in the mountainous regions could be classified into seven categories as shown below.

(1) Soil Slope Collapse "SC", (2) Rock Slope Collapse "RC", (3) Landslide "LS", (4) Road Slip "RS", (5) Debris Flow "DF", (6) River Erosion "RE" and (7) Coastal Erosion "CE".

These classifications take into consideration the failure mechanism and countermeasure options for each disaster type. The schematic illustrations of the disaster types are shown in Figure 2.2, and a brief explanation of each disaster type is given.

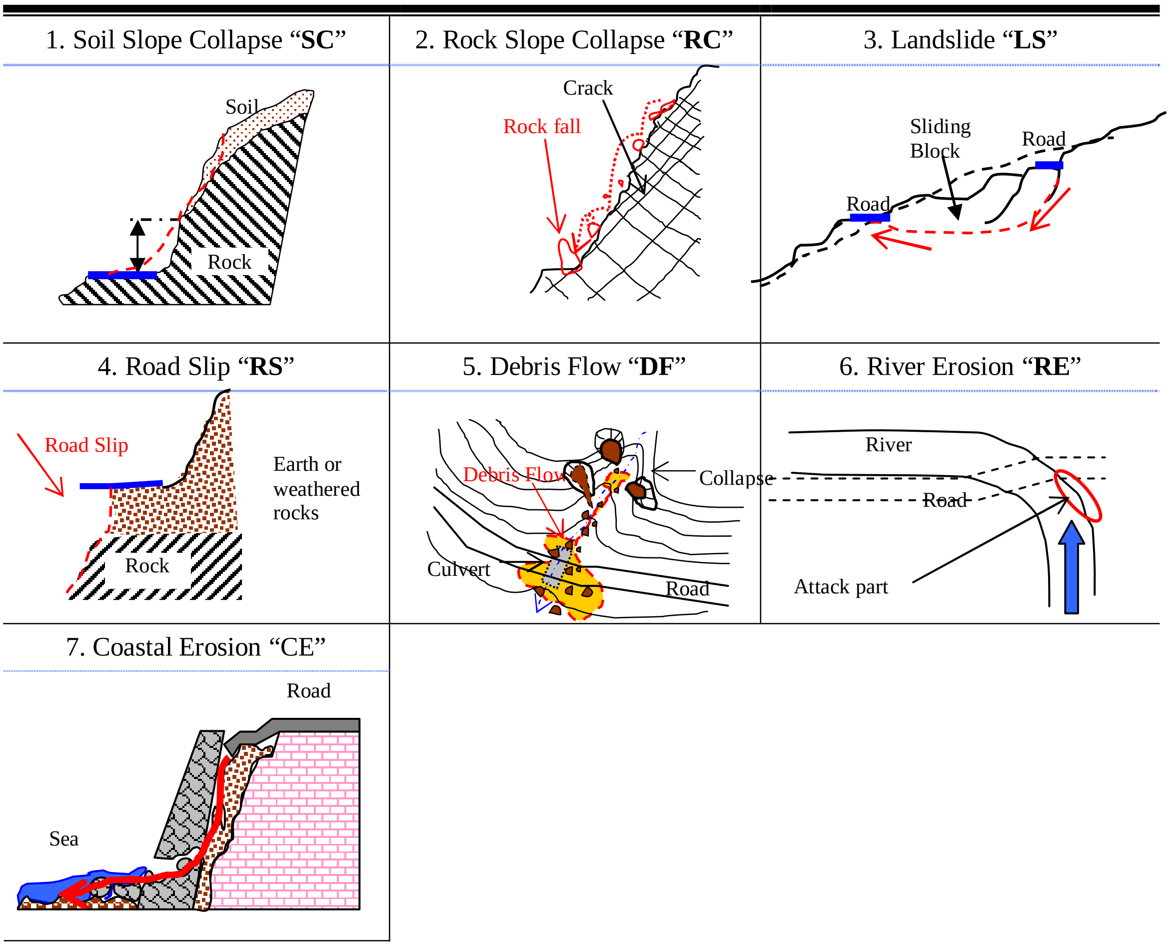


Figure 2.2 Schematic Illustration of Seven Disaster Types

2.2.2 Explanation of Disaster Types

(1) Soil Collapse (SC)

Rapid soil slope failures occur in high cuts or natural slopes with gradients of over 50 degrees and are triggered mostly by heavy rainfall. Material is generally residual soil produced by weathering of rocks or detritus soils hanging in steep slopes. Generally, the volume involved in the collapse is rather small, ranging from dozens to several hundreds of cubic meters.

(2) Rock Slope Collapse (RC)

Rock slope collapses occur in hard rock slopes with gradients over 50 degrees. Collapse modes are free fall or rolling rock, its size is usually less than dozens of cubic meters.

In natural hard rock slopes, large scale failures occur through such mechanisms as large scale planar slide, spread, wedge slide and toppling. But in this classification, these large scale slope failures are included in the "Landslide Type", because countermeasures to treat large scale rock mass failures are similar to the measures for large landslides.

(3) Landslide (LS)

Generally, "landslides" refer to all types of slope failures. In this classification, "Landslide" (LS) is defined as a large mass movement including large mass soil slide, rock wedge block slide, and rock slope toppling or spreading. Frequently, huge mass movements transform into a huge debris flows, as occurred in St. Bernard, Southern Leyte in January 2006.

The typical mode of landslide as defined by Varnes is shown in Figure 2.3.

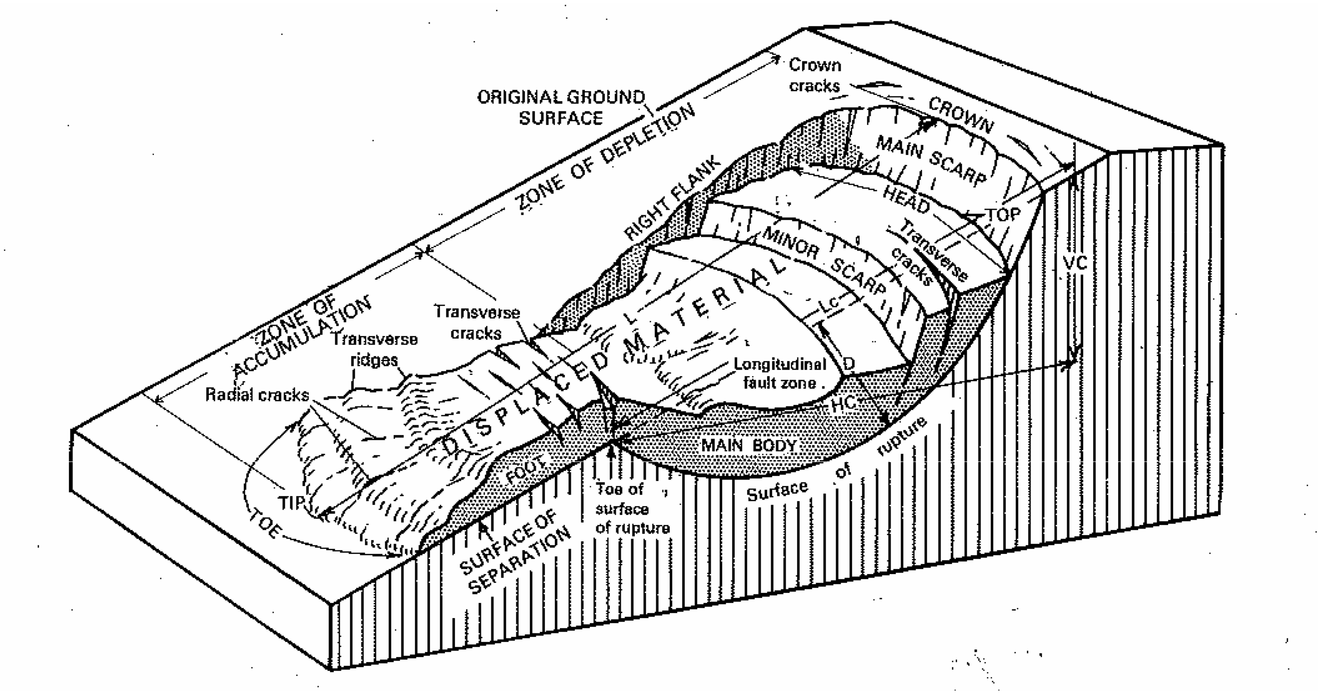


Figure 2.3 Block Diagram of Idealized Complex Earth Slide – Earth Flows (Varnes 1978, Figure 2.1t)

(4) Road Slip (RS)

"Road Slip" is a colloquial term commonly used by DPWH road engineers to mean a slope failure or deformation of the shoulder of roads in hilly areas.

Road slips occur in many places on national highways because of the collapse of the valley-side slope, scouring of slopes induced by leakage of water from destroyed drainages, and settlement of road embankments.

(5) Debris Flow (DF)

Debris flow is the rapid flow of boulders, gravel, sand, silt, clay, and trees mixed with a large quantity of water that is mainly generated by slope collapse under heavy rainfall. It flows rapidly down to the riverbed with slopes of over 20-degrees, and stops to deposit the debris in the riverbed where the gradient is less than 10 degrees.

(6) River Erosion

River erosion is a slope failure type which occurs mainly in embankments, and rarely, on natural slopes along rivers. Slopes along rivers are affected by successive river erosion and scouring by floods resulting in slope failures.

(7) Coastal Erosion

Coastal erosion is a slope failure type along the coastline induced by tidal erosion. It occurs mainly in embankments, and rarely, in natural slopes along the coast.

Of the seven disaster types, Soil Collapse, Rock Slope Collapse, and Road Slips occur most often on national highways, with Road Slips mostly affecting the flow of traffic. This is because Road Slips occur on steep slopes that are difficult to protect by simple measures.

Landslide disasters are not very frequent, but when they occur, they block the traffic for a long time because remedies for landslides require suitable countermeasures which include methods unfamiliar to the engineers in the Philippines.

2.3 Damage by Road Slope Disasters on National Highways

As reported in “Roads in the Philippines 2003,” published by DPWH with the assistance of JICA, a total of 963 road disasters took place in 2000 in 14 of the 17 Regions. which excluded Regions VI, VII and XI.

In this study, a questionnaire survey was made on the occurrence of RCDs on national highways in 2004 and 2005. Annual loss data regarding 451 RCDs in the past ten years (1995-2004) was obtained. Annual loss was estimated by the unit cost of the 451 RCDs. The results are shown in Table 2.1, Figure 2.4.

The total road length that has risks of road closure disaster is 1,774 km out of the 29,005 km of national highways. In 2004 and 2005, RCDs occurred 2,969 and 2,447 times, respectively, or an average of 2,708.

Losses induced by RCDs were estimated at approximately PHP 2,600 million as shown in Table 2.1 and Figure 2.1, which is the sum of the value of human lives lost, detour costs, and reopening costs. This estimate does not include the damage to electricity, communication and other infrastructures installed along the road, impact on economic activities supported by the road, or psychological impacts of the RCDs.

Table 2.1 Annual Average Road Closure Disasters (based on 2004 & 2005 data)

Region	Total Road Length	Road Length with RCD Risk	Annual Nos. of RCDs	Actual Intensity of RCD	Annual Losses
Unit	km	km	nos. of RCDs per year	nos. of RCDs per (year*km)	million pesos per year
Acronym	**TRL**	**RLwRCD**	**ANRCD**	**IRCDa**	**AL**
Expression				**ANRCD/ RLwRCD**	
CAR	1,844	238	981	4.13	1,171
NCR	1,014	5	1	0.20	0
I	1,609	82	41	0.50	25
II	1,753	208	193	0.93	210
III	1,989	260	235	0.90	367
IV-A	2,404	116	62	0.53	47
IV-B	2,172	157	326	2.08	197
V	2,196	30	95	3.19	77
VI	2,880	93	134	1.45	69
VII	1,960	114	153	1.34	66
VIII	2,332	88	86	0.97	63
IX	1,140	103	36	0.35	17
X	1,604	90	57	0.63	39
XI	1,446	102	84	0.82	78
XII	1,304	30	88	2.92	86
XIII	1,357	59	138	2.33	115
Grand Total	**29,005**	**1,774**	**2,708**		**2,627**
Average				**1.45**	
				Figure rounded to two decimals	

RCD: Road Closure Disaster

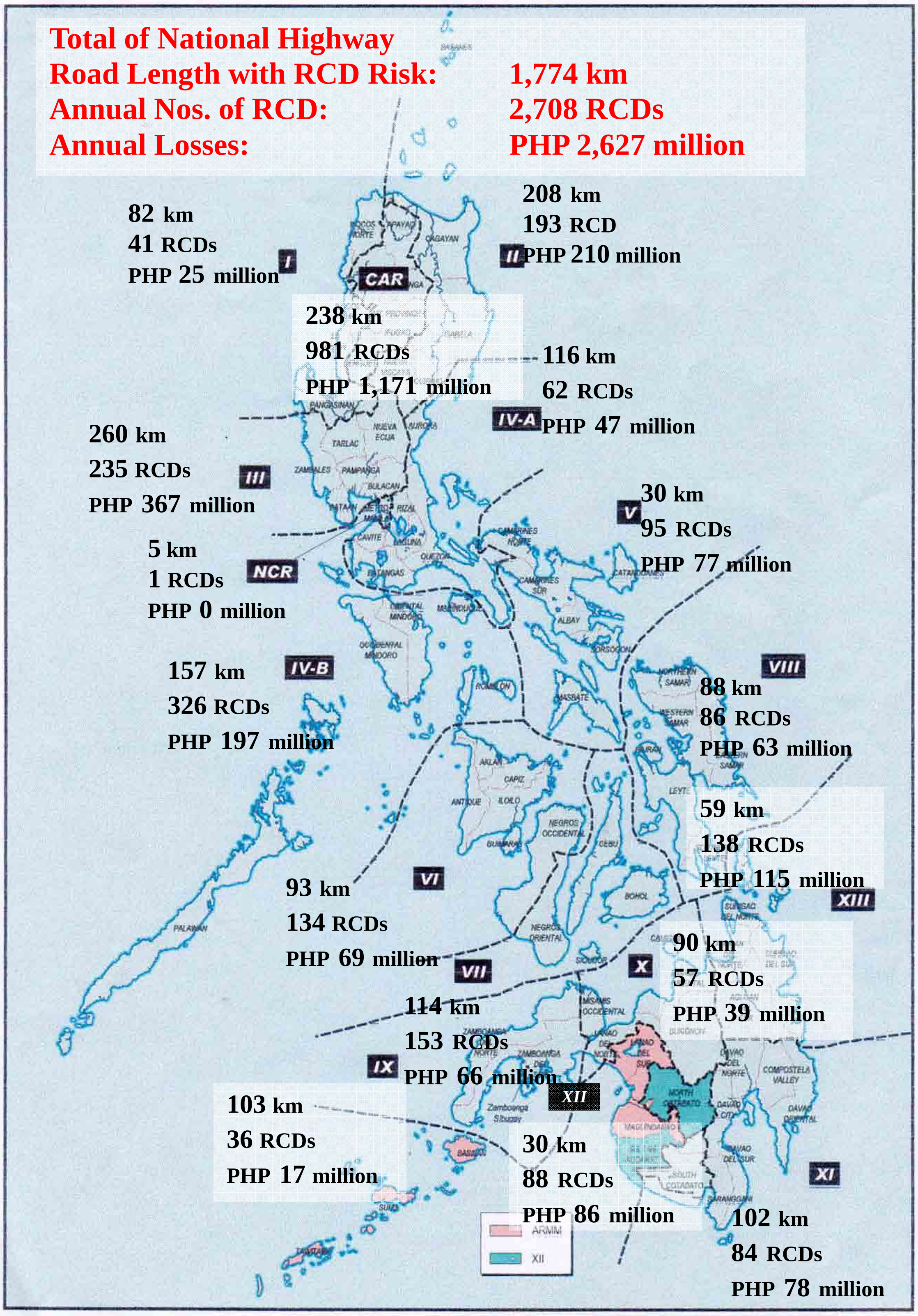


Figure 2.4 Average Annual Numbers of RCDs and Losses per Year (based on 2004 and 2005 data)

2.4 Existing Countermeasures against Road Slope Disasters

2.4.1 Types of Existing Countermeasures

Various kinds of countermeasures for road slope protection on national highways have been implemented for the construction of new roads and the rehabilitation of existing ones. These countermeasures are categorized according to the disaster types for which they are used, as shown in Table 2.2. Site photographs of some countermeasures are shown in Figure 2.5.

Table 2.2 Existing Countermeasures to Prevent Slope Disasters

Types of Road Slope Disasters	Types of Existing Countermeasures
1. Soil Slope Collapse (SC)	1.1 Cutting
	1.2 Surface drainage channels (masonry)
	1.3 Retaining walls (gabions, masonry and concrete)
	1.4 Vegetation
2. Rock Slope Collapse (RC)	2.1 Catch wall (gabions, masonry and concrete)
	2.2 Catch fence
	2.3 Mortar shotcrete
	2.4 Rock shed
3. Landslide (LS)	3.1 Retaining wall (gabions, masonry and concrete)
	3.2 Vegetation
4. Road Slip (RS)	4.1 Surface drainage channel (masonry)
	4.2 Retaining wall (gabions and masonry)
	4.3 Reinforced Soil embankment
5. Debris Flow (DF)	5.1 Sabo dam (masonry)
6. River Erosion (RE)	6.1 Revetments (gabions, masonry and concrete)
	6.2 Groins
7. Coastal Erosion (CE)	7.1 Concrete retaining wall
	7. 2 Grouted Riprap
	7.3 Wave absorbing works (such as groins and wave absorbing blocks)


Concrete crib masonry wall to protect against soil slope collapse


Cutting and masonry wall to protect against soil collapse


Surface drainage to protect against road slip


Masonry retaining wall to protect against road slip


Rock shed to protect against rock slope collapse


Concrete catch wall to protect against rock slope collapse


Masonry sabo dam to protect against debris flow


Revetment to protect against river erosion

Figure 2.5 Site Photographs of Existing Countermeasures

2.4.2 Technical Improvement in Countermeasures

In 1962, the total length of the road network in the Philippines was about 53,000 km. Since then, this network has been expanded to about 200,000 km, including around 30,000 km of national highways as of 2006, and this basic road network sustains the socio-economic activities of the Philippines. The rapid development of the roadwork under adverse natural conditions and limited budgets mentioned in Chapter 2.1 has resulted in the need for more countermeasures on road slopes for the following reasons:

- Existence of unforeseen defects in the slopes during the construction stage
- Inappropriate design or construction in the construction stage
- Absence of suitable repair or rehabilitation works in the maintenance stage.

In road construction, there may be unforeseen slope conditions, which may lead to an imperfect road structure. These portions may result in slope disasters that should be treated properly in the maintenance stage.

Inappropriate design and construction methods should be improved by rehabilitation works in the maintenance stage. Major matters to be improved in the design and construction of countermeasure for slopes are described below.

(1) Drainage Work

Surface drainage is often poor or insufficient to cope with the concentration of surface flow on roads during heavy rainfall. This has been a major cause of the occurrence of erosion or slope failure on the valley side slope of the road. Numerous road slope disasters, specifically soil collapse, landslides and road slips, have occurred during the rainy seasons. These are triggered mostly by water-flow caused by heavy rainfall and subsequent erosion as a result of inappropriate drainage maintenance. Topographically, these road slope disasters are concentrated in two different kinds of sections of national highways.

The first kind is the section lying on a saddle with a deep narrow valley, where the rain water concentrates on the higher ridges of both sides of the valley and flows down through the deep narrow valley (Figure 2.6). The second kind is the section parallel to a large river, where some small tributary streams or canals flow into the larger river. This contributes to water erosion triggering road slope disasters.

As shown in Figure 2.6, rainwater flows laterally or obliquely on the surface of the road. The road shoulder accumulates the water leading to the washout of the road side slope, consequently causing road slope slip disasters.

Figure 2.6 Road Slips Occurring on the Saddle Portion due to Erosion by Surface Runoff

To mitigate the road slope disasters resulting from water flow and erosion, the following technical improvements are recommended to provide a proper and effective drainage system:

- Proper drainage systems that prevent water from flowing into disaster-prone areas should be constructed. If possible, surface water should be guided to locations outside the disaster-prone areas.
- The kind and size of drainage facilities should be selected properly using hydraulic calculations.

(2) Cutting Work

There are not many cut slopes over 20 m high along the national highways, because generally, the road alignment is parallel to contour lines that do not require deep cutting of the mountainside slope. However, in some areas of the national highways, collapses occur repeatedly, showing that the design methods used were inappropriate for the following reasons:

Slope gradient is too steep to maintain the slope (Gradient of cut slope is generally over 45 degrees);

No berm (bench/ terrace) was designed for slopes over 10 m high due to RROW problems; and

Inadequate and in some cases, no drainage system or protection measures were installed for the cut slopes due to budgetary constraints.

It is difficult in many cases to determine the proper design cross-section by stability calculations alone because geological formation of a slope is complicated. In addition, soil characteristics vary considerably and predicting the location of potential sliding surfaces and the accurate strength of the ground is difficult. Moreover, the strength of the slope decreases with time due to weathering after excavation.

Cut slopes are highly susceptible to different types of road slope disasters. Design of cut slopes should be made by empirical engineering review, based on the conditions of past disasters. These are (a) soils and geological formations, (b) design and condition of execution of works, and (c) stability conditions. Suitable engineering judgments are needed depending on site conditions.

(3) Foundations for Structures

The depth of the foundations for structures often does not reach a stable layer, especially on retaining wall structures constructed on steep valley side slopes, river revetments or slope protection works along coastlines. This has caused the collapse of many structures.

(4) Knowledge and Technology for Large-scale Landslides

In some sections where large-scale landslides are occurring, there are no suitable design or countermeasure works implemented.

Placing fill on the landslide foot is a basic countermeasure to mitigate the movement of a large landslide. Earthworks should be applied more practically, taking into consideration the mechanism of slope failure at each site.

The effective technologies recognized internationally for large landslide control can be applied.

(5) Introduction of New Methods

Many slopes on the national highways are located in areas of adverse natural conditions, such as steep topography, fragile geology, etc. In these areas, it is sometimes difficult to prevent road slope disasters by applying common countermeasures such as gabions or concrete walls. Advanced methods such as reinforced soil embankments to prevent slope disaster have already been applied for some slopes. These advanced methods, which are already applied internationally for road slope protection, shall be introduced and implemented by the DPWH in a positive and consistent manner. The following “new” countermeasures can be introduced for each disaster type and are presented in the “Guide III Design of Countermeasures” and are summarized as follows:

(a) Slope Collapse; Concrete crib work.

(b) Rock Slope Collapse; Concrete crib work, Protection nets, Rock bolting; Rock anchoring.

(c) Landslide; Surface/subsurface drainage; Horizontal drilling; Anchoring; Piling.

(d) Road Slips; Reinforced Soil Works, Anchoring.

These countermeasures are so expensive that they should only be applied for key sites along the routes taking into consideration the feasibility of the application.

(6) Overall Plan for the Prevention of Road Slope Disasters in the Maintenance Stage

The engineering defects during the construction stage are the targets for rehabilitation and maintenance. However, road maintenance at present is limited to routine maintenance such as cleaning of drainage and grass cutting. Slope disaster mitigation works, particularly required in the sections with critical slopes, are not sufficient, but rehabilitation efforts have been limited to the reopening of the closed road, resulting in the recurrence of the slope disasters and the increase of maintenance cost.

An overall policy to manage the potential disaster sites, particularly for large-scale landslides, soil collapses, and road slips, should be formulated to allow countermeasures to attain their purpose over a long period of time, prevent the reduction of slope stability and reduce repeated works.

Furthermore, the road should be designed with considerations to reduce the maintenance cost.

CHAPTER 3

ACTIVITIES FOR ROAD SLOPE DISASTER MANAGEMENT IN DPWH

3.1 General

The ongoing "Government Rationalization Program" pursuant to Executive Order (EO) No. 366 signed by President Arroyo on 4 October 2004" has resulted in a number of new proposals for restructuring the DPWH based on the objectives of the program as follows:

- Focusing government efforts on its vital/core functions, priority programs such as projects under the 10-point Agenda of the Administration, and achieving the poverty-reduction targets under the Millennium Development Goals (MDG);
- Improving the quality and efficiency of government services by eliminating/minimizing overlaps and duplication, and by rationalizing delivery and support systems, organizational structures and staffing;
- Improving agency accountability for performance and results; and
- Implementing programs and projects of the government within the allowable resources.

As mandated in the EO, the possible actions regarding the functions/programs/activities/ projects of the Department/Agency include (a) scaling down; (b) phasing out; (c) abolition; and (d) strengthening.

In DPWH's Strategic Plan for 2005-2010, its organizational goals focus on the following:

- Improved public access to activities, goods, and services through the preservation, improvement and expansion of the national road network;
- Protection and enhancement of communities and the environment through flood control and mitigation measures and the provision of other infrastructure facilities; and
- Improved public satisfaction with DPWH through organizational reforms and culture change, and effective delivery of quality goods and services.

3.2 The Organizational Structure of DPWH

The proposed structure of DPWH, consistent with the mandate provided for in the aforementioned EO, has been completed together with consultation within and external to DPWH, i.e., the Department of Budget and Management. The DPWH's Change Management Team has prepared the proposed organizational structure under said EO and its implementation is just awaiting the final decision of the DPWH Secretary.

The proposed organizational structure of DPWH is illustrated in Figures 3.1, 3.2 and 3.3.

Under the said structure, the Planning Service provides technical services relating to public works and highways infrastructure, planning, programming and project development. It also provides technical assistance and support; and maintains close coordination with other offices/agencies on matters relating to public works and highways, planning, programming and project development. The Service handles the Department-wide Road and Bridge Information Application（RBIA）, Pavement Management System (PMS), Bridge Management System (BMS), and Multi-Year Programming and Scheduling (MYPS) applications.

The Service has four divisions, the Development Planning Division, Project Evaluation Division, Programming Division, and the Infrastructure Planning Research and Statistics Division. Due to the re-engineering of the processes under the Planning Service, Department Order 142, series 2001 "Modifying the Functions and the Organizational Structure of the Planning Service" was issued realigning the functions/responsibilities in anticipation of the improvement to be implemented by the Business Improvement Implementation Projects (BIIPs) under the Road Information Management and Support System (RIMSS). The Planning Service Divisions and the corresponding BIIPs implementations are shown below:

<u>Development Planning Division (DPD)</u>
BIIP C01 – Network Planning and Multi-Year Programming
BIIP C07 – Pavement Management System and Bridge Management System

<u>Project Evaluation Division (PED)</u>
BIIP C01 – Network Planning and Multi-Year Programming
BIIP C08 – Road Infrastructure Safety

<u>Programming Division (PD)</u>
BIIP C01 – Network Planning and Multi-Year Programming

<u>Infrastructure Planning Research and Statistics Division (IPRSD)</u>

Locational Referencing System (LRS)
Geographical Information System (GIS)
Agency Performance Indicators (API)
BIIP C02a – Road and Bridge Information Applications
BIIP C02b – Road Infrastructure Surveys

Some highlights of the organizational changes include:

- Creation of a Section in IPRSD (LRS/GIS, Inventory and Data Collection Administration Section) to manage the data regarding the entire highway network including GIS and integration of LRS and it will also be responsible for coordinating all data collection and ensuring data quality through the efforts of the Regions and Districts, through the Road and Bridge Information Application (RBIA)as the Department Official source for all data related to roads and bridges;
- A new section of IPRSD was created called the Special Projects Section to respond to all ad-hoc type requests as well as to coordinate the Agency Performance Indicators Reporting;
- Revision of the PED to function as a Traffic Studies Division, which was previously under the function of the IPRSD. New sections were also created in this Division for Road Safety and Traffic Analysis and Traffic Equipment;
- Combination of the Regional Planning Section and the Project Identification and Packaging Section under the DPD to create the Infrastructure Network Development Planning Section;
- Combination of the Technical Evaluation Section and Economic Evaluation Section under the PED to create the Project Assessment Section under the DPD;
- Renaming of the Impact Evaluation Section under the PED to the Post Project Assessment Section and it was moved to the DPD; and
- Moving the Environmental Impact Assessment Section from PED to DPD, although the staff in this section are currently under the ESSO.

The existing organizational structure of the Planning Service is given in Figure 3.4.

The Bureau of Maintenance (BOM) is primarily tasked with the maintenance of the nation's infrastructures and is engaged in the continuous upgrading of the technical skill of its personnel. It conducts field inspections to effectively monitor maintenance activities of the district/city engineering offices.

The BOM has five divisions, the Planning and Programming Division, Monitoring and Methods Division, Inspectorate Division, Building Services Division and the Inventory and Statistics Division. The existing organizational structure of the BOM is given in Figure 3.5.

The functions of the other major offices of the department are given in Table 3.1.

Table 3.1 Functions of the Other Major Offices in DPWH

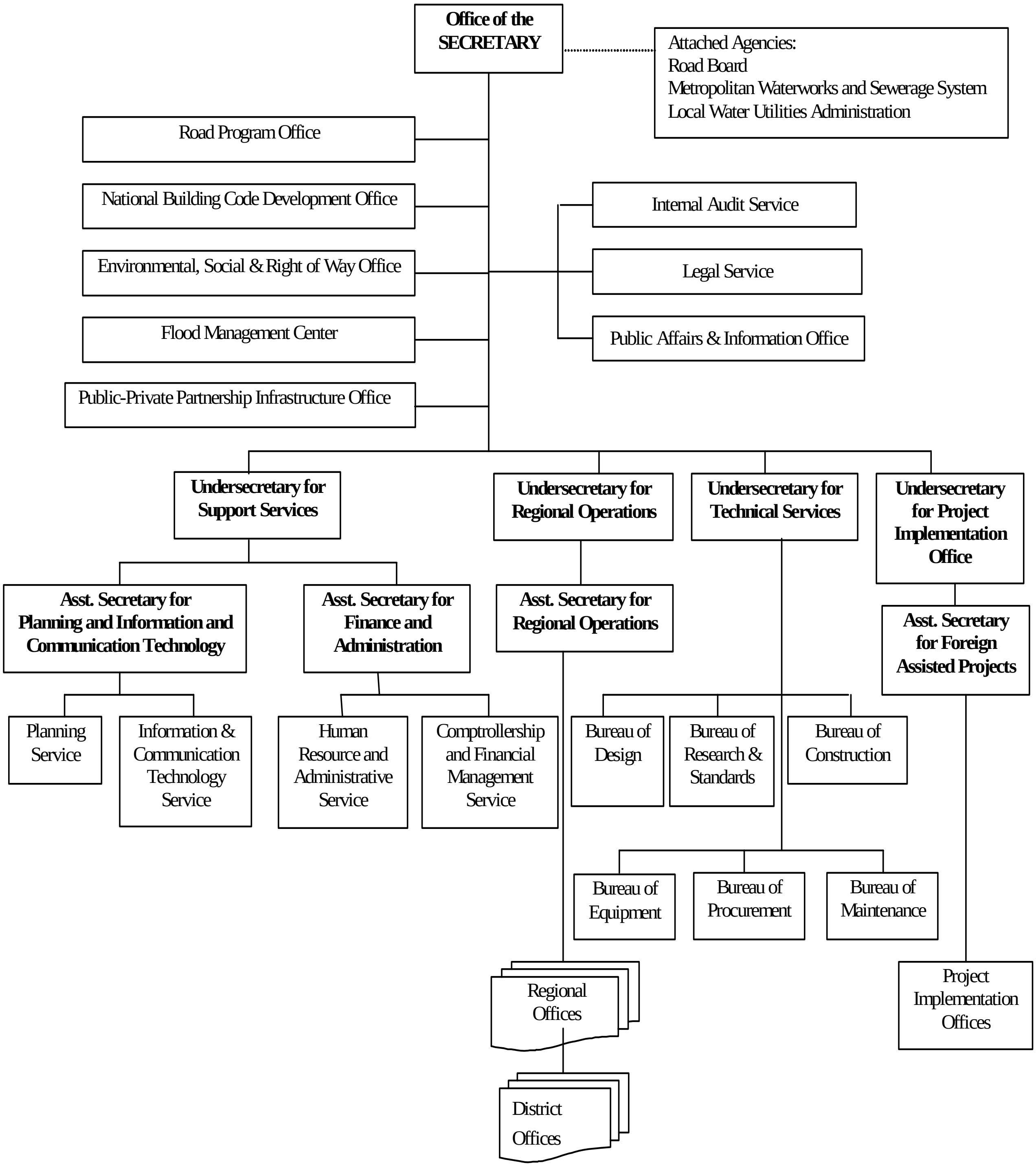
Office	Summary of Functions
Information and Communication Technology Service	▪ Responsible for formulating information technology (IT) plans, strategies, policies, budget, methodologies, standards, guidelines and resources; ▪ IT research and development; managing and maintaining the Department's IT resources ▪ Evaluating IT programs, projects, activities and procurements; instituting process improvements and re-engineering of processes; ▪ Development and maintenance of enterprise-wide and individual unit applications; ▪ Development and implementation of IT Training Programs; and ▪ Development and maintenance of the Department's website.
Administrative and Manpower Management Service	▪ Prepares and implements an integrated human resources management plan ▪ Provides services related to human resources training, education and development ▪ Develops, establishes and maintains efficient and cost-effective supply and property management systems; secures and maintains the DPWH building facilities and establishes efficient and effective security systems; and ▪ Develops, establishes and maintains an efficient records system and library facilities.

Office	Summary of Functions
Comptrollership and Financial Management Service	▪ Provide the Department with coordinated services relating to financial systems and procedures, budget, cash, accounting and all financial housekeeping matters, and to maintain and improve upon the financial management internal control system. ▪ Advise the Secretary on all matters relating to the accounting of government expenditures and receipts, budgeting and cash management, project finances and financial systems and procedures, and providing assistance in its area of specialization to any unit of the Department.
Bureau of Design	▪ Conducts, supervises and review the results of field surveys for highways, flood control and water resources development systems and other public works projects; ▪ Reviews the preparation of schemes, designs, specifications, estimates, tender contract documents covering architectural, structural and electrical and other technical design aspects of highways, flood control and other projects of the Department; ▪ Evaluates the design, specifications, estimates, and tender documents covering the architectural, structural, mechanical, electrical, and other technical design aspects of public works projects of all agencies in accordance with current standards and guidelines.
Bureau of Research and Standards	▪ Identifies the appropriate standards to be used in compliance with the agency's needs for infrastructures in coordination with the private manufacturing and construction industries; and ▪ Supports the infrastructure program so that a well-focused research program can be designed with the assessment of every piece of testing equipment of the DPWH program.

Office	Summary of Functions
Bureau of Construction	▪ Reviews and evaluates programs, estimates, contracts, and progress reports of DPWH projects, and ▪ Inspects, checks and monitors construction projects of DPWH implementing offices and other agencies.
Bureau of Equipment	▪ Formulates guidelines, policies, rules and regulations with regard to nationwide allocation and utilization of equipment required by various infrastructure projects, and equipment leasing; ▪ Conducts research on modern brands and models of equipment with regards to equipment capability, performance and operation; ▪ Analyzes, reviews and evaluates nationwide equipment field office operations and maintenance; ▪ Evaluates actual field performance of equipment utilized in various nationwide infrastructure projects; and ▪ Administers the rental management system.

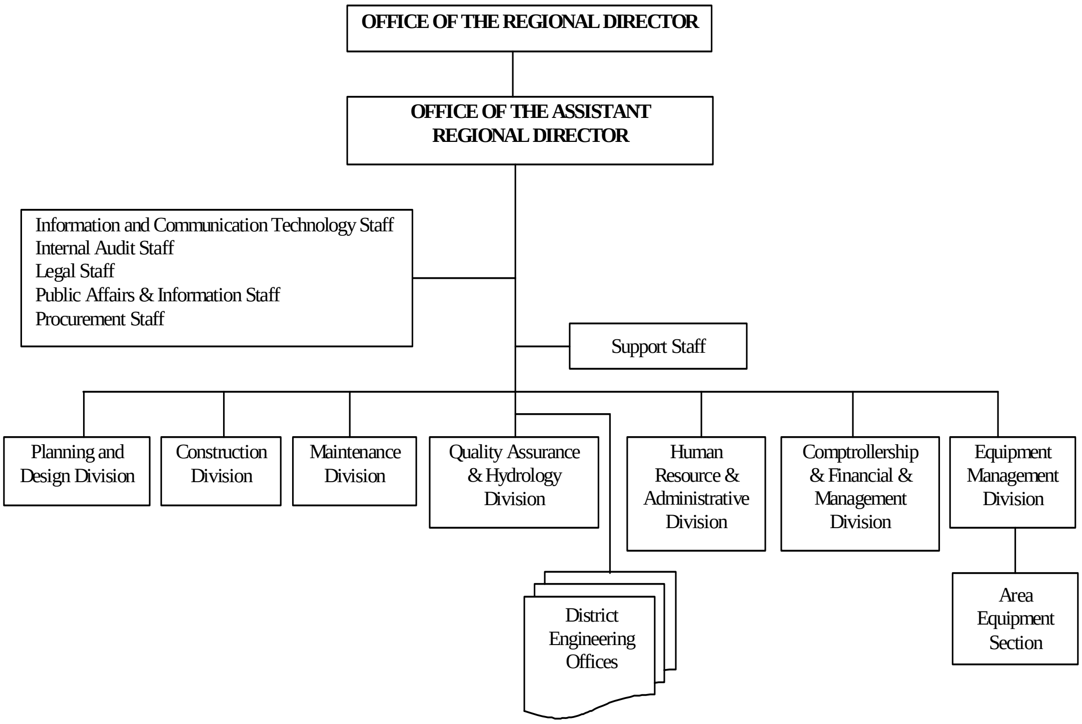
The existing staffing for DPWH in terms of number of regular positions is given in Annex A. In addition to the permanent positions, there are approximately 10,551 contractual and casual employees.

The existing organizational structures for the department, regional and district engineering offices are given in Annexes B, C, and D.



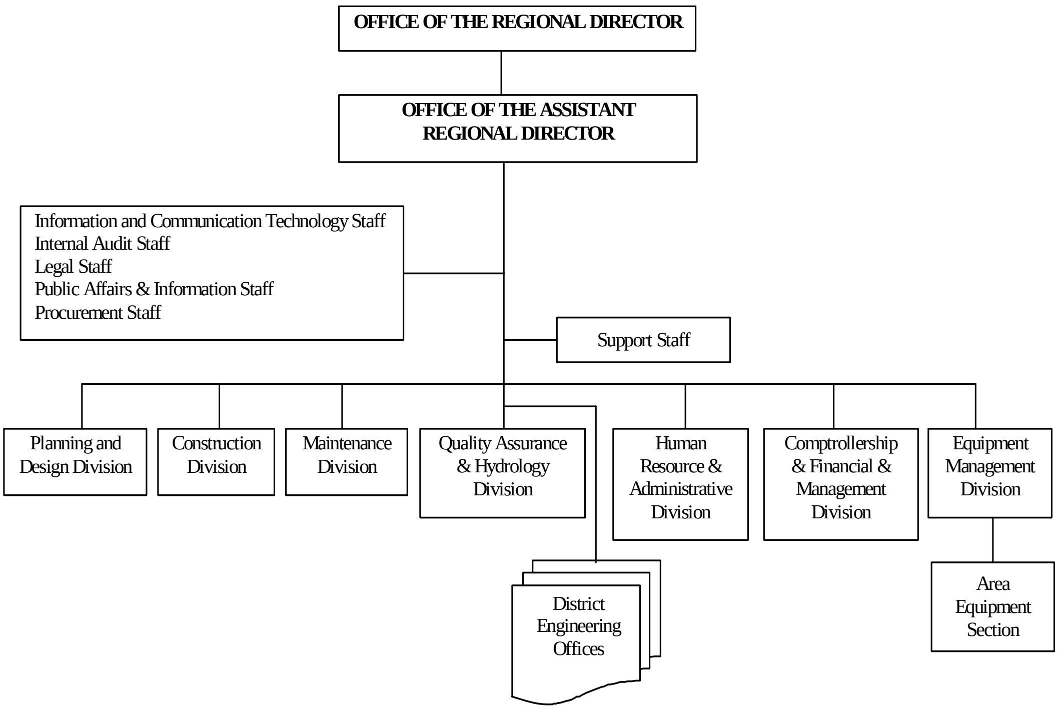
Source: Change Management Team-Department of Public Works and Highways, 2006

Figure 3.1 Proposed Organizational Structure of DPWH under EO 366



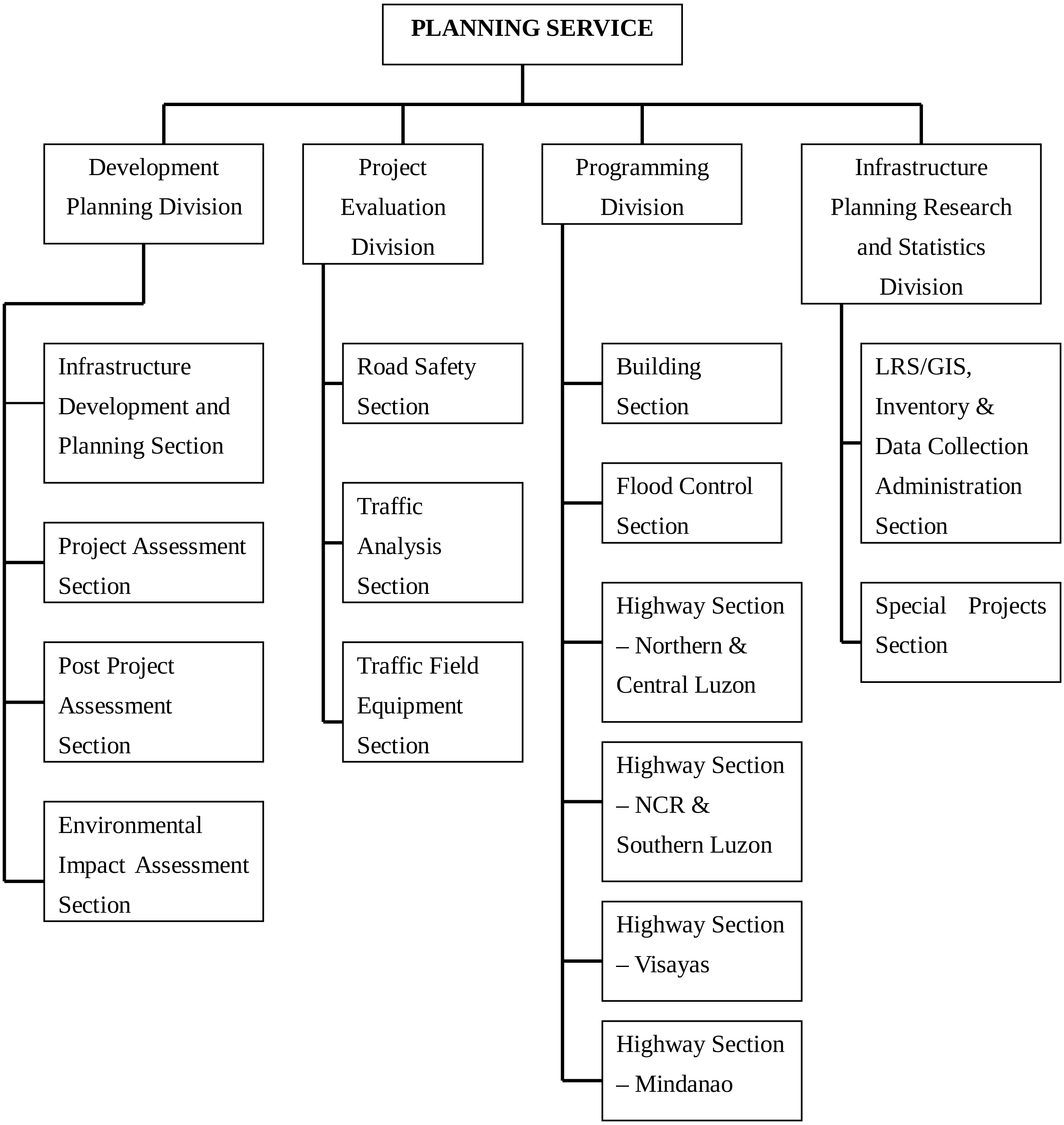
Source: Change Management Team-Department of Public Works and Highways, 2006

Figure 3.2 Proposed Typical Organizational Chart – DPWH Regional Office Under EO 366



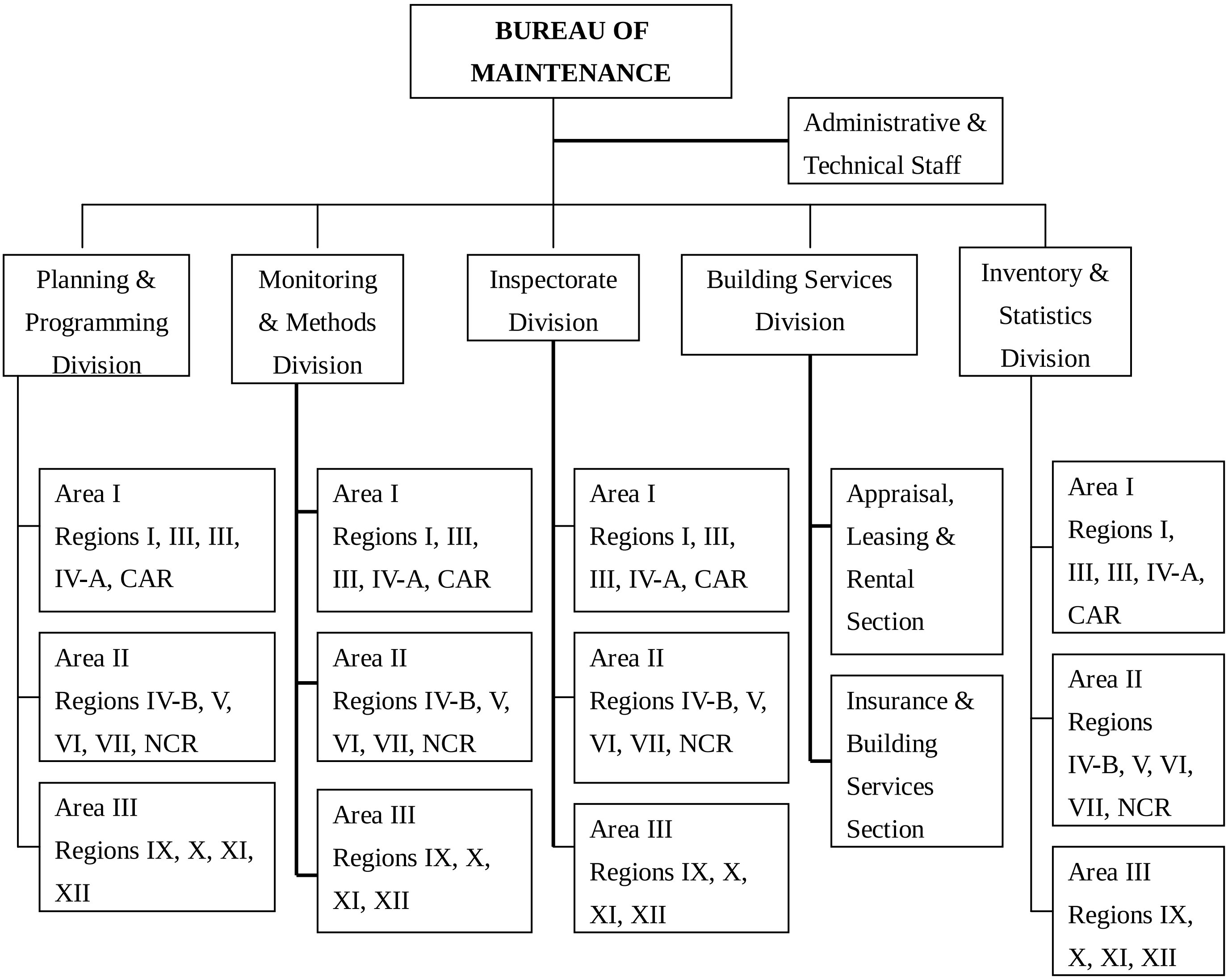
Source: Change Management Team-Department of Public Works and Highways, 2006

Figure 3.3 Proposed Typical Organizational Chart – DPWH District Engineering under EO 366



Source: Planning Service-Department of Public Works and Highways, 2006

Figure 3.4 Existing Organizational Structure of the Planning Service – DPWH



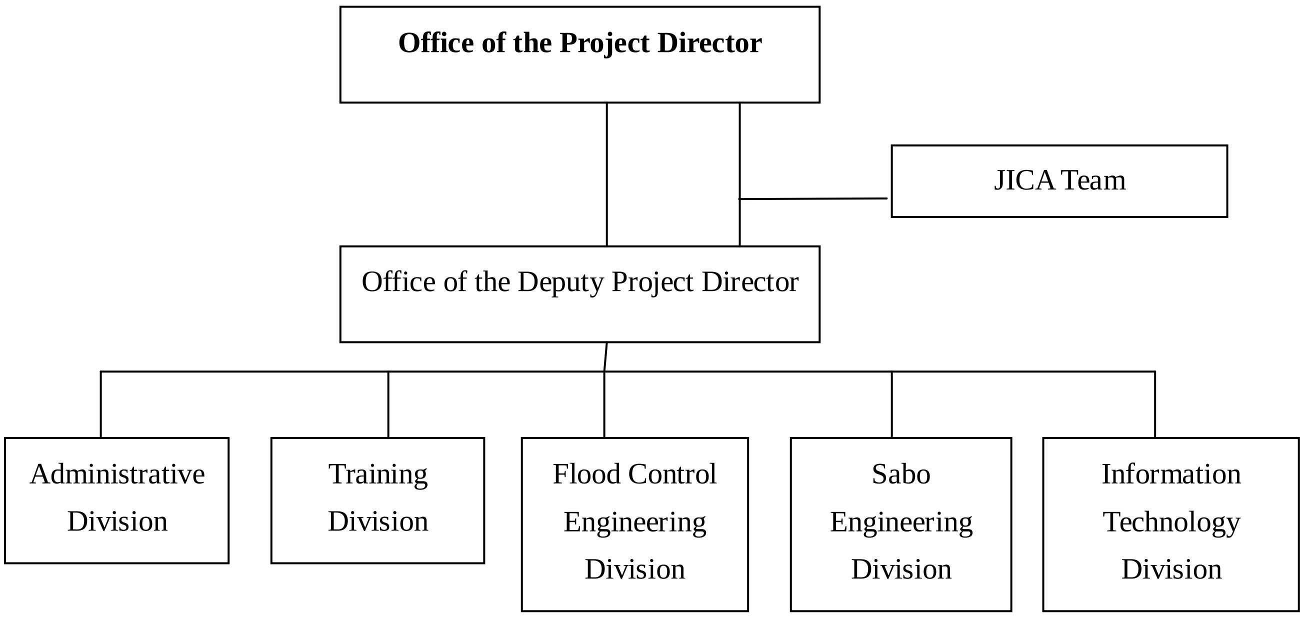
Source: Planning Service-Department of Public Works and Highways, 2006

Figure 3.5 Existing Organizational Structure of the Bureau of Maintenance – DPWH

<u>Flood Control and Sabo Engineering Center</u>

The Flood Control and Sabo Engineering Center or FCSEC was conceived as the institution within DPWH that would implement the JICA-assisted Enhancement of Capabilities in Flood Control and Sabo Engineering Project (Project ENCA) starting in 2000. Initially intended as a permanent institution within the DPWH, it was later decided to establish the FCSEC as one of DPWH's Project Management Offices (PMO), as legislation was required for the creating of a permanent institution. Created through Department Order No. 237 dated 13 December 1999, FCSEC is headed by the Project Director and is under the direct supervision of the Project Director for the PMO-Major Flood Control Projects and the overall administration of the Undersecretary for Planning. The FCSEC was officially approved by the department of Budget and Management (DBM) on December 2001.

The organizational chart of FCSEC is given in Figure 3.6 below:



Source: FCSEC-Department of Public Works and Highways, 2007

Figure 3.6 Organizational Chart – FCSEC

The functions of the JICA Team and the four technical divisions are as follows:

(a) JICA Team – Assist in the development of technical standards; Assist in training programs; Assist in applied research; and Assist in the formulation of computer database systems.

(b) Training Division – Prepare training programs; Develop and prepare training materials; Screen and evaluate the training participants; and Facilitate the conduct of training.

(c) Flood Control Engineering Division – Formulate technical standards; Conduct research and development; Conduct studies, monitoring and evaluation on selected projects/areas; and Conduct training in the field of flood control engineering.

(d) Sabo Engineering Division – Formulate technical standards; Conduct research and development; Conduct studies, monitoring of selected projects/areas; and Conduct training in the field of sabo engineering.

(e) Information Technology Division – Develop and manage computer database systems; develop other computer programs; Conduct surveys and investigations; Install and monitor hydrological and seismic stations; and Conduct training in the field of information technology.

3.3 Implementation System for Road Maintenance and Disaster Management

While the DPWH already has a Road Maintenance System in place, it has proven to be insufficient as it lacks a major component – that of disaster management, especially for sediment-related road closure disasters. Thus, regular road maintenance activities are undertaken based on the existing system and exclude preventive maintenance activities related to road slopes. In effect, a major factor in assuring the function of the national highways is ignored, as only pavement and drainage maintenance activities are undertaken.

The District Engineering Offices, though aware of the deficiencies in the road maintenance system, cope with sediment-related disasters on national highways within their jurisdiction, in the most expeditious manner possible, simply through immediate road reopening without any long term preventive works being undertaken to avoid future road closures.

3.3.1 Legislation on Disaster Management

The primary legislation on disaster management in the Philippines is Presidential Decree 1566 issued of 11 June 1978 – Strengthening the Philippine Disaster Control, Capability and Establishing a National Program on Community Disaster Preparedness. The major provisions of the law are as follows:

- Policy on self-reliance among local officials and their constituencies in preparing for, responding to, and recovering from disasters or emergencies;
- Organization of disaster coordinating councils from the national levels (National Disaster Coordinating Council or NDCC) to the municipal levels (Local Disaster Coordinating Council or LDCCs) and statement of their duties and responsibilities;
- Preparation of the National Calamities and Disaster Preparedness Plan (NCDPP) by the Office of Civil Defense (OCD) and the implementation the plans by the NDCC member agencies and LDCCs;

- Conducting periodic drills and exercises by concerned agencies and LDCCs; and
- Authority for government units to program their funds for disaster preparedness activities in addition to the 2% calamity fund as provided for under Presidential Decree 477.

The disaster management activities of the NDCC-member agencies, as well as the procedures and guidelines for inter-agency coordination and information dissemination, are defined under the Implementing Rules and Regulations of PD 1566 to Republic Act No. 7160 or the Local Government Code of 1991. The latter contains provisions on disaster preparedness and prevention/mitigation programs. Republic Act No. 8185 of 1996 amended sections of RA 7160 and sets aside 5% of the revenue from regular sources as annual lump sum appropriations for relief, rehabilitation, reconstruction and other works or services in connection with calamities which may occur during the budget year. However, such funds shall be used only in the area, or a portion thereof, of the local government unit or other areas affected by a disaster or calamity as determined and declared by the local “Sanggunian” concerned.

3.3.2 National Disaster Coordinating Council (NDCC)

The National Disaster Coordinating Council (NDCC) is the primary body responsible for various facets of responding to national disasters. It serves as the President’s adviser on disaster preparedness programs, disaster operations and rehabilitation efforts undertaken by the government and the private sector. It acts as the top coordinator of all disaster management and is the highest allocator of resources in the country to support the efforts of the lower Disaster Coordinating Council (DCC) levels (regional, provincial and city/municipal). In the discharge of its functions, it utilizes the facilities and services of the Office of Civil Defense of the Department of National Defense as its operating arm.

The legal basis of the disaster management system is Presidential Decree No. 1566 dated June 11, 1978. Presidential Decree No.1 or the Integrated Reorganization Plan of 1972, which was implemented through LOI No. 19, defined, among other things, the organization, mission and functions of the Office of Civil Defense as a bureau under the Department of National Defense. Presidential Decree No. 1566, on the other hand, provided for the strengthening of the Philippine disaster control capability and established a community disaster preparedness program nationwide.

The membership of the NDCC is as follows:

(1) Secretary, Department of National Defense – Chairman

Members

(2) President Executive Secretary, Office of the President

(3) Secretaries of the Departments of Social Welfare and Development, Public Works and Highways, Budget and Management, Interior and Local Governments, Justice, Transportation and Communications, Health, Agriculture, Education, Finance, Labor and Employment, Trade and Industry, and Environment and Natural Resources

(4) Chief of Staff, Armed Forces of the Philippines

(5) Director, Public Information Agency

(6) Administrator, Office of Civil Defense

(1) Prevention of RCDs through Identification of Potential Disaster Sites

While it is difficult to predict the actual site of a future disaster, the identification of potential sites, specifically RCDs, can be achieved through the preparation of "hazard maps" which pinpoint possible areas for RCDs. This is for the purpose of forewarning the local population to avoid such sites, especially during inclement weather. At present, there is no single specific government agency that is solely responsible for the preparation of such maps. MGB, PHIVOLCS, PAGASA, FCSEC conduct hazard mapping, but there is no integrated working policy among the agencies resulting in duplication of efforts among the agencies concerned.

(2) Assistance to the National Disaster Coordinating Council (NDCC)

To respond adequately to national emergencies, the United Nations Development Program and the Government of Australia are assisting the NDCC in Hazards Mapping and Assessment for Effective Community Based Disaster Risk Management. The project's overall goal is to contribute to strengthening the capacities of key stakeholders in localities vulnerable to natural hazards to protect/enhance the quality of the environment and sustainably manage their natural resources, as well as their capacities to prepare for and respond appropriately to natural disasters. The project's purpose is to support disaster risk reduction throughout the country. However, given that some areas are more hazard prone than others, the project will support the areas identified by the Philippine Government for priority hazard mapping and community preparedness initiatives. The objectives of the project are as follows:

- Equip key stakeholder groups with the resources (financial, technical, and/or advisory services), knowledge and training that will enable them to perform effectively for disaster risk reduction;
- Strengthen coordination processes and procedures within organizations and sectors (public, private and community) for effective risk reduction.
- Initiate the mainstreaming of risk reduction into local development planning.

The components of the project include:

- Multi-hazard identification and disaster risk assessment;
- Community-based disaster preparedness;
- Initiate the mainstreaming risk reduction into the local development planning process;
- Mainstreaming/Institutionalization; and
- Resource Mobilization and Donor Coordination.

3.3.3 Other Agencies in the Philippines Concerned with Disasters

(1) Mines and Geosciences Bureau (MGB) under the Department of Environment and Natural Resources (DENR)

The Department of Environment and Natural Resources – Mines and Geosciences Bureau (DENR-MGB) produces geohazard maps for selected urbanized and developed areas in the country. The geohazard maps of Metro Manila, Baguio City, Cagayan de Oro City, Zamboanga City, Butuan City, Subic and Olongapo City, Davao City**,** Surigao City, Oriental Mindoro and portions of Cavite City and San Pedro, Laguna have already been completed and are available to the public. Processing of information for Cebu City and Tuguegarao City, in Cagayan is on-going.

The geohazard maps provide information on potential areas of slope failures, liquefaction, and subsidence. The geohazard maps are a necessity for the design of infrastructure. Once geologic hazards are properly identified and characterized, their effects can be mitigated, if not eliminated, by instituting preventive measures.

With the issuance of DENR Administrative Order (DAO) No. 2000-28 on March 14, 2000, the Urban Geology Units in the MGB Central and Regional Offices were established. Among the mandates of these entities is the assessment of geologic hazards in urban areas. The DAO No.

2000-28 has institutionalized the Engineering, Geological and Geohazard Assessment (EGGA) system, which requires that all development projects produce an EGGA Report as an additional requirement to the Environmental Compliance Certificate (ECC) applications. The production of a geohazard map for a proposed project site is inherent to this system.

(2) Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) under the Department of Science and Technology (DOST)

For hazard mapping, PAGASA gathers basic information and observation data on meteorological and hydrological hazards including nature, frequency and magnitude and processes, validates and analyzes the information to locate the hazard using historical records to identify critical hazard zones. The results of the analyses are usually presented in the form of maps that show the type and degree of hazard in a given geographical location. Hydrometeorological hazard maps prepared and documented that show the location and frequency of hydrometeorological hazards such as tropical cyclones, floods, extreme rainfall, thunderstorms (TSTM), storm surge, extreme wind and other hazards.

In vulnerability analysis, the availability of more information such as a socio-economic profile of the area is very helpful. With such information, it is possible to identify geographically, with reasonable accuracy, those elements (i.e. settlements, communities and assets) that are more particularly susceptible to damage or destruction from a hazard. This is done by relating the hazard to the human settlement and its constructed environment. The results of the vulnerability analysis are also presented in the form of maps.

Comprehensive typhoon damage assessment is one of the major works of PAGASA under the Natural Disaster Reduction Branch (NDRB). PAGASA formed a team, the Special Tropical Cyclone Reconnaissance, Information Dissemination and Damage Evaluation (STRIDE) Team, which is intended to provide decision and policy makers real time information regarding the implementation of mitigation strategies to limit loss of human lives and the damage caused by typhoons to infrastructure, agriculture, and forestry.

(3) Philippine National Police

In cases where fatalities or injuries occur due to RCDs or other disasters, the police are called to conduct an investigation of the incident to determine culpability (human or natural). They prepare an appropriate police report including the TARAS-designed accident report form and the DEO secures a copy, which is submitted to the DPWH Regional and the Central Offices for input into the TARAS.

3.3.4 Disaster Management System in DPWH

The measures for responding to RCDs occur at two levels: immediate response and long-term solutions. For the “immediate response”, the concern is for the immediate reopening of at least one-lane to assure the flow of vehicular traffic. For the long-term solution, the objective is not only restoration of the infrastructure to its condition prior to the disaster, but also prevention of future disasters occurring at the site. Such long-term activities are usually funded out of the DPWH’s capital outlay for infrastructure or through Overseas Development Assistance (ODA). On the other hand, funding the “immediate response” works/activities is usually sourced from the district’s regular maintenance funds.

(1) Road Maintenance System

The existing road maintenance management system ignores the areas peripheral to the road pavement. This lack of attention affects road conditions and subsequently road maintenance requirements. Through the establishment of the database that identifies specific road sections as potential sediment-related disaster sites, routine and preventive maintenance works on road slopes could be undertaken systematically to prevent sediment-related road disasters. This requires enhancing the RBIA by increasing the amount of information available on existing and potential road disaster sites, including enhancing the technical capability of DPWH engineers, especially at the Regional and District Offices, on the prevention of road slope disasters.

The current system for undertaking maintenance works by administration (MBA) and by contract (MBC) would be enhanced by identifying additional job items that would focus on the prevention of sediment-related disasters through routine and preventive road slope maintenance activities.

(2) Emergency Management System

The DPWH, through Department Order No. 36, promulgated its Calamities and Disaster Preparedness Control Plan (CDPCD) and Standard Operating Procedures (SOPs) in 1988. The Plan contains the following provisions:

- Creation of the Department’s National Disaster Coordinating Body (NDCB)
- Standard Operating Procedures (SOPs) as follows:
  - SOP 1: Fire Prevention and Control
  - SOP 2: Typhoon and Flood Preparedness and Control
  - SOP 3: Volcanic Eruption, Earthquake and Tidal Preparedness and Control
  - SOP 4: Preparedness for Attack and Disorder

- SOP 5: Disaster (Accident) Preparedness and Control

- Creation of Regional/District/City Disaster Preparedness and Control Plans and SOPs
- Functions of the Disaster Teams
- Communication

The plan is intended to anticipate all possible contingencies making use of available DPWH resources and also tap the assistance of the private sector, particularly those in the construction industry, to enhance capabilities on disaster preparedness and control.

The DPWH's NDCB is the implementing arm of the department in exercising direction and control over all emergency operations nationwide and maintaining close coordination with the NDCC through the OCD. It consists of the then Undersecretary for Regional Operations, Construction, Equipment and Maintenance as Chairman and the Assistant Secretaries and Directors of the BOC, BOD, BOE, BRS and BOM as members. It utilizes the offices and facilities of the BOM as "Disaster Operations Centers" where disaster-related reports are received and relevant instructions are disseminated.

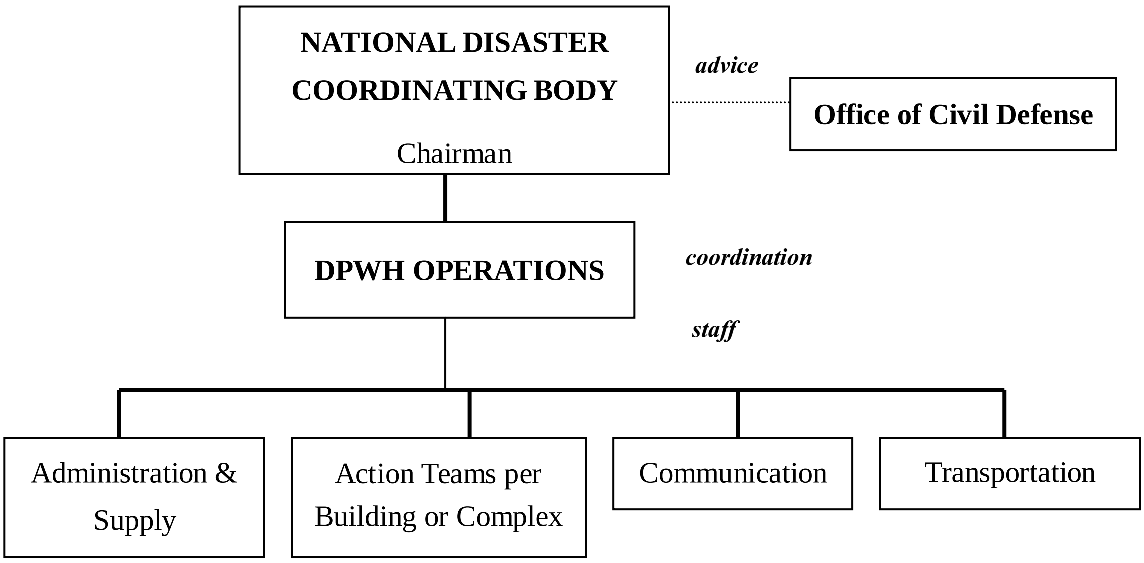
The functions of the NDCB are as follows:

- Activate the Operations Center on a 24-hour basis at the first indication or warning of typhoon or calamity and to continue activation until after the emergency;
- Receive all situation reports on damages as well as requests from the Regional/District/City Coordinating Bodies and other agencies for assistance through the Operations Center. The situation reports should include, among other things, the following:
  - Type/nature, location (station limits) and extent of damages;
  - Location of traffic disruptions and possible detour routes;
  - Restoration activities being undertaken;
  - Estimated date for reopening to traffic;
  - Rough estimate of the costs of restoration; and
  - Request for and nature of any required assistance.
- Receive all telex, telegrams and phoned-in disaster-related reports through the Operations Center
- After the emergency, to submit the regional damage reports (in the prescribed formats) through the BOM to the Secretary.

The organizational structure of the NDCB is illustrated in Figure 3.7.

DPWH's Regional Disaster Coordinating Bodies (RDCBs) and the District/City Disaster Coordinating Bodies (DCBs) were established with structures and duties similar to the NDCB.

However, at present, these Disaster Coordinating Bodies seem to no longer formally exist.



Source: Bureau of Maintenance-Department of Public Works and Highways, 2006

Figure 3.7 Organizational Structure – DPWH's NDCB

(3) Information System for Road Maintenance

The absence of a "Road Slope Disaster Management System" is evident from the existing RBIA where information on road conditions is limited to surface damage and visual observations (pavement condition). Adding the Road Slope Management System (RSMS) to the RBIA as illustrated in Figure 3.8 would result in a holistic view of existing road conditions including identification of specific areas for potential road slope disasters and improved allocation of maintenance resources to Routine and Preventive Maintenance of the Road Slopes.

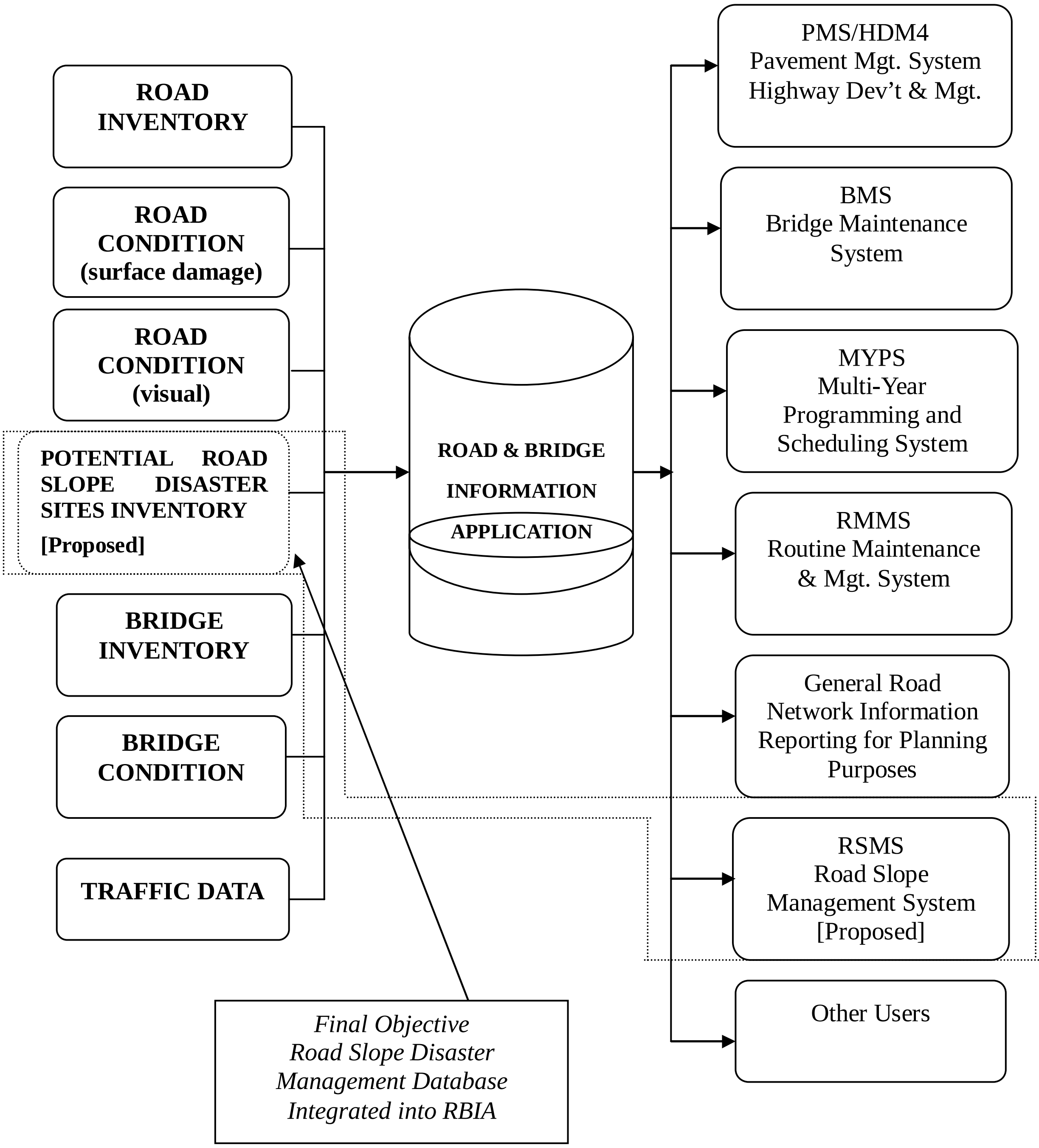


Figure 3.8 Proposed Integration of Study Outputs to RBIA - An Illustration

In the interim and prior to the full integration of the RSMS to the DPWH system (RBIA and applications), the RSMS will function as a separate and independent system with limited connectivity to the existing DPWH system. Eventually, however, RSMS will feed into the RBIA through its 'potential road slope disaster sites inventory" which would serve as input to the PMS, MYPS, RMMS and RSMS itself. The interim arrangement will be configured as shown in Figure 3.9.

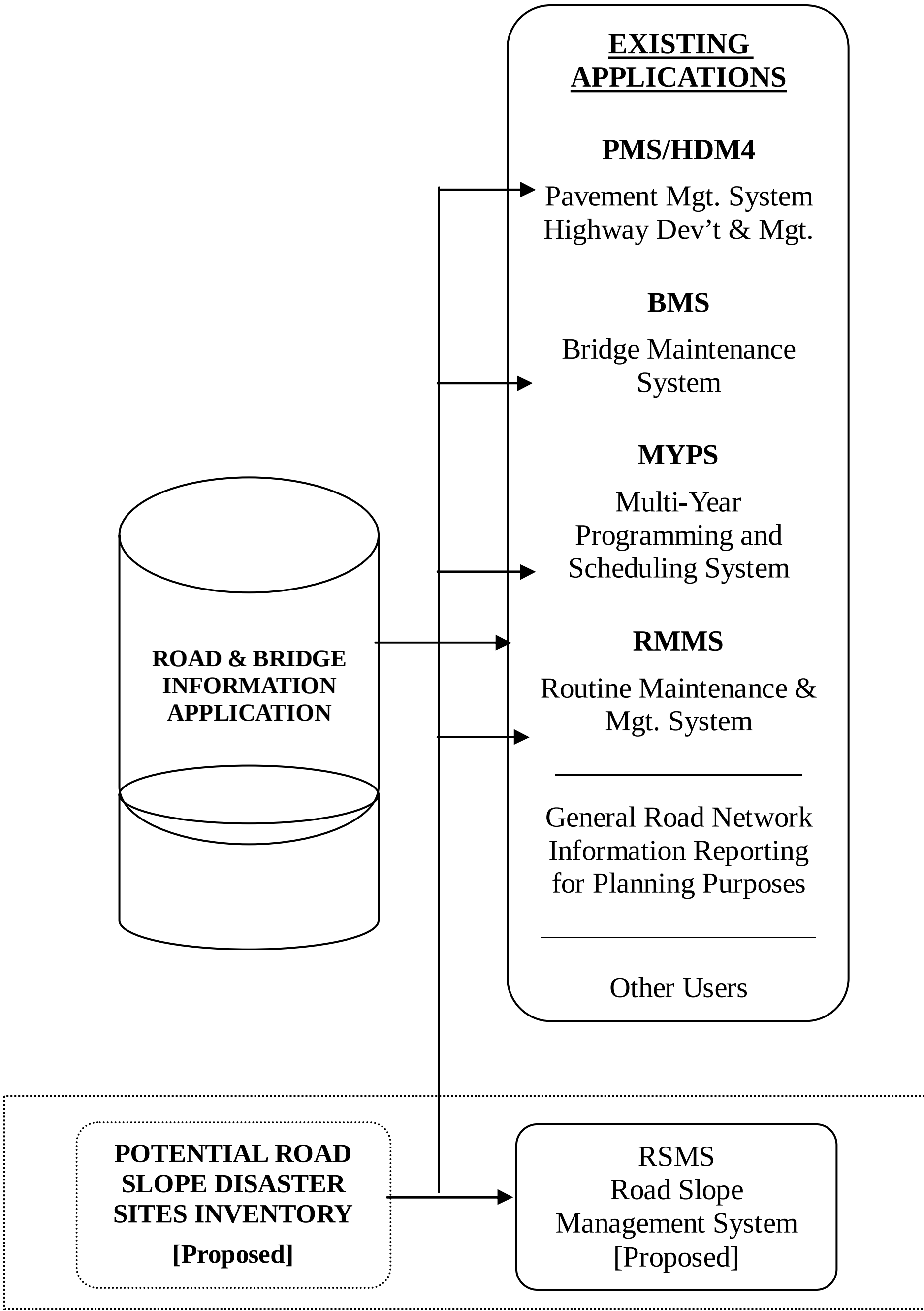


Figure 3.9 Interim RSDMS Interface with RBIA and Other Existing Applications

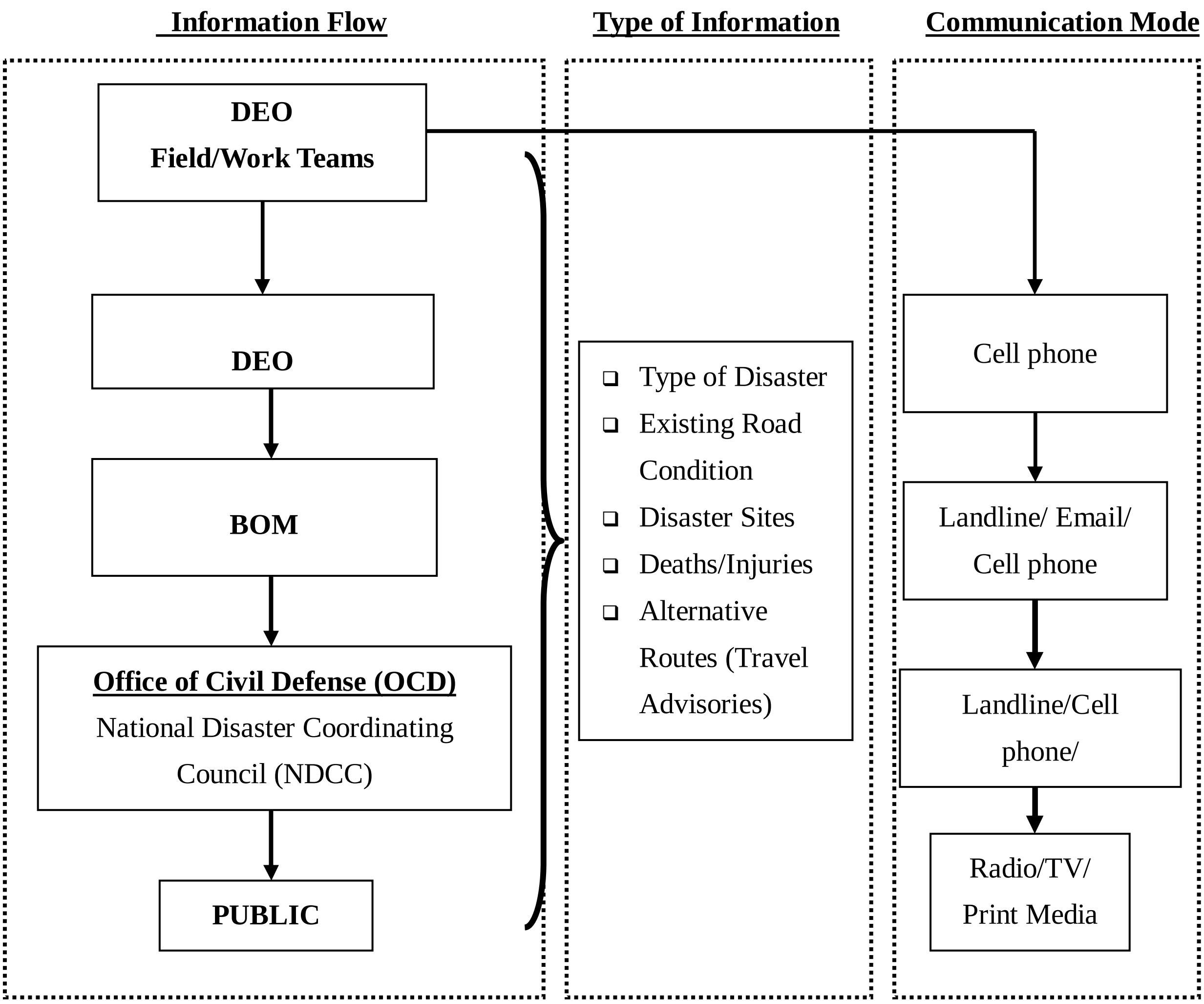
Currently, there seems to be no formalized standard operating procedure (SOP) for generating or reporting information on the occurrence of RCDs by the DEOs. The existing practice is for information on RCDs to be reported directly by the DEO's Maintenance Engineer to the Bureau of Maintenance (BOM) at the Central Office for relay to the National Disaster Coordinating Council (NDCC) for dissemination to the public. In general, information given concerns the occurrence and location of road disasters, e.g., landslides, road closures, flooding, etc., and recommended alternative routes.

The agreed reporting frequency between the BOM and the District's Maintenance Engineer is every 4-6 hours until such time that the condition has normalized. Reporting is done through email, cell phone (text or voice) or landline (fax or voice), depending on the communication mode available and most convenient. The reports include information on road closures, any injuries or deaths caused and other pertinent information needed. The information flow is illustrated in Figure 3.10.

During and after each disastrous event such as typhoons, heavy rains and earthquakes, the DEO dispatches its road maintenance teams to sites historically identified as potential disaster sites. These maintenance teams are often already assigned permanently to maintain specific road sections and are considered familiar with the terrain and where road closure disasters could occur. In sections where the risk is considered high, the DEO may already position earth-moving equipment to insure that the road is immediately reopened when the situation stabilizes.

(4) Organization at the DEO Level

The implementation of the DEO's road maintenance program is undertaken by maintenance work teams led by a "kapatas" or "foreman" who is responsible for supervising the team's activities in the field. Their specific activities for a specified period are managed by the DEO's area engineers for the specified road sections, while overall supervision of the DEO's maintenance activities is under the Maintenance Engineer. The composition of the work teams also vary by DEO with most of the members of the maintenance work teams being temporary personnel. The number of personnel seems to depend on the coverage/area of responsibility of the DEO. Table 3.2 below gives the number of permanent and temporary staff, work teams per DEO and the average number of members per work team. In addition, the minimum and maximum number of permanent and temporary staff, work teams and average composition per work team are also given. The method of deployment and tasks of these work teams are given in Table 3.3.



Source: Bureau of Maintenance-Department of Public Works and Highways, 2006

Figure 3.10 Reporting Flow for On-going Disaster Situations on National Roads

Table 3.2 Number of Permanent and Temporary Maintenance Staff and Work Teams of Sample DEOs

Details	Permanent Maintenance Staff	Temporary Maintenance Staff	Work Teams	Average Members/ Work Team
No. of Sample DEOs (with Valid Replies)	93	88	91	87
Average No. per DEO	9.19	52.86	5.97	14.96
Minimum Number	1	2	1	3
Maximum Number	32	828	35	34

Source: Survey Conducted by JICA Study Team/Department of Public Works and Highways Counterparts, 2006

Table 3.3 Deployment and Tasks of DEO Maintenance Work Teams in Sample DEOs

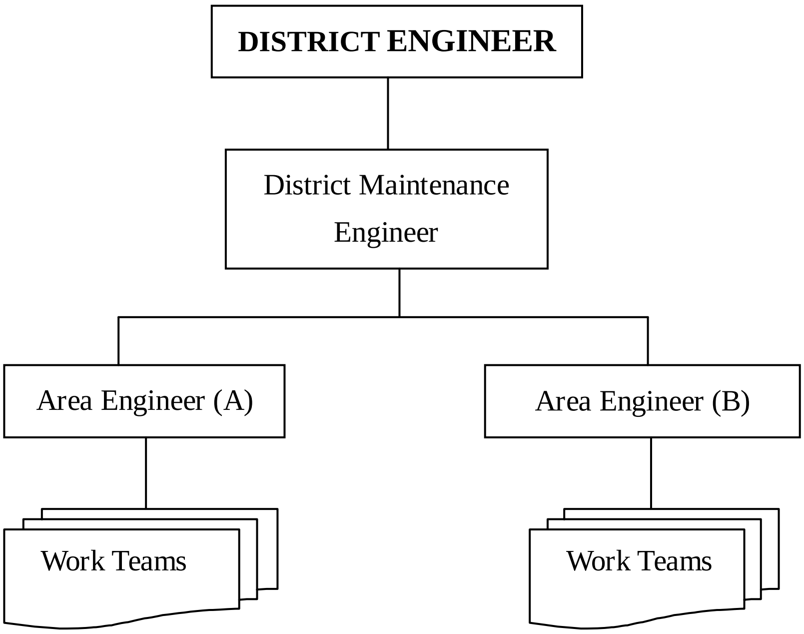
Deployment
• Maintenance work teams deployed daily. Teams are assigned permanently in their respective areas. However, they maybe rotated to other road sections if necessary.
• Maintenance work teams are scheduled on a weekly basis according to the situation/condition of the road. The maintenance engineer/area engineer monitors the road maintenance activities.
• The deployment of the maintenance work teams is by road section as scheduled by the Maintenance Engineer. Each team is headed by a maintenance foremen or "capataz." The maintenance teams are permanently assigned to a specific road section. In this District, we have a mobile team, which is assigned to any road section as the need arises.
• A maintenance team is composed of laborers led by a "capataz," maintaining a specified road section. The number of laborers is determined by the road section length in kilometers divided by three. The laborers in the team work either as a group or are assigned a specific 3-km stretch of road depending on urgency, need for closer/easier supervision or type of activity to be done. Equipment owned by the district is deployed wherever needed and on a priority basis. Activities awarded through contract mostly involve those requiring equipment. Work orders are issued

Deployment
from time to time to implement the activities.
• Work teams are deployed to their respective road sections on a weekly basis as per the quinquennial work schedule.
• The maintenance work teams are deployed daily. Following the semi–monthly schedule, the teams work not only on one road, but are rotated to others. The chief of the maintenance together with his foreman manages the road maintenance activity in their area of responsibility.
• Works teams are assigned individual road sections to maintain based on a semi-monthly schedule of activities. Each team has the materials, labor and equipment resources for the period. Their activities are based on the approved annual maintenance work program

Tasks
• Each maintenance crew team is given a quinquennial work schedule managed by the maintenance engineer.
• Undertake vegetation control, manual ditch cleaning, temporary patching, patching potholes, reshaping unpaved shoulders, etc.
• First to be deployed are the maintenance crews for traffic management in disaster areas. Office staff is activated to take charge of the monitoring activities. Then all equipment and vehicles that will be needed in the clearing operation are deployed. After the clearing operation, restoration crew will follow to restore the national roads and bridges to their original condition.

Source: Survey Conducted by JICA Study Team/Department of Public Works and Highways Counterparts, 2006

Based on the results of the survey, the assumed typical organizational structure of the DEO's maintenance unit is illustrated in Figure 3.11.



Source: Survey Conducted by JICA Study Team/Department of Public Works and Highways Counterparts, 2006

Figure 3.11 Organizational Structure – DEO's Maintenance Unit

The deployment of the teams doing maintenance work is on a road section basis. For example, for district road maintenance work composed of 5 road sections, each section will have a corresponding foremen assigned for supervising laborers working on maintenance-related activities along the national roads and bridges under its territorial jurisdiction. Each team is assigned one road section permanently, although this can be pulled out/rotated if necessary or in emergency cases. The composition of the work teams are not standardized, therefore, a work team can be composed of 3-34 members. The teams have an average of 15 persons as shown in Table 3.2.

On the availability of sufficient road maintenance equipment, the survey results showed that the amount of equipment owned/leased by the DEO was severely limited. Most of the equipment is DPWH-owned, with only a small number being leased by the DEO. Given the coverage area of a DEO, the equipment seems inadequate for the DEO to respond to multiple disasters including road closure disasters in their area (Table 3.4).

Table 3.4 Number of pieces of Maintenance Equipment in Sample DEOs by Type of Equipment

	TYPE of EQUIPMENT						
	Bulldozer	**Grader**	**Payloader**	**Road Roller**	**Hydraulic Excavator**	**Dump Truck**	**Service Vehicle**
No. of Sample DEOs (with Valid Replies)	10	100	77	46	13	94	71
Total	14	164	97	58	14	209	295
Average number/ DEO	**1.40**	**1.64**	**1.26**	**1.26**	**1.08**	**2.22**	**4.15**

3.4 Budgetary Situation in Road Maintenance

3.4.1 Regular Funding Sources for Road Maintenance

Currently, funding for road maintenance activities is wholly sourced from the Special Road Support Fund programmed by the Road Program Office (RPO), and from the proceeds of the Road User Charges collected pursuant to RA 8794. From 2002 to June 2006, DPWH had withdrawn the accumulated amount of P17.09 B from the said funds for road maintenance. The regular routine maintenance budget of about P4 Billion sourced from the General Appropriations Act (GAA) was discontinued when the national government experienced severe budgetary constraints. However, the proposed 2007 national budget has allocated about P4 Billion for the routine maintenance requirements of the DPWH.

Based on data provided by the Road Board Secretariat, the annual collections and allotment releases are summarized in Tables 3.5 and 3.6.

Table 3.5 Revenues Realized from MVUC Collections (in million Pesos)

Fund No.	Description	Year						Total*
		2001	2002	2003	2004	2005	2006**	
151	Special Road Support Fund	2,536.46	3,515.98	4,364.50	5,319.11	5,765.66	3,297.60	24,799.29
152	Special Local Road Fund	162.07	230.70	272.88	332.44	360.60	206.10	1,564.78
153	Special Road Safety Fund	237.97	330.47	409.16	498.75	540.52	309.19	2,326.06
151	Special Vehicle Pollution Control Fund	235.19	342.28	409.03	498.75	540.52	309.19	2,334.95
	TOTAL	**3,171.68**	**4,419.42**	**5,455.57**	**6,649.05**	**7,207.31**	**4,122.07**	**31,025.07**

*Note: * From the total amount of P31,025.07 million, 1% or P310.25 million is deducted for the RB administration operations fund.*

*** From January to June 2006 only.*

Source: Road Board

Table 3.6 Allotment Releases to Specified Agencies from MVUC Collections (in million Pesos)

Fund No.	Description	Year					Total	Unexpended Balance
		2002	2003	2004	2005	2006*		
151	Special Road Support Fund	700.00	4,000.00	4,680.92	5,738.19	1,992.63	17,091.74	7,459.55
152	Special Local Road Fund			33.01	347.94	171.00	551.94	997.19
153	Special Road Safety Fund		68.52	61.32	526.50	450.38	1,106.71	1,196.08
151	Special Vehicle Pollution Control Fund			144.46	276.70		421.16	1,890.44
	Road Board Administration /Operations Fund	1.35	-	14.14	14.82		30.34	279.91
	TOTAL*	**701.35**	**4,068.52**	**4,933.86**	**6,904.15**	**2,614.03**	**19,201.90**	**11,823.17**

*Note: * - Total may not add up due to rounding.*

Source: Road Board

As of June 2006, the unspent total balance from Motor Vehicle User Charge (MVUC) collections has reached P11.82 B of which P7.46 billion are intended for national road maintenance.

The use of Fund 151 is directly under the purview of DPWH through the Road Program Office (RPO) and allocations from the fund are based on the Annual Work Program and Multi-year Work Program prepared. This fund is presently the only source for routine and preventive road maintenance. However, the Department of Budget and Management (DBM) has withheld the utilization of the full amount of the available revenues from MVUC resulting in the unspent (unutilized) balance of the Special Road Support Fund reaching P7.46 billion as of June 2006.

3.4.2 Other Funding Sources for Road Maintenance

Routine Road Maintenance by Administration (MBA) includes the following emergency activities:

Table 3.7 Emergency Activities of Maintenance by Administration

Activity No.	Activity Name
401	Initial response to emergencies – Roadways
402	Initial response to emergencies - Bridges
41X	Emergency Projects

Source: Bureau of Maintenance, Department of Public Works and Highways

When the cost of the immediate response is within the financial resources of the DEO, the DEO undertakes the activity right away using its road maintenance budget.

Each MBC contract allocates 15% of the total amount to Activity 41X. These emergency funds can be utilized at the discretion of the District/City Engineer.

When events such as typhoons and earthquakes cause substantial damage to the road infrastructure beyond the capacity of the DEO's resources the DEO reports the event to the DPWH Regional and Central offices for the purpose of securing funds to restore the infrastructure.

(1) Immediate Response Fund (IRF) – Regional Offices

The IRF was introduced in Department Order No. 65 in 1988 in order to have a ready fund in the Regional Offices for immediate repair of damaged roads and bridges due to natural calamities or insurgency. The 5% fund retained in the Regional Offices from the quarterly release of maintenance funds for national roads and bridges is reserved as the "Immediate Response Fund".

The District/City Engineers report to the Regional Director within 24 hours from the occurrence of such calamities and request initial funds to undertake immediate repair. Such additional funds are made available after submission of the appropriate Programs of Work for the emergency repairs. In case the IRF is not sufficient to undertake such repairs, a corresponding request for additional funds is forwarded to the Secretary through the BOM Director from the Quick Response Fund of the department.

(2) Quick Response Fund (QRF) – Central Office

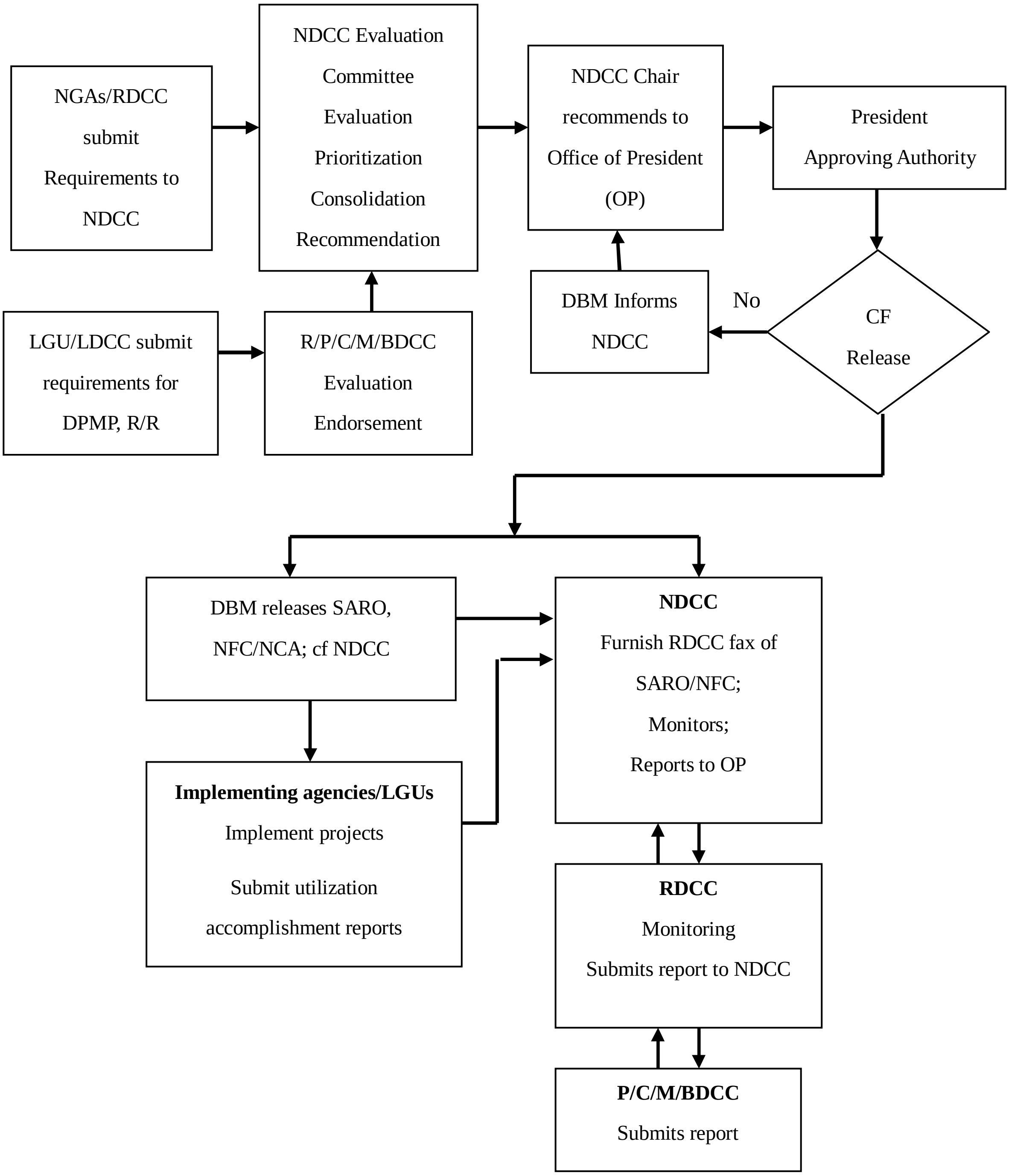
The QRF is taken from the National Calamity Fund as a standby fund to be used in connection with calamities and primarily for the immediate repair/restoration of calamity-damaged infrastructure facilities in order to normalize the situation as quickly as possible.

The DPWH has, over the years, been given allocation under the GAA of an amount in the range of 20-25% of the appropriation for repair and reconstruction of permanent structures under the calamity fund.

(3) Calamity Funds

The NDCC administers the national calamity fund under the General Appropriations Act. The fund is used for aid, relief and rehabilitation services to areas affected by man-made and natural calamities and repair and reconstruction of permanent structures. The limited budget allocation of the national calamity fund prompted the NDCC to rationalize its use so that urgent and immediate needs in affected areas are duly addressed based on the priority levels set.

If the RCD occurred during a major typhoon or other disaster event, the reopening cost for the damaged infrastructure may be funded out of the national government's calamity funds under the Office of the President. However, certainty that funding will be provided is low due to the limited budget available. The procedure for securing funding out of the calamity fund is illustrated in Figure 3.12.



Source: Office of Civil Defense - National Disaster Coordinating Council, 2006

Figure 3.12 Steps in Securing Funding Using the National Calamity Fund

(4) Other Funding Sources

Other possible funding sources used for reopening cost include ODAs that are made available by various donor countries to assist the national government in times of disasters. These are usually donations given in times of major disasters and, depending on the donor's conditions, may be used for funding reopening costs.

3.4.3 Road Maintenance Expenditures at the DEO Level

Based on the 118 survey questionnaires received, the actual number of usable responses varies per year, from 76 to 99. The actual road maintenance expenditure by DEO depends on the maintenance budget allotted to the specific DEO. Some DEOs have been given more substantial maintenance budgets than other DEOs. The actual average maintenance expenditures from 2001-2005 and those estimated for 2006 are given in Figure 3.13. Table 3.8 shows the number of DEO's categorized into specific ranges of road maintenance expenditure values. Table 3.9 shows the average, minimum and maximum road maintenance expenditures and shows that these values declined from 2001 to 2005. The proposed 2006 average maintenance expenditure, is lower than the 2001-2004 levels.

Table 3.8 Number of DEOs by Range of Road Maintenance Expenditures, 2001-2006, (in thousand pesos)

Ranges of Road Maintenance Expenditures	Year					
	2001	**2002**	**2003**	**2004**	**2005**	**2006**
No. of Sample DEOs (with Valid Replies)	**76**	**83**	**88**	**94**	**99**	**94**
<1,000	1	1	1	1	1	1
1,000 <x< 5,000	4	1	7	8	5	6
5,000 <x< 10,000	9	15	8	27	32	25
10,000 <x< 20,000	21	22	25	36	41	43
20,000 <x< 500,00	35	35	40	21	20	18
>50,000	6	8	7	1	0	1

Source: Survey Conducted by JICA Study Team/Department of Public Works and Highways Counterparts, 2006

Table 3.9 Range of DEO Road Maintenance Expenditures, 2001-2006 (in thousand pesos)

Type of Values	Year					
	2001	2002	2003	2004	2005	2006
No. of Sample DEOs (with Valid Replies)	76	83	88	94	99	94
Average	25,061	25,037	24,740	15,298	14,131	15,015
Maximum	95,679	92,150	86,305	51,309	44,556	83,757
Minimum	220	219	219	230	115	121

Source: Survey Conducted by JICA Study Team/Department of Public Works and Highways Counterparts, 2006

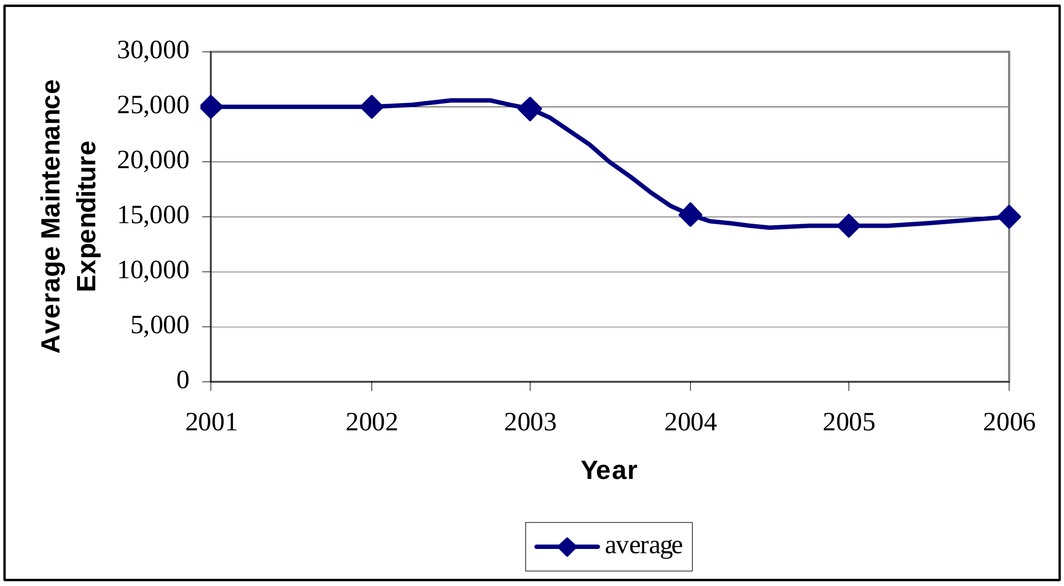


Figure 3.13 Average Maintenance Expenditure - Sample District Engineering Offices, 2001-2005 (2006 proposed budget) (in thousand pesos)

3.5 Proposed 2006–2010 DPWH Medium-Term Public Investment Program

3.5.1 Medium Term Plan

The DPWH, in its medium term investment program, has proposed a total of P236.76 billion for 2006-2010. Of this amount, P146.52 billion is to be funded from ODA of which P70.51 billion is for on-going projects and P13.52 billion is intended to fund the cost over-runs of completed and on-going projects. Thus, only P76.01 billion or 51.9% is actually intended to finance proposed (new) projects.

Of the total amount allocated, only P90.24 billion or 38.1% is to be funded out of local funds. This shows the continuing dependence of the national government on ODA to fund the infrastructure program (Table 3.10).

As can be observed from Figure 3.14, the funding gap by 2008 widens further, with more projects being funded out of ODA and continues on up until 2010.

Table 3.10 Proposed Allocation for Highway Projects, 2006-2010 (in million Pesos)

Highway Projects	Proposed Allocation (in million pesos)					
	2006	2007	2008	2009	2010	Total
A. Foreign-Assisted Projects	24,340.79	20,836.14	27,658.94	33,931.62	39,754.79	146,522.28
A1.On-going	24,294.84	19,775.25	15,341.96	8,076.06	3,025.57	70,513.68
Cost Over-runs	5,020.86	7,044.89	837.80	613.12	-	13,516.67
A2.Proposed	45.95	1,060.89	12,316.98	25,855.56	36,729.21	76,008.59
B. Locally-Funded Projects	16,283.84	22,721.66	18,437.93	16,719.99	16,077.46	90,240.88
TOTAL	40,624.63	43,557.80	46,096.86	50,651.61	55,832.24	236,763.14

Source: Department of Public Works and Highways, January 2007

3.5.2 Assistance from Donor Agencies

However, not all of the afore-mentioned financial allocation is intended for road projects of DPWH, but also for some soft-assistance that has been integrated into the ODA funding. Foremost of this would be funding for institutional capacity building under NRIMP 2 from 2008 onwards such as optimization of the RIMSS business improvement processes applications and the completion of on-going and proposed business improvements. The estimated cost of such soft-assistance is approximately P3.45 billion of which P2.24 billion is the loan amount. The World Bank loan appraisal for NRIMP 2 is currently on-going.

NRIMP 2 is also intended to continue NRIMP 1 activities in terms of the implementation of the Long Term Performance-Based Maintenance Contracts (LTPBMC) for asset preservation, possibly exploring other possible modalities. In addition, a Landslide and Road Slip Component is also being considered with the financial allocation proposed at P538.2 million.

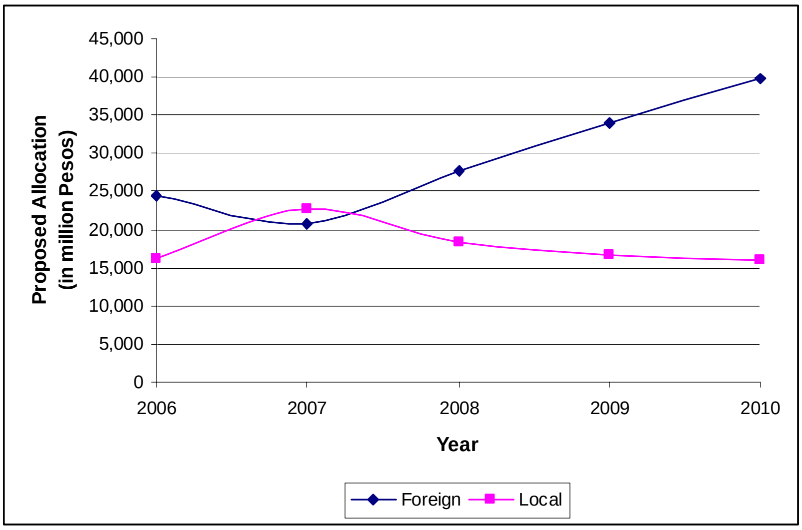


Figure 3.14 Proposed Allocation for Highway Projects, 2006-2010 Foreign and Locally-Funded

3.6 Issues in Road Maintenance

The current system for the conduct of road routine maintenance activities excludes road slopes and is therefore not included in the estimation of the EMK. Thus, an important issue would be how the cost of including road slope maintenance activities could be included/integrated into the EMK.

The second issue is how road slope-related maintenance activities would be funded given that, currently, the financial resources allocated by the national government through the GAA and MVUC are insufficient. That is, GAA funding for routine road maintenance has been suspended for a number of years and all road maintenance is being funded out of the MVUC. Even the release of road maintenance funds out of the MVUC has been very erratic and less than the Road Board-approved amount. This has resulted in the continued deterioration of the national road system.

The third issue is who will undertake the road-slope related maintenance activities given that the DPWH DEO does not even have the manpower to undertake routine maintenance. While the implementation of the “rationalization plan” may improve DEO’s manpower resources, this may only be in keeping with the targeted 90%/ 10% MBC-MBA allocation. Although DPWH is still piloting the LTPBMC modality, the results are still being evaluated and new modalities are being proposed that may further delay the privatization of the DPWH’s road maintenance activities.

CHAPTER 4

DEVELOPMENT OF ROAD SLOPE MANAGEMENT SYSTEM (RSMS)

4.1 General

The Study has been implemented in accordance with the scope of work described in Chapter 1 wherein the Road Slope Management System or RSMS for national highways of the Philippines is a major output. The RSMS is composed of the Inventory Survey Method, RSMS Database System and Technical “Guides” to support the implementation of the RSMS.

The outline of the RSMS is described in this Chapter.

4.1.1 Necessity of RSMS

The Study aims to improve the current low reliability of the traffic function of the national highways. The existing situation regarding road slope disasters and activities by DPWH has been analyzed and detailed in Chapters 2 and 3.

Around 2,700 RCDs resulting in about P2.5 billion in economic losses occur annually on national highways. However, the measures to prevent and mitigate these RCDs have not been sufficient due to the limited budget allocated and the lack of an effective policy to cope with RCDs.

This situation can be improved through the implementation of systematic and effective management by DPWH, the organization that is tasked to ensure the reliable traffic function and safety of the national highways.

Practical and successful risk management regarding RCDs together with the existing road maintenance systems such as PMS and BMS will improve the traffic function and safety of national highways as illustrated in Figure 4.1. This will contribute, not only in the reduction of losses (reopening cost, human lives lost, and detour cost), but also in indirect costs such as stagnation of social activities or the psychological impacts of RCDs.

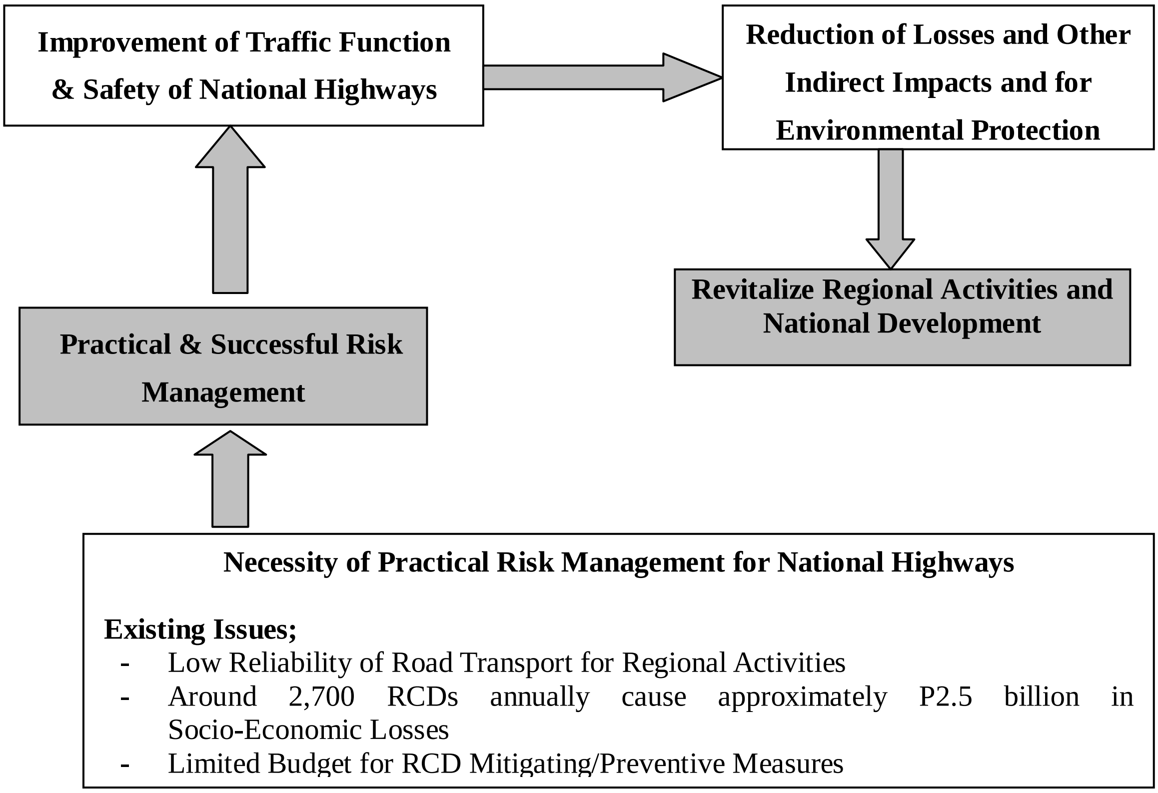


Figure 4.1 Purposes and Necessity of Practical Risk Management

4.1.2 Outline of RSMS Component

RSMS is composed of three major components listed below:

(1) Inventory Survey of road slopes on national highways
(2) Database System for road slopes on national highways
(3) Risk Management Planning

Three Volumes of Technical “Guides” have been prepared to support the implementation of the three major components of RSMS, as follows:

(1) Guide I: Risk Management Planning
(2) Guide II: Inventory Survey
(3) Guide III: Design of Countermeasures

As shown in Figure 4.2, the first step of the RSMS is the Inventory Survey of road slopes to collect information on risk levels, disaster magnitude, countermeasure alternatives, and feasibility of countermeasures for each slope. This information is imported to the RSMS

Database System to be utilized in Risk Management Planning.

(1) Inventory Survey; Data Collection regarding Road Slopes

(a) Preliminary Inventory Survey
- Identification of Disaster-Prone Slopes
- Disaster Frequency Assessment

(b) Detailed Inventory Survey
- Detailed Observation of Critical Slopes
- Countermeasure Planning and Cost Estimation (Sheet 4)
- Indicative Feasibility Assessment (Sheet 5)
- Encoding of Collected Slope Data

↓

(2) RSMS Database System
- Import/export function between inventory data and RSMS database
- Formulation of slope inventory (Integrated Table of Risk Management for Road Slope Disasters)
- Map Display

↓

(3) Risk Management Planning
- Slope Disaster Prevention Projects
- Risk Avoidance Management System

↓

Implementation of Road Management
- **Implementation of Slope Disaster Prevention Projects**
- **Risk Avoidance Management**

Figure 4.2 Structure of Inventory Survey

(1) Inventory Survey

The Inventory Survey is designed to be implemented by completing five types of templates prepared for two stages, the Preliminary Inventory Survey and the Detailed Inventory Survey.

The Preliminary Inventory Survey is undertaken to identify disaster-prone slopes and assess the disaster frequency of the slopes.

The Detailed Inventory Survey is carried out for selected critical slopes. In this stage, detailed slope observations, countermeasure planning and indicative feasibility assessments are undertaken and all information collected is encoded in the RSMS Database.

(2) RSMS Database Formulation

The RSMS database has the following functions:

(a) Import and Export Function between Inventory Data Sheets and the Database

The database can import and export text data from the inventory data sheet input in Excel.

The information provided in these Excel files is imported into the database after validation. Image files (digital photos, scanned sketches, etc.) are not imported but linked into the database.

(b) Formulation of Road Slope Inventory Table

The database can formulate road slope inventory tables (see Appendix 4-1 Integration Table of Risk Management for Road Slope Disasters). These inventory tables by region, district, road section and disaster type, etc. can be displayed and exported in Excel format.

(c) Map Display Function of RSMS

Basic map functions of GIS quality are available in the RSMS. From the RSMS database, slope locations are exported and displayed on the RBIA map with symbols that show disaster types and necessity for DIS.

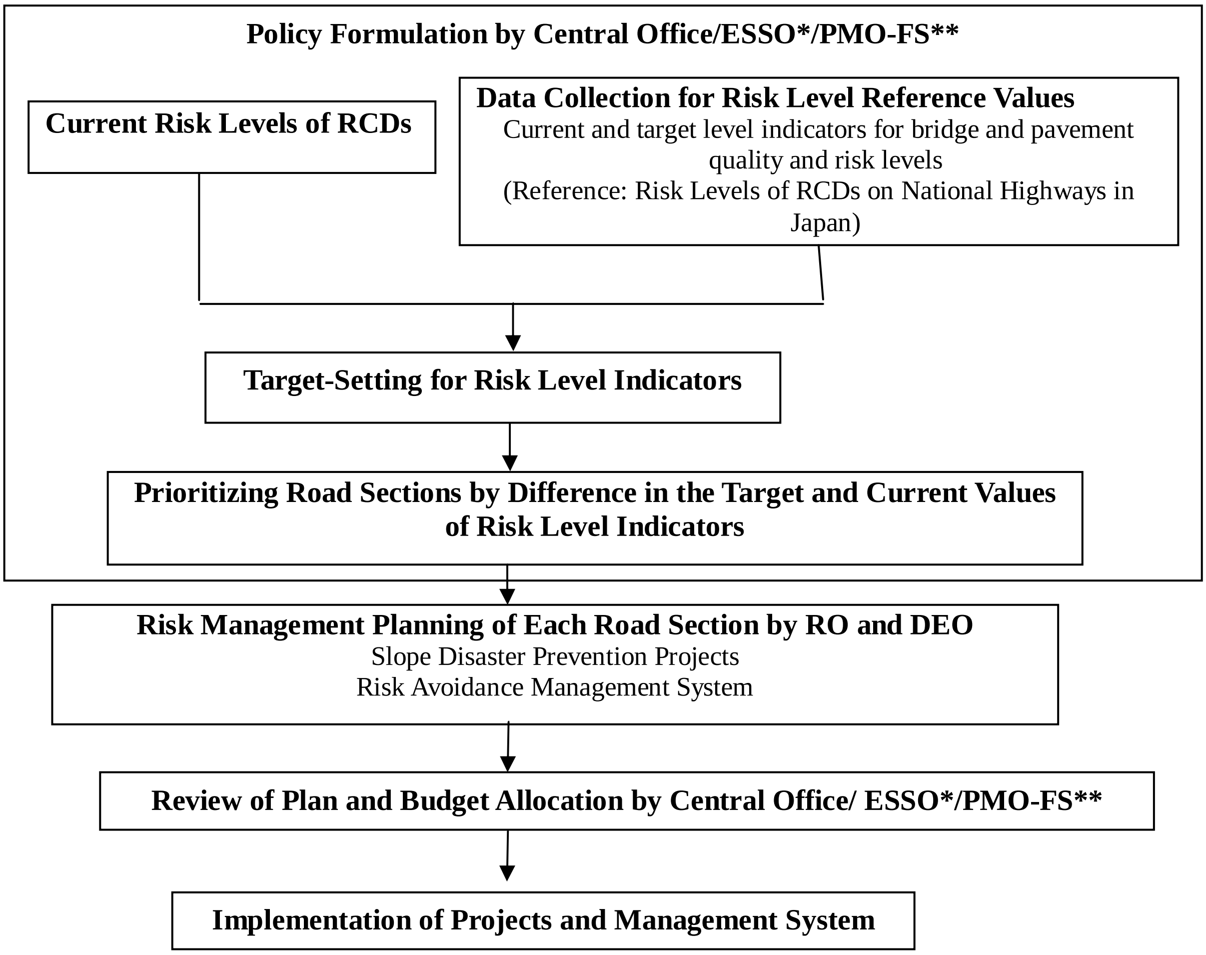
(3) Risk Management Planning

(a) Formulation of Slope Disaster Prevention Projects

The formulation flow for Slope Disaster Prevention Projects is shown in Figure 4.3.

Risk level and feasibility indicators which are obtained from the processed Inventory Surveys (IS)/RSMS database are used for risk management planning. The detailed procedure for risk management planning of RCD is described in Section 4.5 and Volume 2 of Guide II: Risk Management Planning.

The RSMS methodology mentioned above has been applied in the selected 332 km of national highways as a pilot activity and has been completed successfully as reported in Chapter 5. The procedures for each component of the RSMS are described in this Chapter and detailed in the three Guides.



* ESSO: Environment and Social Safeguard Office
** PMO-FS: Project Management Office - Feasibility Studies

Figure 4.3 Formulation of Slope Disaster Prevention Projects

(b) Risk Management

Risk avoidance measures such as early warning and traffic regulation systems are important components of risk management for RCDs. This should be undertaken according to DPWH's Calamities and Disaster Preparedness Control Plan (CDPCD) and Standard Operation Procedures (SOPs) based on Department Order No. 36 of 1988. The RSMS database and risk management policy (target level and priority ranking of road sections) should be used for the formulation of new, and revision of existing plans, risk avoidance management plans and operating procedures for specific road sections. The outline for this risk management is shown in Section 4.3.

4.2 Implementation System for RSMS

4.2.1 PDCA Cycle for RSMS

The Road Slope Management System (RSMS) will be implemented using the PDCA Cycle[1] as shown in Figure 4.4.

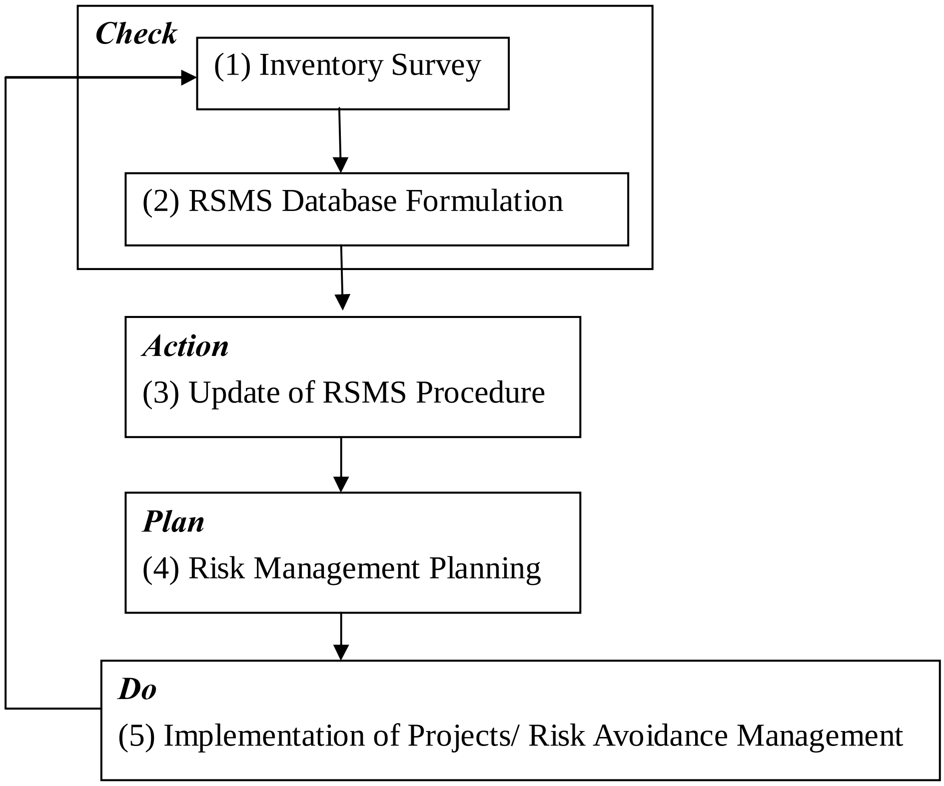


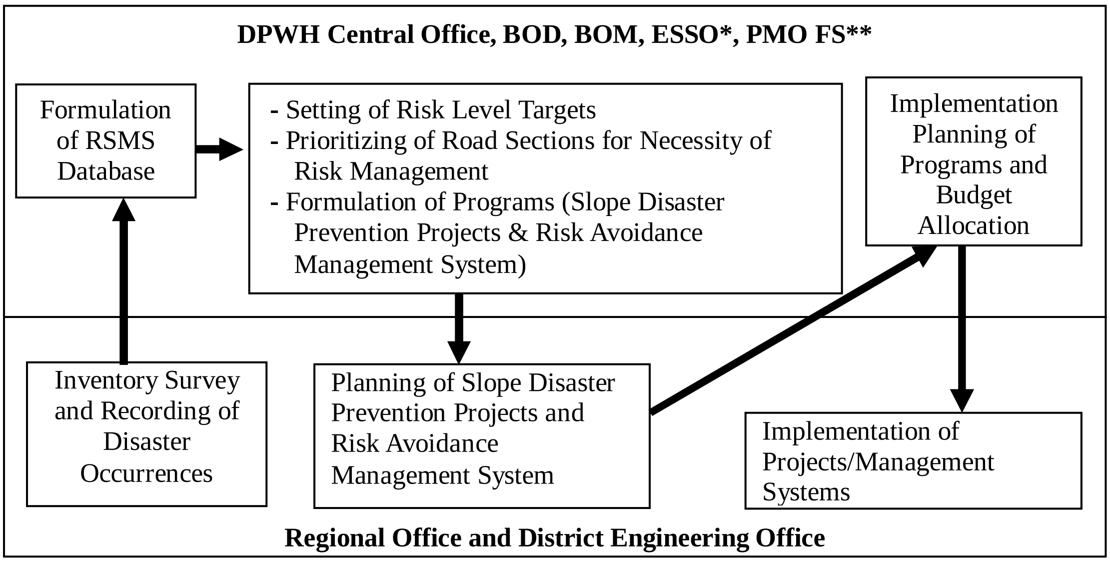
Figure 4.4 PDCA Cycle for RSMS

The PDCA cycle for the Road Slope Management System (RSMS) starts from "Check": Inventory Survey and RSMS Database Formulation. The update of the Management Procedure on Road Closure Disasters (RCDs) is established in this Study (Action). Risk Management Planning is established after completion of the first database on road disasters (Plan) and Implementation thereafter (Do).

4.2.2 Implementation System for RSMS and DPWH Unit Responsible

The work flow and organization responsible for risk management planning are shown in Figure 4.6.

[1] PDCA Cycle: Plan, Do, Check, Action Cycle defined in Project Management Body of Knowledge by Project Management Institute of USA (PMI)



ESSO: Environment & Social Safeguard Office

PMO FS: Project Management Office Feasibility Study

Figure 4.5 Implementation System for Road Slope Management

Risk management is undertaken by the office responsible as shown in Figure 4.6 and the role of each unit/organization is shown in Table 4.1.

The Planning Service (PS) is the lead coordination center for the RSMS database and risk management planning. BOM coordinates the planning and implementation of the Risk Avoidance Management System as is the current practice.

The planning units of the RO and DEO serve as the focal points for the inventory surveys and risk management planning, while the maintenance units coordinate the planning and implementation of the Risk Avoidance Management System and routine maintenance rehabilitation work as is the current practice.

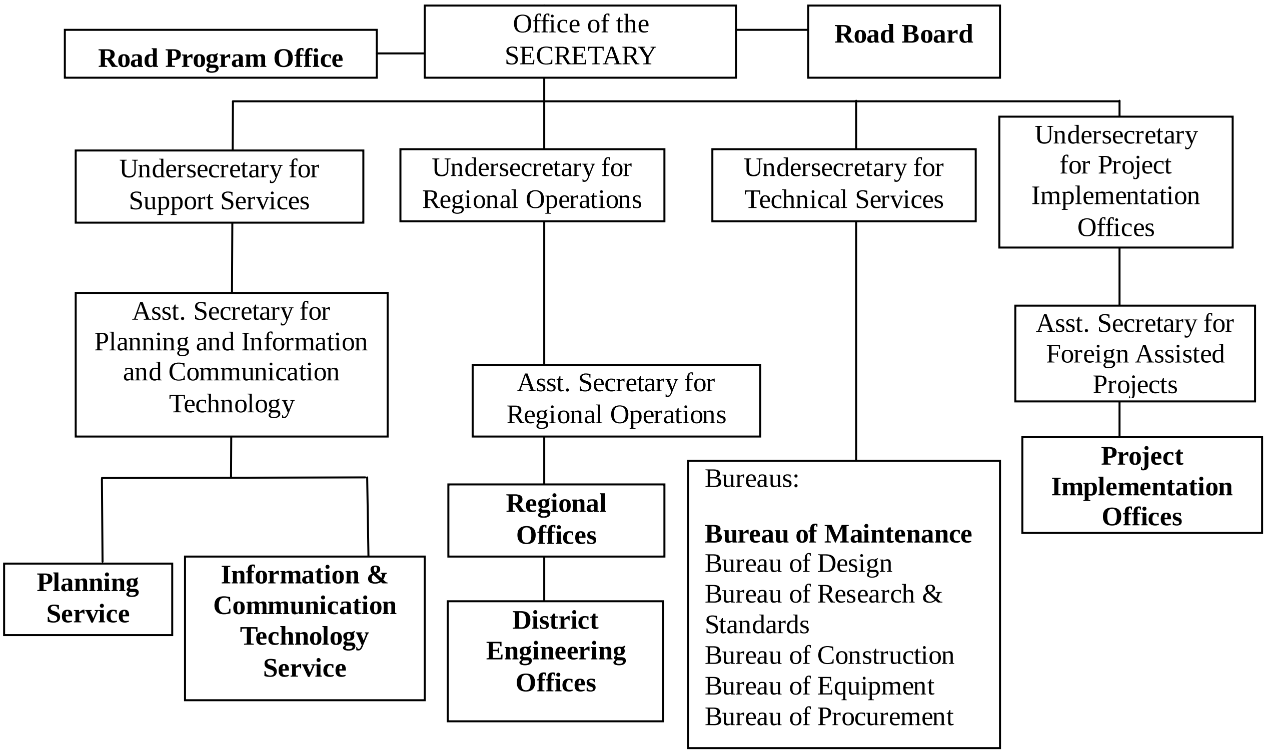


Figure 4.6 Organizations in Responsible DPWH for Road Slope Risk Management

Table 4.1 Role of Units in DPWH on Road Slope Risk Management

Office	RSMS Database	Disaster Prevention Works	Risk Avoidance Management Systems
Road Board	Final decision on financial coordination (maintenance)		
Road Program Office	Coordination with other road programs in the department		
Planning Service	Formulation of Database	Policy and program formulation for slope disaster prevention	
Information & Communication Technology Service		Data preparation for program formulation	
Bureau of Maintenance		Program formulation and implementation direction & support for routine maintenance	Program formulation implementation direction & support
Bureau of Design		Review of countermeasure plan and design	
Other Bureaus	Related technical service		
Regional Office	Approve inventory survey and disaster recording	Approve slope disaster prevention projects and routine maintenance system	Approve risk avoidance management system
District Engineering Office	Preparation of inventory survey and disaster records	Planning of slope disaster prevention projects and routine maintenance system	Planning of risk avoidance management system
Project Implementation Offices		Assistance on project/ system implementation by request	

4.3 Inventory Survey Method

The inventory survey method designed and prepared in this Study has been revised and finalized during its application in the pilot Inventory Survey of sections covering 332km of national highways.

The detailed procedure for the inventory survey method is described in Volume III: Guide II Inventory Survey and Risk Assessment. The outline of the said procedure is as follows;

4.3.1 Purpose of the Inventory Survey

The general purpose of the Inventory Survey is to collect information regarding road slopes on national highways in order to establish reasonable risk management planning and actual risk management. Specific purposes of the Inventory Survey are listed below:

(1) Identification of disaster prone slopes;
(2) Assessment of Potential Frequency of Road Closure Disasters (FRCDp) involving slopes;
(3) Disaster magnitude of slopes;
(4) Preliminary preventive countermeasure planning and cost estimation for slopes;
(5) Indicative feasibility assessment for preliminary countermeasures; and
(6) Encoding of collected information in a RSMS Database System.

4.3.2 Flow and Major Output of Inventory Survey

The inventory survey is composed of a Preliminary Inventory Survey (PIS) and a Detailed Inventory Survey (DIS) as shown in Figure 4.7. The survey is carried out by filling out six types of Inventory Formats; Sheet 1 to Sheet 6 as shown in Table 4.2.

(1) PIS; Screening of Survey Slopes (sheet 1)

All slopes which have road closure disaster risks along national highways are checked and surveyed. The criteria for the screening of slopes to be surveyed in the PIS are identified from view points of geometry of road slopes that have RCDs risks (refer to Guide II, Chapter 2). According to the criteria, slopes to be surveyed are selected in the first work of PIS. Selected slopes are recorded in “Sheet 1” with the following basic slope information:

(a) Road name, Road section ID
(b) Disaster type
(c) Photographs of the slope

(2) PIS; Disaster Frequency Assessment and Selection of Slope for DIS (sheet 2)

Actual Frequency of Road Closure Disaster (FRCDa) is recorded and Potential Frequency of Road Closure Disaster (FRCDp) is estimated automatically by filling in inventory Sheet 2.

FRCDa and FRCDp are defined as follows.

FRCDa: Actual frequency of road closure disaster per year. (nos. per year)

FRCDp: Potential frequency estimated in PIS (nos. per year)

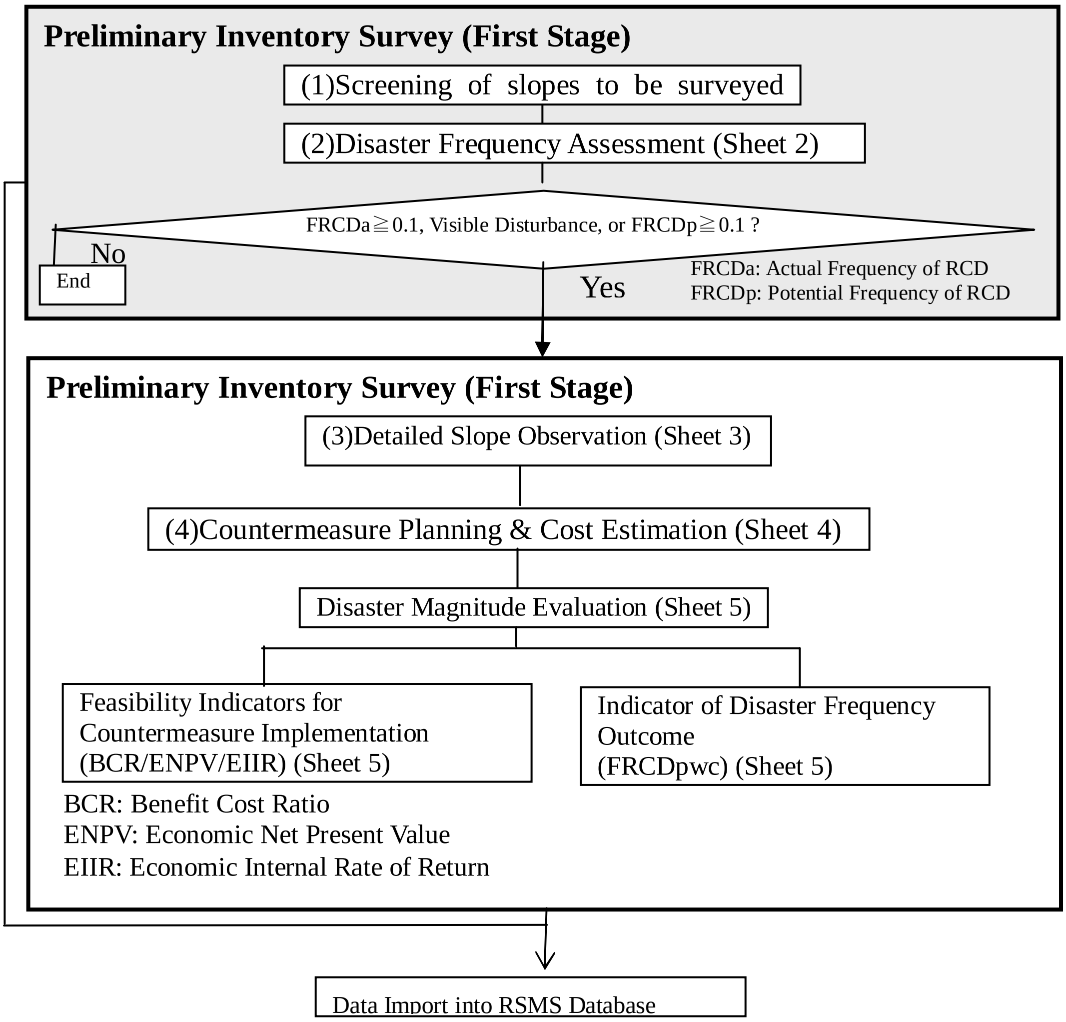


Figure 4.7 Flow of Inventory Survey and Risk Assessment

Slopes to be surveyed in DIS are selected by the following criteria.

Selection Criteria for DIS: FRCDa≧0.1 , Visible disturbance is present, or FRCDp≧0.1

This criterion indicates that slopes which have FRCDp more than once in ten years should be selected for DIS.

(3) DIS; Detailed Observation (Sheet 3)

The first stage of DIS is detailed observation of the slopes that are recorded on Sheet 3, where hazard and risk condition of slopes with basic road structures are shown in a front view and cross sections. Through this work, the dimensions and other basic information needed to estimate the disaster magnitude and to plan countermeasures are identified as shown in Figure 4.8.

(4) DIS Countermeasure Planning and Cost Estimation (sheet 4)

Considering the detailed observation of the slopes, preventive countermeasures are planned with rough cost estimations on Sheet 4 as shown in Figure 4.9.

In Guide II, three countermeasure alternatives are indicated as follows.

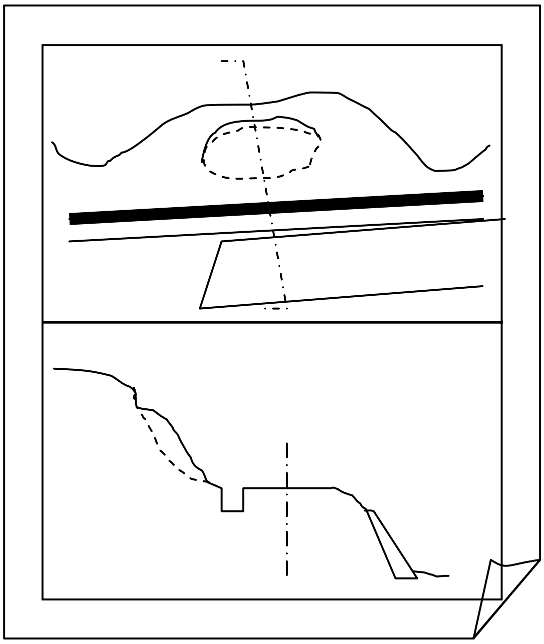
(a) Alternative I: Permanent countermeasures

(b) Alternative II: Limited reduction of probable disaster frequency or magnitude

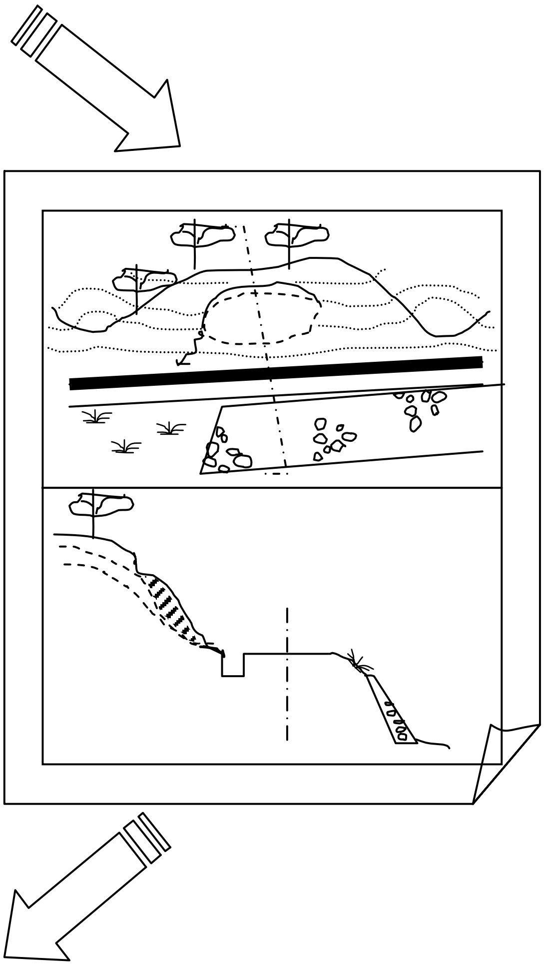
(c)Alternative III: Temporary measures to control disaster occurrence

(a) Alternative I: Permanent countermeasures and (b) Alternative II: Limited reduction of probable disaster frequency or magnitude

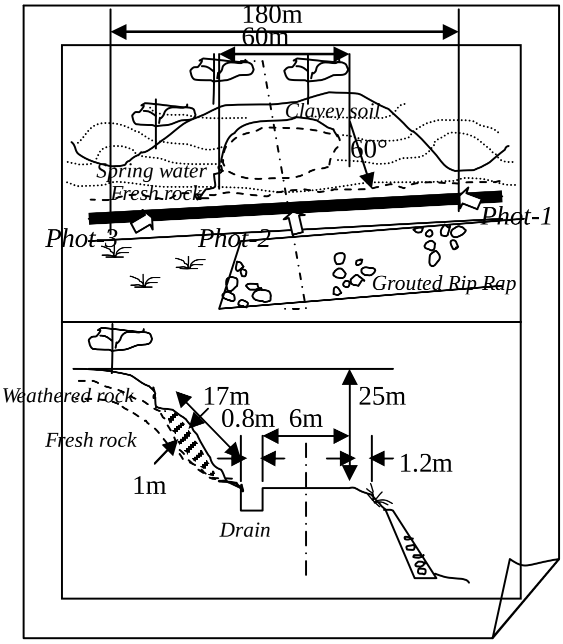
can be applied in a multi-year maintenance program, and (c) Alternative III: Temporary measures to control disaster occurrence can be utilized in daily maintenance activities.



Start drawing the sketch:
- Draw the road of surveyed section.
- Draw the existing structures, geometry and actual road slope conditions.



Continue the sketch:
- Draw the contour line.
- Draw the detailed information of the existing structure, geometry and geological structure of the road slope.
- Draw vegetation.



Finish the sketch:
- Record dimensions of the object.
- Record information of the existing structures, geometry, geology and road slope conditions.
- Record the location on photographs.

Figure 4.8 Output Image of Completing Sheet 3: Sketch

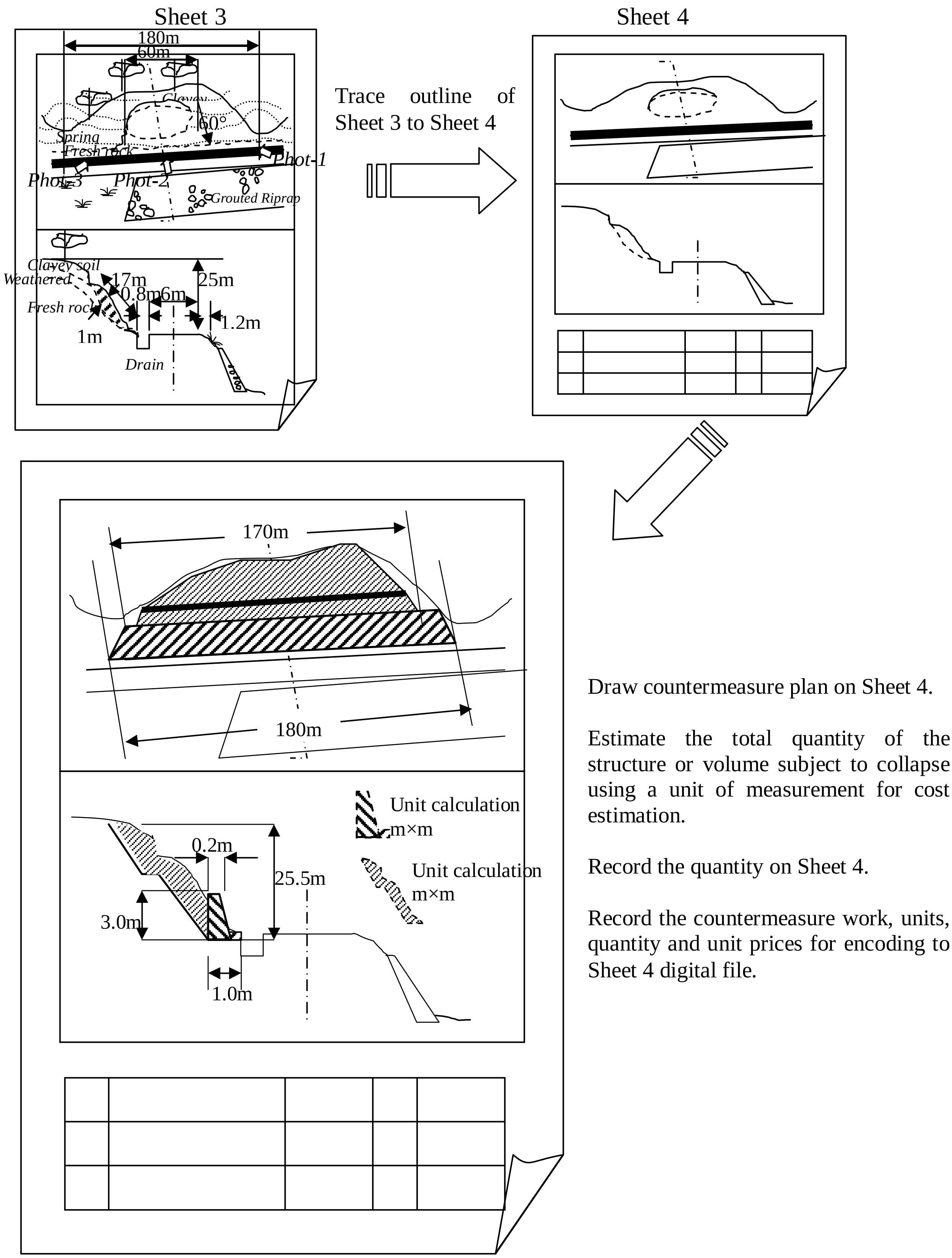


Figure 4.9 Procedure of Countermeasure Planning

(5) Indicative Feasibility Assessment (Sheet 5)

The indicative feasibility assessment (Sheet 5) is composed of the following three parts which are conducted as shown in Figure 4.10.

(a) Disaster Frequency and Magnitude

(b) Annual Losses without Countermeasures

(c) Feasibility Indicators of Countermeasures

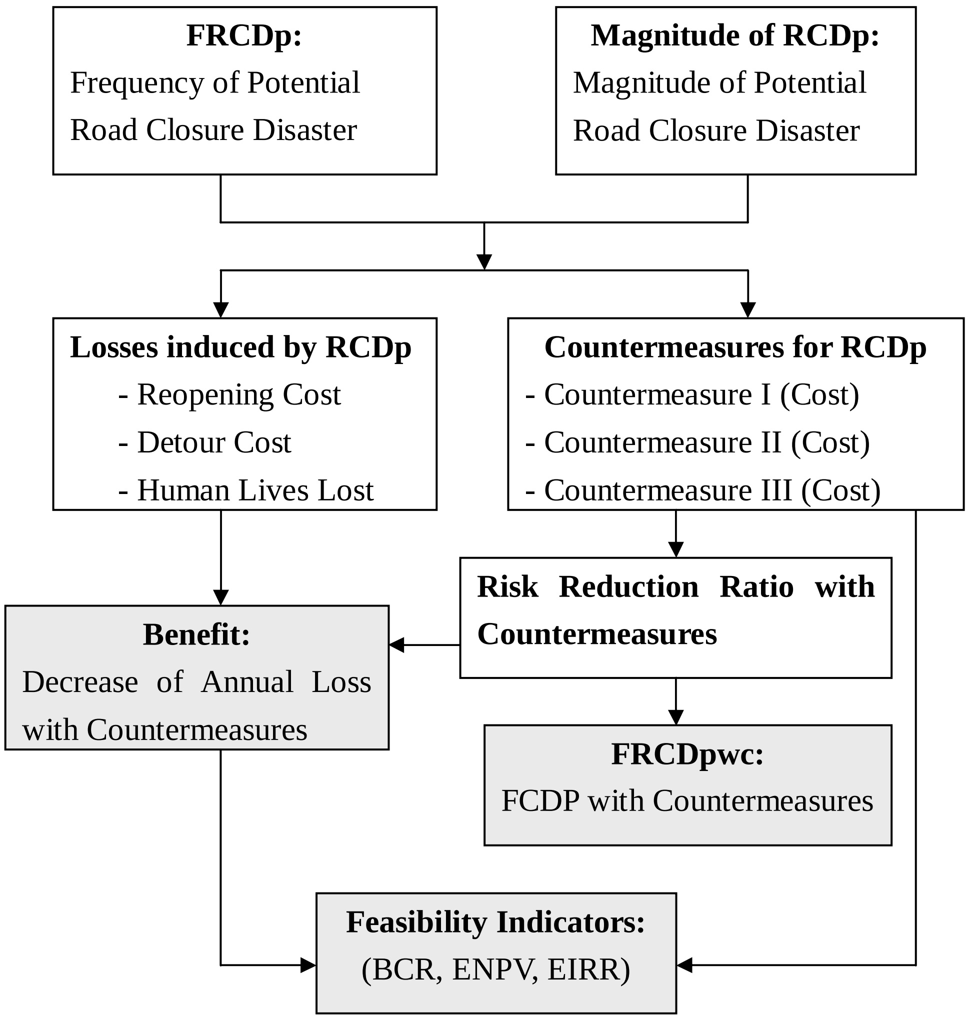


Figure 4.10 Framework for Indicative Feasibility Assessment

(a) Potential Disaster Frequency and Magnitude

Disaster frequency was already assessed on Sheet 2 and linked in this Sheet 5. Estimation of disaster magnitude such as the accumulated soil/ rock volume on the road per

RCD and length of road closure site is evaluated based on 'Detailed Observation of DIS' and entered on the Sheet 5.

(b) Potential Annual Losses without Countermeasures

Annual reopening cost, annual value of human lives lost, and annual detour cost can be calculated on Sheet 5. For this estimation, coefficients, unit costs, and expressions are prepared as shown in "Guide II Inventory Survey and Risk Management" by analysis of past disaster records.

(c) Feasibility Indicators of Countermeasures

The following indicators can be calculated for the three countermeasure alternatives in Sheet 5 by filling out the Risk Reduction Ratio (RRR).

Risk level outcome indicator:

Potential Frequency of RCD with Countermeasures (FRCDpwc)

Feasibility indicators:

Benefit/ Cost Ratio (BCR), Economic Net Present Value (NPV), Economic Internal Rate of Return (EIRR)

4.3.3 Formats of the Inventory Survey

The following six types of Inventory Formats are prepared to collect information regarding road slopes. Their objectives and outputs are summarized in Table 4.2 and each format is shown in Appendix 4-1**.**

(1) Sheet 1-General Information
(2) Sheet 2-Selection of Detailed Inventory Survey
(3) Sheet 3-Sketches
(4) Sheet 4-Planning of Countermeasures
(5) Sheet 5-Indicative Feasibility Assessment
(6) Sheet 6-Disaster Record

As described in 2.2, disaster types occurring on national highways are classified into the following seven types:

(1) Soil Slope Collapse "SC", (2) Rock Slope Collapse "RC", (3) Landslide "LS", (4) Road Slip "RS", (5) Debris Flow "DF", (6) River Erosion "RE" and (7) Coastal Erosion "CE".

Since the seven disaster types involve different failure modes, mechanisms, and factors contributing to the slope failures and therefore require different rehabilitation measures, when completing Sheets 2 and 5, different formats are used considering the characteristics of each disaster type.

Table 4.2 Inventory Format

	Sheet No Sheet Name	Content of Work	Output
Preliminary Inventory	**Sheet 1** **General Information**	Screening/ identification of slopes to be surveyed	- Location - Disaster type - Photograph
Preliminary Inventory	**Sheet 2** **Selection of Slopes for DIS**	-Disaster frequency assessment - Selection of Slopes for DIS	- FRCDa - FRCDp - Evaluation of DIS necessity
Detailed Inventory Survey	**Sheet 3** **Sketches**	-Including hazard area, failure mechanism, risk object situation	-Front view of slope -Cross section of slope
Detailed Inventory Survey	**Sheet 4** **Planning of Countermeasures**	- Planning of countermeasure alternatives	- Layout of countermeasure alternatives - Cost of countermeasure alternatives
Detailed Inventory Survey	**Sheet 5** **Indicative Feasibility Assessment**	-Evaluation of disaster magnitude - Evaluation of annul loss - Assessment of outcome and economical feasibility	- Disaster magnitude - Potential annual losses, - Benefits from countermeasures - FRCDpwc - Feasibility indicators: BCR/ENPV/EIRR
Sheet 6 **Disaster Record**		- Record of past disasters - Additional records when disasters occur after the Inventory survey	- Disaster occurrence date - Disaster magnitude - Damage: RCD days, reopening cost, persons killed
Integrated Table of Risk Assessment for Road Slope Disaster		- The table is formed by importing sheet 1 through 6 into the RSMS database.	- Major information collected through the Inventory Survey

4.3.4 Features of the Inventory Survey

As described above, the inventory survey method proposed in the Study have the following features.

(1) Estimation of Potential Frequency of Road Closure Disaster (FRCDp)

Because this inventory survey is designed to be utilized for road slope disaster management, the focus is on the evaluation of the hazard conditions that could cause slope disasters serious enough to disturb the road traffic function. Therefore, assessment of hazard conditions shall be quantitative.

The concept of “Frequency of Road Closure Disasters (FRCD)” is introduced to quantify the hazard condition of the road slopes. The unit of FRCD is the number of occurrences per year (nos. per year).

For example, FRCD=1 shows that road closure disasters occur once a year.

FRCDp; Potential Frequency of Road Closure Disaster is the major indicator to estimate hazard level, risk level and feasibility indicators throughout the inventory survey. The function of FRCDp for the inventory survey is shown in Figure 4.11.

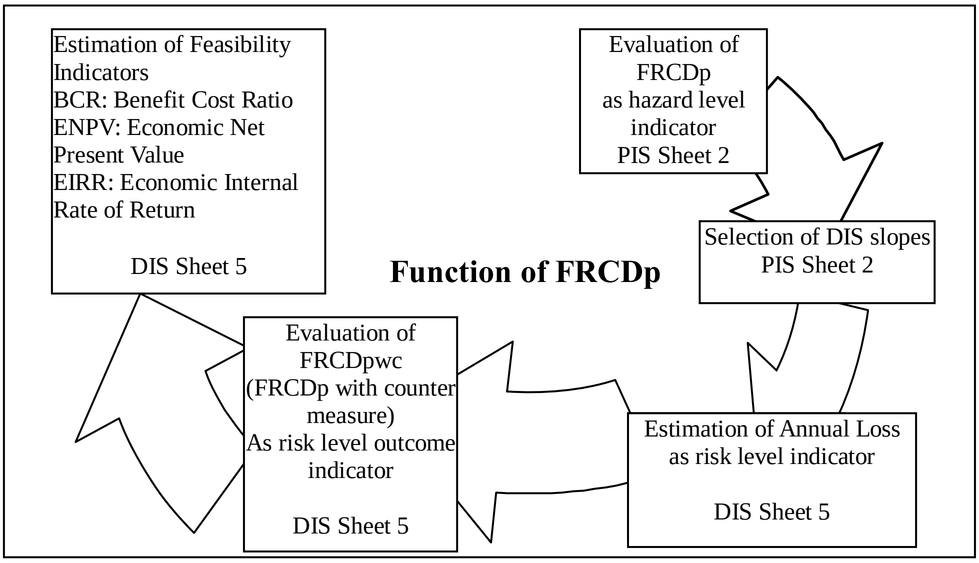


Figure 4.11 Function of FRCDp for Inventory Survey

As shown in the figure, FRCDp is used in the following estimation and decisions.

(a) Criteria to Select Slopes for DIS

(b) Estimation of Annual Loss

(c) Evaluation of FRCDp with Countermeasures

(d) Estimation of Feasibility Indicator

The following factor groups are applied to evaluate FRCDp, referring mainly to the Japanese slope inventory format established in 1996, which is also commonly used internationally.

1) Geometry of Slope; height of slope, gradient of slope, etc,

2) Surface condition; vegetation ratio, surface material, etc,

3) Disturbances, existence of deformation, erosion, etc,

4) Existing countermeasure's effectiveness

Different sub-items for the seven disaster types are given considering failure mechanism and factors contributing to slope instability. Evaluation scores for each item have been calculated by "Multiple Regression Analysis with Dummy Parameter" using survey data from 250 km of road sections that were collected in the pilot Inventory Survey. The detailed procedure is given in Appendix 4-3.

(2) Indicative Feasibility Assessment

The Indicative Feasibility Assessment is the final result of the Inventory Survey. It is difficult to conduct a feasibility assessment in this kind of an inventory survey. But by introducing the concept of FRCDp it is possible for economic loss and countermeasure effectiveness to be estimated as mentioned above. This provides important information for target setting of risk level and economically effective policy-making for road slope management. The procedure for the Indicative Feasibility Assessment is as follows:

The survey data on the detailed hazard conditions is recorded on Inventory Format Sheet 3 and the countermeasure alternatives to prevent or mitigate the risk level of road disasters are planned on Sheet 4 in DIS.

Indicative Feasibility Assessment is carried out on Sheet 5 using all the information obtained during the Inventory Survey with additional information such as 'length of detour road', 'AADT: Annual Average Daily Traffic', average vehicle operating cost, and risk reduction ratio realized by implementing the countermeasures.

On Sheet 5, the following indicators for policy making are estimated:

Risk Level Indicators

- Annual loss due to RCD
- Annual reopening cost
- Annual value of human lives lost
- Annual detour cost
- AL: Annual loss of reopening cost, value of human lives lost, and detour cost

Risk Level Outcome Indicator

- FRCDpwc: Potential Frequency of RCD with countermeasures (RCD per year)

Feasibility Indicators of the Countermeasures

- BCR: Benefit/Cost ratio (ratio)
- ENPV: Economic Net Present Value (pesos)
- EIRR: Economic Internal Rate of Return (percentage)

(3) Evaluation by Disaster Type

As described in Chapter 2 and 4.3.3, slope disasters along the national highways in the Philippines are classified into seven types; (1) Soil Slope Collapse “SC”, (2) Rock Slope Collapse “RC”, (3) Landslide “LS”, (4) Road Slip “RS”, (5) Debris Flow “DB”, (6) River Erosion “RE”, and (7) Coastal Erosion “CE”

Differing inventory formats were designed for the various disaster types considering their individual characteristics of failure mode and their failure mechanisms.

4.4 Development of Road Slope Database System in RSMS

4.4.1 Design Concept

The Study Team reviewed the RBIA's basic concepts and how this has been used by the engineers of the DEOs, and how they had felt about the RBIA. This was done by reviewing document/manuals, interviewing MIS personnel, and carrying out the questionnaire survey for the DEOs. The purpose of the survey was to help establish the basic design of the RSMS database application system consistent with RBIA's database. As a result of the discussions between the Study Team, Counterpart Team and DPWH JICA Expert, the basic design and development policy for RSMS database application system was established. Although the answers to the questionnaire survey were delayed, the results supported the design policies described below. The results of the survey of the RBIA database system including the questionnaire survey are given separately in the Appendices.

The following elements were considered, which affected the application design:

The database system is to be utilized by DPWH. In the future, DPWH should be able to plan and coordinate the needed system enhancements or integration into another system such as RBIA.

The database system is to be designed from the viewpoint of the users so that it can provide them with helpful functions and information.

These elements led the Study Team to the following basic design/development policies.

a) To design/develop a compact database application system
‘Compact’ does not mean that the quality of the new database application system would be low. Although it is not a state-of-the-art system, it nevertheless provides useful functions. In addition, this database system is definitely stand-alone and independent of the existing applications such as RBIA. A specific hardware (server PC) has been newly installed.

b) To design/develop an easy-to-use system for the users
Users have less appreciation if the system's operation is too complicated. Especially for beginners, a thick manual full of jargon is not useful. User-friendly interfaces and easy-to-understand manuals are the basis for the application system.

c) To adopt a standard tool
The standard software tool (ex. Oracle, SQL Server for database, Visual Basic for

programming language) or system (Windows 2000 or higher OS) was adopted whenever possible. This reduces the maintenance time/cost and the cost for future system enhancements, if any. The selection of the software tools was not specified by the Study but was left to the local subcontractor since this gave more software firms a chance to join the bidding process. Only one limit was set by the Study Team, that being that Microsoft Access will not be considered for the Relational Database Management System for RSMS database application since it had been developed originally as a database system for a single user. Up to now, its use as the Relational Database Management System for enterprise application has not been superior to other software such as Oracle.

These three points are important. However, they are not specific to the RSMS database application system. These points are quite valid for general application when designing database application software of small-to-medium size. The Region and/or District Engineering Offices of DPWH are essential to the daily highway maintenance activities in cooperation with the Central Office. The Study Team considered the following factors, which were specific to RSMS.

1) How the information acquired in-situ by the Region and/or District Engineering Offices is delivered and registered in the database?

2) Who will access and manipulate the data?

3) What kinds of parameterized queries are issued to the database and by whom? In other words, what kinds of questions are typically asked and by whom?

4) How are the answers to the queries utilized? If referenced by the members of the Region and/or District Engineering Offices, how is the information to be delivered?

In addition, initially the RSMS database application system was intended to be used only by the users in the DPWH Central Office. This was decided based on information obtained from the Study Team's survey on RBIA. The RBIA application system adopted two methods explained below for distant users.

1) Server-client application utilization via WAN. This was adopted by the Regional Offices and some of the District Engineering Offices in order to access the RBIA database. However, the network traffic was too heavy to provide sufficient response speed for the user.

2) Distribute copies of the database to the remote offices. Although this did not consider

WAN availability in the remote offices or communication speed. Additionally, the license fee for the database application system should be considered. In RBIA's case, it cost too much. In addition, the updates of the information can not be accessed until the latest version is sent from the DPWH Central Office.

Considering the above, the Study Team decided on the process using Excel files as a communication tool between the distant offices and the RSMS database in the server located in the DPWH Central Office. Moreover, the map display of the stored data in the database seemed indispensable for the spatial understanding of road disasters.

Hence, the RSMS database application system was designed to have three components.

1) Excel files for communicating data and information between the Central Office where the database server computer is located and the remote offices.

2) The Relational Database Management System, which is the core of the RSMS database application system; and

3) A map display system for visual understanding of the stored information.

Brief explanations of each of the three components are given below.

(a) Process Using Excel Sheets

Basically, Excel files are used as follows:

Step.1

The slope inventory survey is carried out by members of the Region or District Engineering Offices. Survey Sheets specific to the survey type are used for recording the information acquired at the survey sites. Photos are also taken. The information is input into Excel worksheets at the Regional or District Engineering Offices. The Excel files are sent to the Central Office via email, etc.

Step.2

At the Central Office, the Excel files are first stored in specified folder(s) in a disk attached to the database server PC. The operator checks the contents of the Excel sheets, as to whether all mandatory information has been recorded with valid values. No checks are performed regarding the geological or civil engineering aspects. If a problem is found, this is reported to the relevant member of the Regional or District Engineering Offices for resolution. The Excel files with problems are sent back if necessary. After validation, the information recorded in the Excel files is imported into the database. Image files (digital photos, scanned sketches, etc) are not imported into the database.

Step 3

At the Central Office, the accumulated inventory survey data in the database will be analyzed from the viewpoint of risk management. The functions of the database application such as parameterized queries will help the decision-making processes be more effective and faster. A list format or chart will be produced in the Excel files and sent to each Regional Office in order to explain the management plan or to collect comments from the relevant offices. Feedback will be sent back to the Central Office.

This process is repeated as necessary between the Central Office and the Region/District Engineering Offices. The RSMS database application system had to be designed so that these processes could be handled smoothly in daily operation.

(b) Database Application

There was no other choice than the Relational Database Management System for the core of the RSMS database, considering that it had been widely accepted in the various application systems from those using mainframe computers to those using small PCs. All of the user operations should be done via simple forms or menus. To maintain the security of the data and to avoid data deletion, a password and privilege-based user management was considered. In addition, a database backup and restore function requiring only a simple form-based operation was considered.

(c) Map Display Function

At the conceptual design stage, there was no intention to include GIS software in the RSMS database application. Instead, clickable maps were considered in order to achieve the basic map functions such as selecting an area or a road of interest, display the locations of the survey points, etc.

The figure below shows the application diagram, which is comprised of the output from the conceptual design stage. The functions of each module are also described in this report.

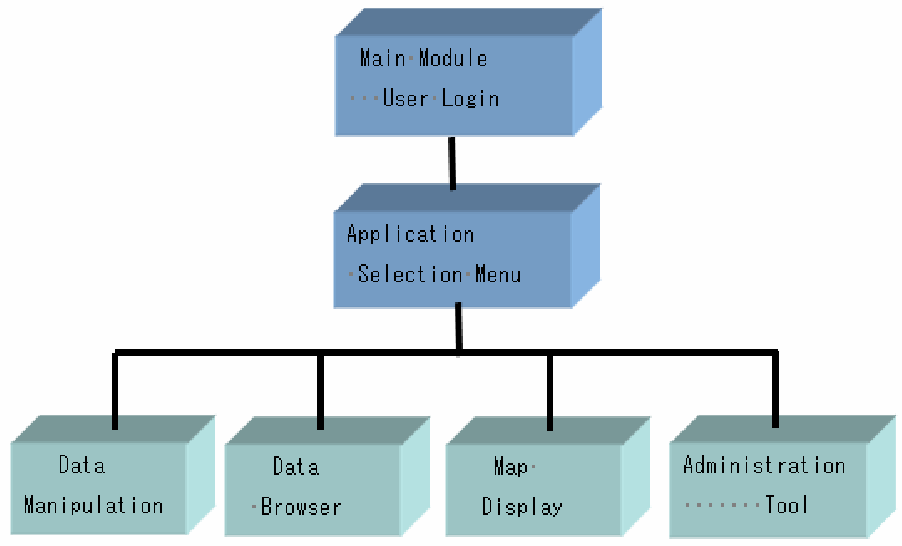


Figure 4.12 Diagram of the Application Modules

For each component of the application, the required functions are given below.

+ Main Module (Entry Point)
    * User log-in control with password
    * Menu of sub-modules
    * Online Help
+ Data Manipulation Module
    * Only authorized users can use this module
    * Add new data using forms
    * Add new data from Excel files (data import)
    * Modify data using forms
    * Remove (Hide)/Restore data
    * Delete removed data
    * Online Help

      Note 1.

      'Remove' means that data is not deleted from the database. Instead, a 'Removed' flag is set to the data. Removed data can be 'restored'. The removed data are outside the scope of the query. On the other hand, 'delete' permanently deletes data that was previously 'Removed' from the database.
+ Data Browser

* Parameterized Query
* The results of the query are displayed in the form
* The results of the query are displayed in a list and can be exported into Excel
* The results of the query can be printed

+ Map Display Module
  * Display clickable maps. The maps have a hierarchical structure from 'A Map of the Philippines' to Regional maps, with 2 or 3 levels
  * The survey points on the national highways are displayed on a map and can be selected by clicking the area
  * The survey sheets for the selected points are displayed on the PC monitor
  * The displayed survey sheets can be printed and exported into a user-specified folder
  * New survey points can be added into the map by simply modifying the HTML source using a text editor
+ Administration Module
  * Change the users own password (all type of users)
    This is the only function within the Administration Module that non-privileged users can access
  * Reset the password of other users
  * Register/Delete users
  * Start/Shutdown the database
  * Backup/Restore the database
  * Online Help

The outline of the database table structure was part of the conceptual design. Relationships between the tables and constraints were investigated since the columns of the tables might be changed due to changes in the inventory survey sheets. The figure shown is a schematic display of the database table definitions.

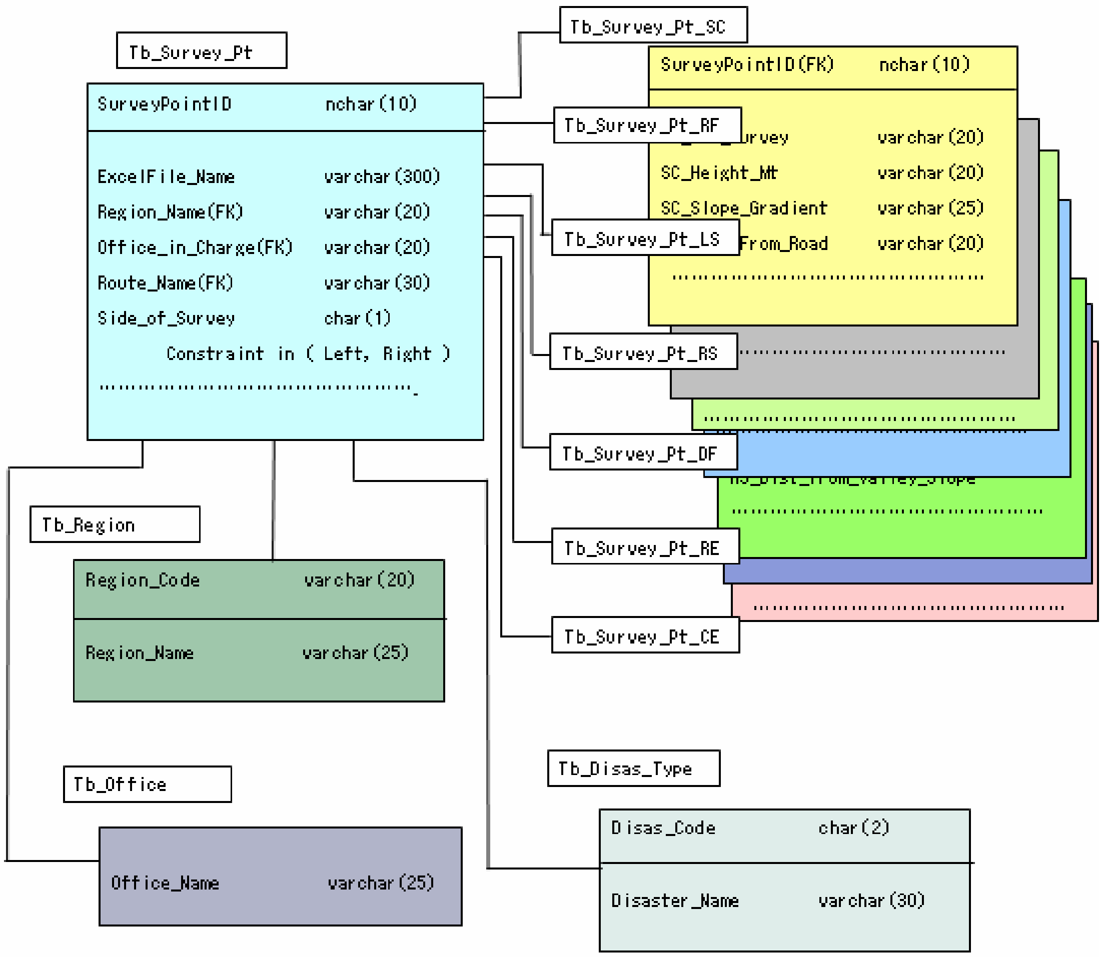


Figure 4.13 Structure of the Database

Given below is part of the table definition specifications.

Table Name		Tb_Survey_Pt
Description:		Table of Survey Points
Columns		
	Name	Survey Point ID (PrimKey)
	Type	nchar (10)
	Name	ExcelFile_Name
	Type	nvalchar (300)
	Constraint	NotNull, unique
	Description	Filename of corresponding excel sheet
	Name	Region_Name
	Type	nvarchar(30)

Constraint	NotNull
Foreign key	Tb_Region(Region_Name)

The outputs from the conceptual design played a fundamental role in the detailed design and program development.

4.4.2 Program Design and Development

GeoSpatial Solutions, Inc was selected as the subcontractor based on the results of the bidding. They have reviewed the conceptual design and started the detailed design and program development. The Study Team asked them to review the basic development policies mentioned in the previous section.

The subcontractor procured the following software and hardware to develop the application system after the Study Team gave their approval.

* IBM X206 Server PC with additional memory and disk storage.

* Microsoft Windows Server 2003 with 5 CALs (client access licenses) as the server OS.

* Microsoft SQL Server 2005 Standard Edition with 5 CALs (client access licenses) as the Relational Database System

The detailed design conformed to the conceptual design except for the map function. For the map function, the subcontractor proposed to use a GIS application which was already installed at the DPWH Central Office. The Study Team and DPWH accepted the proposal after discussion with the subcontractor.

After the three month period for application development, the first version of the RSMS database application system was released at the end of October 2006. Before the release, user tests were performed at the project office and DPWH Central Office. Some bugs and inappropriate terminologies were pointed out and modification requests were submitted. Most were solved for the first release. However, the other requests, especially on program enhancement, were implemented in a later version.

For example, in the first release, the user had to register the inventory survey points on a GIS map manually. There was no automatic way to import the position information of the survey points from the RSMS database into the GIS application. Users felt greatly inconvenienced because of having to register the survey points manually. One of the barriers that hindered the automatic data import was the fact there was no direct data interface between GIS and the database. Another was that there was no coordinate information (Longitude/Latitude or XY) of the inventory survey points in the database. The Study Team advised the subcontractor to use an intermediate file, which was an output from the database and acted as input to the GIS. This was not a totally automatic method, which would have been preferred but rather, a semi-automatic procedure in a sense. This got rid of the first barrier. Even if not a perfect automatic procedure, it saved on user’s operation time. As for the database not having the coordinates of the survey points, the Study Team proposed to use the starting kilo-post and the start meter of the survey point to calculate the XY coordinates using linear interpolation since the XY coordinates of the kilo-posts can be obtained from the GIS. The subcontractor contrived a more sophisticated way considering the basic ideas shown above, and the enhanced Map Display application was implemented.

A two day user training session was held by the subcontractor at the project office in the second week of November 2006. The members of the Study Team, DPWH Counterpart Team, and DPWH MIS personnel attended the training. A user’s manual was prepared by the subcontractor and published in the Interim Report. The manual and the training were of much help to the users’ understanding of the operation of the RSMS database application system. The manual was revised to reflect the enhancements added to the application system after the first release and it is included in the guide to the Draft Final Report.

The next figure shows a form from the RSMS database application system. For example, the data browser form provides the users with forms similar to the inventory survey Excel sheets. Therefore, the users feel no difficulty in operating the application program.

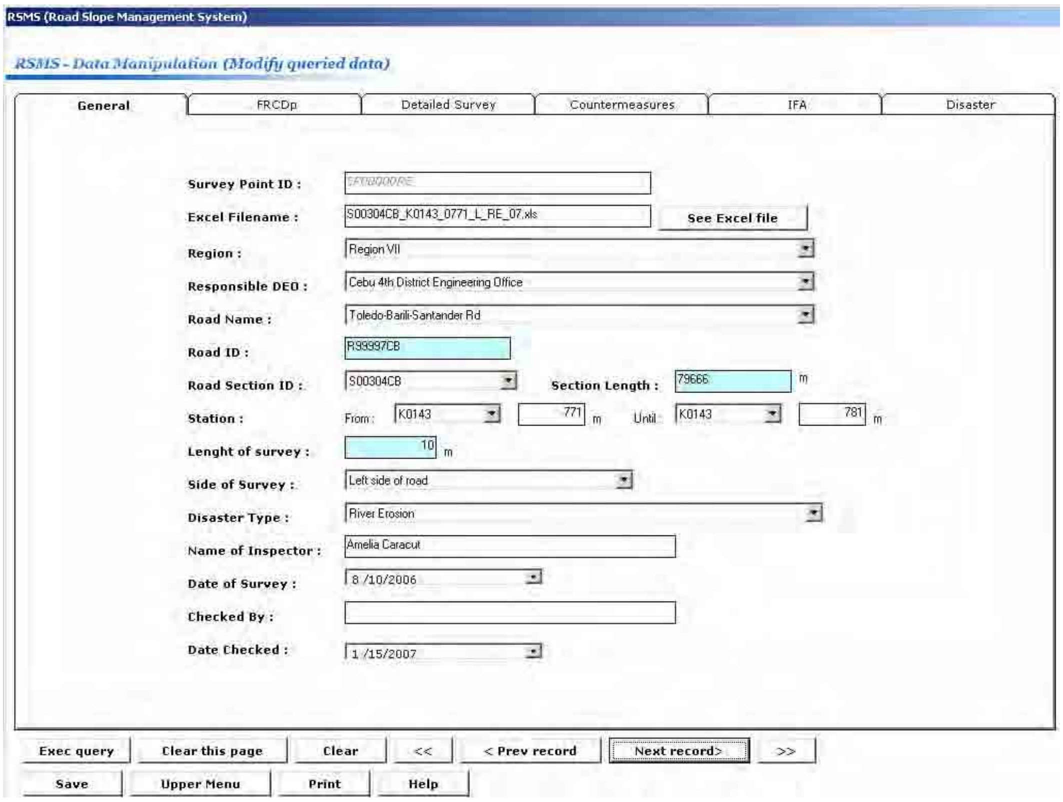


Figure 4.14 RSMS Database Application Data Browser Form

The input boxes on the form were aligned aesthetically so that they will be easy for the user to understand. In addition, simple and intuitive words or phrases were drawn on the buttons, such as ‘Upper Menu’.

Because the user interfaces relating the browser and the query, such as the browser module form shown above or the form which displays the data retrieved from the database shown below are the most commonly used interfaces they were discussed at length and have been improved as much as possible since the conceptual design phase.

The following figure displays the form displayed when a user retrieves all the data from the database. In addition, the user can filter the data by issuing a query. A query is a kind of search condition such as ‘List the survey points in Region X where the most probable type of disaster is landslide’. The user can use the following items as elements of the query.

* Region Name

* Engineering Office Name

* Road Name

* Disaster Type

* Survey Year

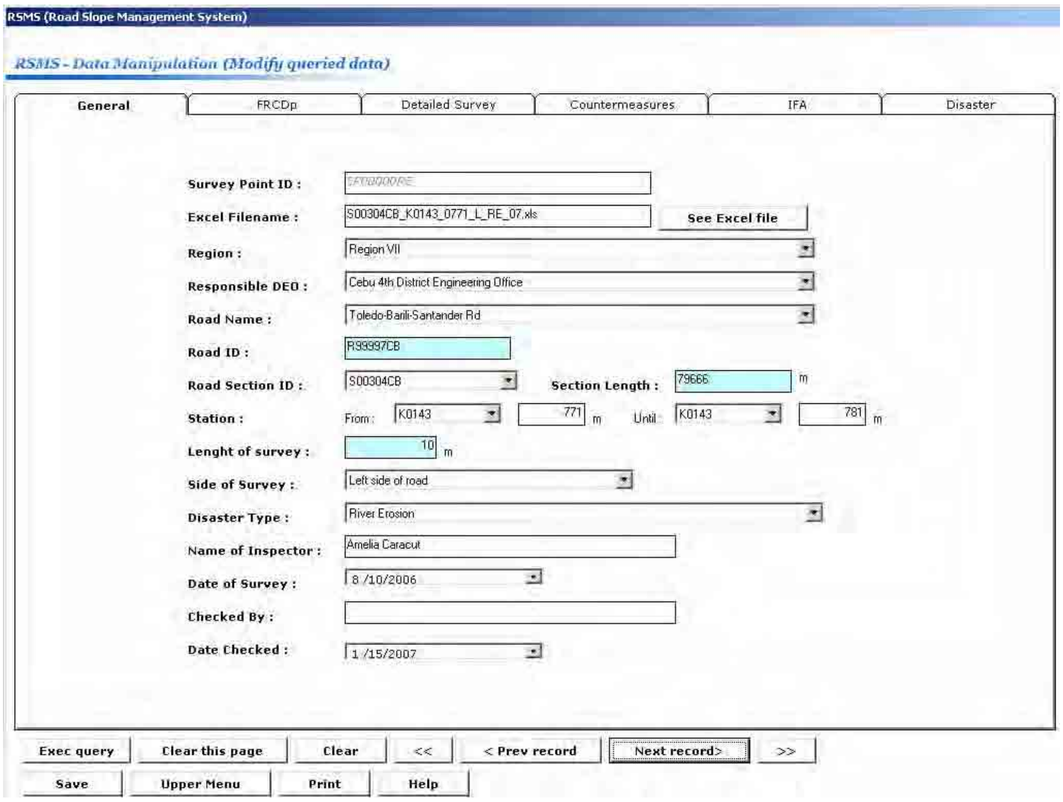


Figure 4.15 Example of Data Retrieval

The list of the data retrieved can be exported into Excel files easily. A pie chart or bar chart can be drawn and exported into the same Excel file. This function reduces the time for decision-making.

The survey point data can be imported into the GIS map easily. Their locations are displayed on the map so that the user can determine the geographic distribution of the survey points. The user can access the survey Excel files on the monitor for the GIS application. The following figure shows an example of the map display.

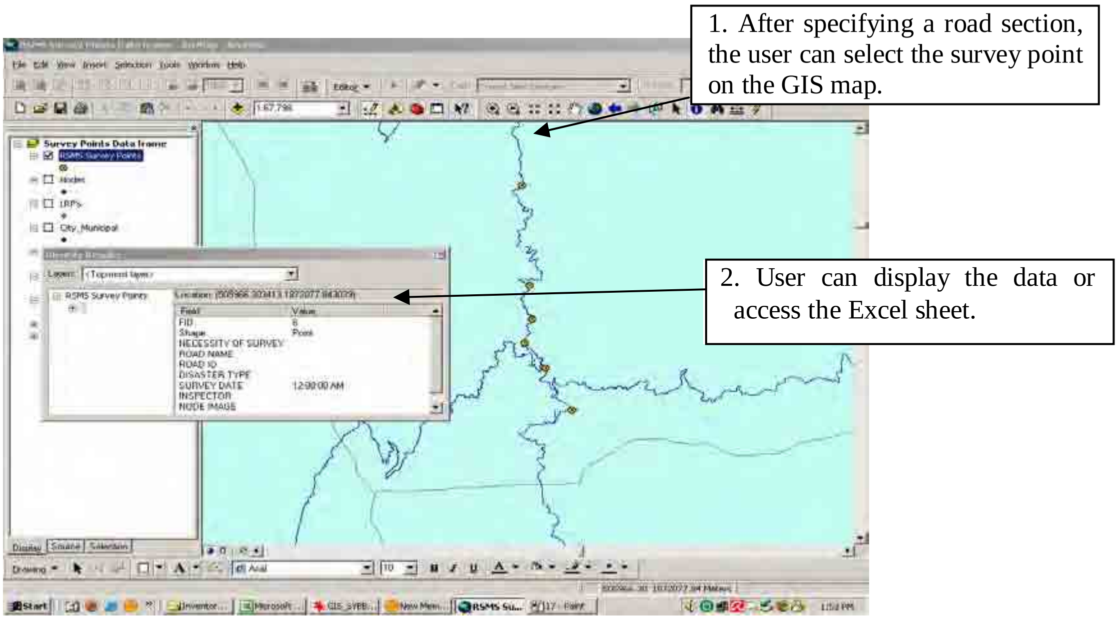


Figure 4.16 Example of Map Display

4.4.3 Database Creation for Selected National Highways

The data from the inventory survey have been stored in the RSMS database. All Preliminary Inventory Survey (PIS) data collected in the pilot study were stored in the database. A list of the survey points is shown in the Appendix of this volume. The Detailed Inventory Survey (DIS) data were stored in the database as the survey was being undertaken and the Excel files sent to the project office.

The result of the PIS, which is stored in the database, can be browsed with condition(s) that the user specifies. In other words, the user can extract the data which satisfies the conditions he/she specified. Such data query can be done with ease and a manager can extract the data of his/her interest without the help of dedicated operators.

For example, a manager would like to print out a list of the slopes in CAR where a Road Slip is the most probable disaster. Only four or five user inputs that are typed-in or menu selections are required. The following figure shows user interaction and the results obtained schematically.

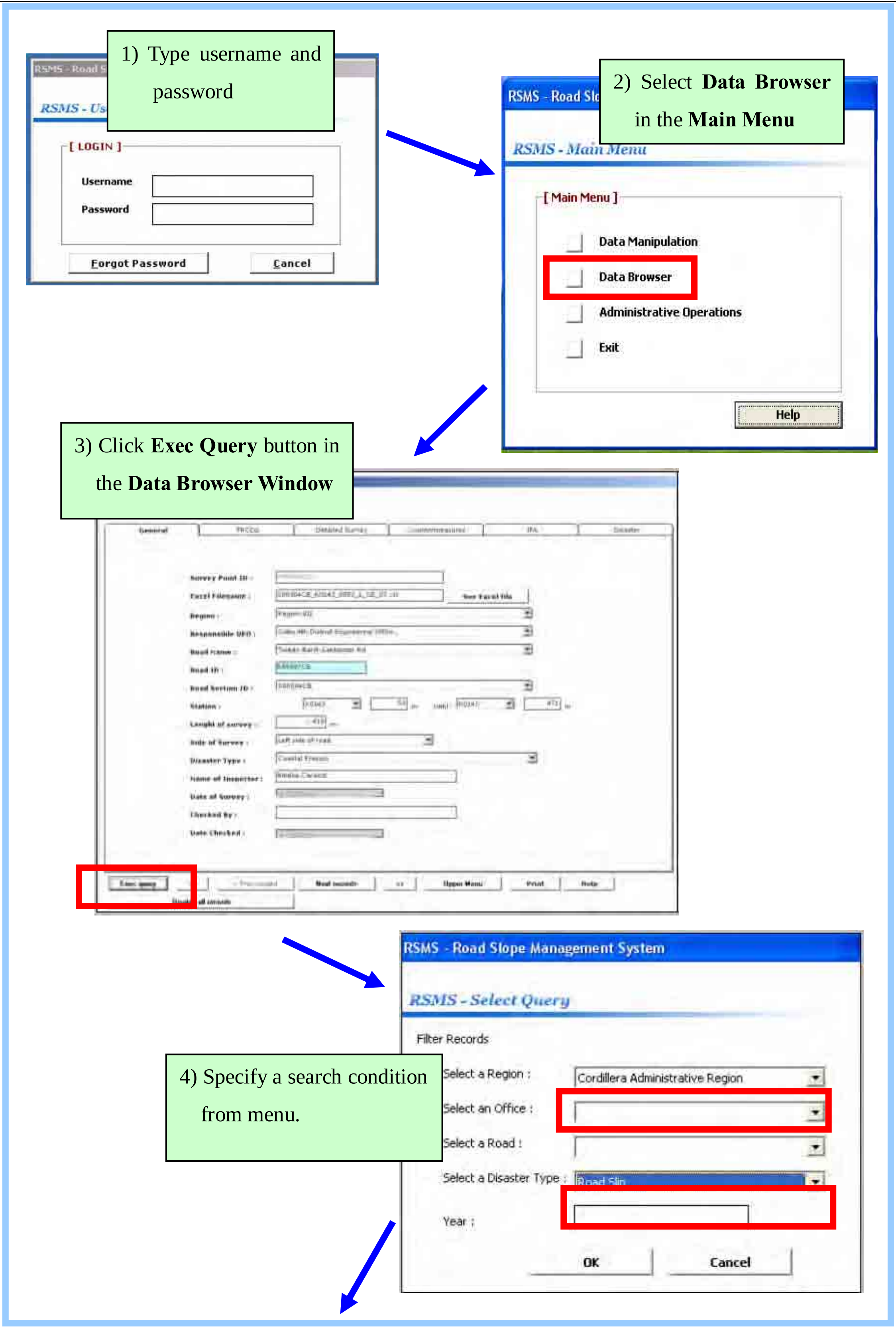


Figure 4.17 Example of Data Query (1)

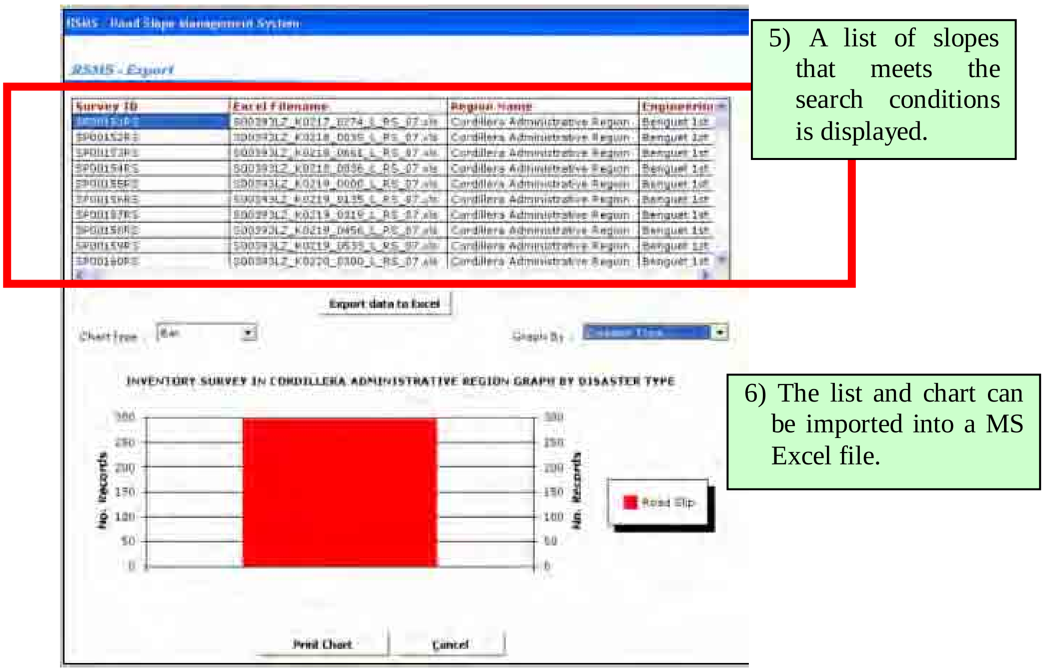


Figure 4.18 Example of Data Query (2)

Such lists and charts help to extract the necessary information from the database easily and promptly.

The figure below is another example of the chart. The pie chart shows the percentage of each disaster type for all PIS data.

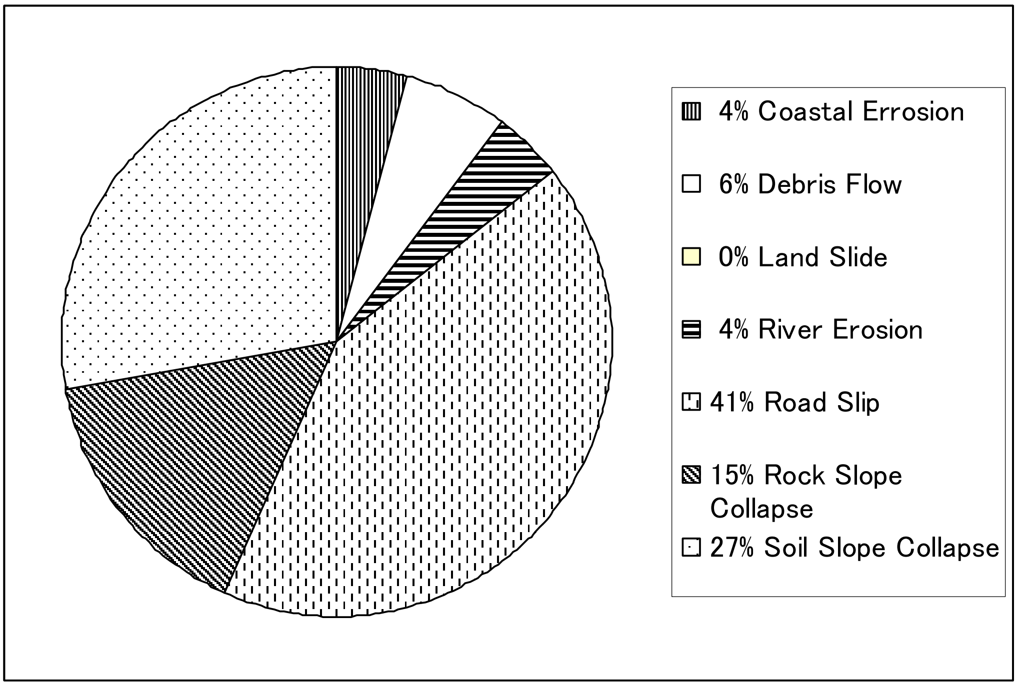


Figure 4.19 Pie Chart of All PIS Data by Disaster Type

Some of the common problems which the Study Team encountered when inputting information into the RSMS database, are described below:

* Sufficient information was not given. For example, in Sheet 2 of the survey sheet, only one item should be selected when choosing between ‘Geometry’ and ‘Surface Condition’. It was also observed that frequently neither ‘Present’ nor ‘None’ were checked for ‘Spring/Surface Water’ status even though it is necessary to input the proper choice of the two or both ‘Grasses’ and ‘Trees’ were checked as ‘Dominant vegetation/surface covering’ when only one can be dominant. Based on the discovery of these problems, the Study Team and the counterparts instructed DPWH engineers of the participating offices on how to properly make entries into the survey sheet at the seminar conducted for them.

* Kiloposts in several road sections were missing from the RBIA database. For example, in a particular road section, kiloposts 37 km, 38 km, 40 km, and 41 km exist while that of 39 km is missing. According to MIS personnel, these kiloposts were missing in the information sheets collected from the local offices when they input kilopost data into the RBIA database. The Study Team felt the necessity to check and input these missing kiloposts into the RBIA and RSMS database in cooperation with the MIS and local engineering offices.

* Some information recorded in the inventory survey sheet conflicts with the content of the RBIA database. For example, a road would belong to more than one engineering office. Sometimes, the boundary positions (such as Km 145+300m) are different in the survey sheet and the RBIA database. This is may have been caused by misunderstanding or incorrect knowledge. A request should be made for them to conform to the RBIA database.

4.4.4 Deployment Plan

The use of the RSMS database application system is limited to the DPWH Central Office for the time being. However, it is important to consider its future deployment to the local offices. This would result in the following benefits:

They would have the same information as the Central Office.

They would get information more promptly, for example, in case of the occurrence of a disaster.

The Study Team has surveyed the possible ways for the future deployment as explained below.

(1) Integration with RBIA

The integration of the RSMS database into the RBIA database application system is one such choice. The advantages and disadvantages of this integration are given below:

Advantages

1) A highly sophisticated database application system might be developed. All kinds of data with respect to bridges and roads including the slope inventory and disasters can be stored and analyzed.

2) Resources such as PCs, licenses for local copies of RBIA database, etc. are utilized more effectively.

Disadvantages

1) The cost for application development might be high.

2) As the new integrated database application system may be a complicated large-scale application, the response time of the system might be slower than the present RBIA. It might also take time before most of the bugs are solved and stable operation commences.

Apart from integration with RBIA, there are other possible approaches on-line and/or off-line. This is the same as the present situation of the RBIA database in the remote offices.

(2) Client Access from Remote Offices

The RSMS database application system is designed so that a client PC can access the database via the network. Only the RSMS client application should be installed in the client PC with no license fee. The main advantages and disadvantages of this integration are given below:

Advantages

1) Users at the remote offices can access the RSMS database directly and browse the latest data. They can register data or modify the data if the policy for daily operations allows.

2) No additional cost is incurred unless the concurrent access to the RSMS database server exceeds the limit (5).

Disadvantages

1) The response speed via WAN might be insufficient.

2) The Map Display program cannot be accessed. To solve this problem, GIS network licenses for the remote offices should be purchased.

3) There is the possibility that the database operation by inexperienced user may affect the consistency of the database. Hence, operational procedures to maintain security and data integrity and user training are vital.

(3) Distribute Copies of the Database to the Remote Offices

Some District Engineering Offices have no WAN connections with the Central Office. Like the RBIA application, it is possible to distribute copies of the database to the local offices. The main advantages and disadvantages of this integration are given below:

Advantages

1) Slow response speed by WAN can be avoided.

2) Free license of Microsoft SQL Server 2005 Standard Edition, which is the edition of SQL Server 2005 with limited functions, are available as the database engine. GIS software installed in the local offices might be used as a GIS map display system for RSMS. However, tests should be made to check whether the RSMS map function affects the functioning of RBIA on the same GIS engine.

Disadvantages

1) The database contents are read only and not up-to-date until the latest version is distributed.

2) It needs a high specification PC to maintain the speed of the database operation, since it acts as the database server in the remote office.

More investigation is necessary after the operation of RSMS database application becomes stable. The Study Team believes that the integration with the RBIA database system is the proper way in the medium-to-long term.

4.5 Method of Risk Management Planning

The method for risk management planning is described in Volume II: Guide I Risk Management Planning. The outline is discussed below. The work flow of the planning is shown in Figure 4.20.

4.5.1 Policy/ Program Making by DPWH-Central Office

The inventory survey/RSMS database can provide risk level indicators for the evaluation of the effectiveness of slope disaster prevention projects and the setting of the next stage target level. Planning should be done utilizing the RSMS database as shown in Figures 4.20 and 4.21

(1) Assessment of the Risk Level of RCD under the Current State

FRCDp and Annual Loss (AL) of individual slopes from the RSMS database can be processed into the following risk level indicators of a road section as shown in Figures 4.20 and 4.21 and Table 4.3.

- Potential Intensity of RCD of a section (IRCDp)
- Potential Intensity of Annual Traffic encountering RCD (IATEp)
- Potential Intensity of Annual Loss (IALp)

(2) Data Collection of Reference Values for Target-Setting

The following reference data is arranged for target-setting:

- International comparison of Risk Level Indicators of RCD on Highways; and
- Current and target level indicators of quality and risk levels of bridges and pavements on highways in the Philippines.

(3) Target-Setting for Risk Level Indicators

Risk level indicators for target-setting are as follows:

- IRCDt: Target Potential Intensity of RCD of a section [nos. of RCD per (year*km)]
- IATEt: Target Potential Intensity of Annual Traffic encountering RCD of a section [nos. of RCD per year]
- IALt: Target Potential Intensity of Annual Loss of a section [pesos per (year* km)]

IALp is the overall indicator of risk level. Other indicators are used for comparison with other objects such as pavement and bridges.

Viewpoints of target-setting are as follows:

The purpose of risk management is the improvement of traffic reliability which serves as the foundation for social and economic activities and regional development and attracting industrial investors and tourists.

There must be a balance with the current and target levels of the pavement and bridge management.

Targets are set corresponding to the importance of the roads (arterial and secondary)

To set realistic targets, it is important to consider the indicative cost to reach the target.

(4) Prioritization of Road Sections for Risk Management

The benefit gained from the implementation of a risk management plan is the difference between the present state potential value of Intensity of Annual Loss and the target values:

Benefit = IALp - IALt

Sections with a large difference between the present-state potential value and target value of risk level indicators are high-priority (bottle neck) sections for risk management.

(5) Direction to Local Offices for Planning the Projects and the Management System

The DPWH Central office, through the Regional Office, will send the list of sections as prioritized through application of the 'Necessity of Risk Management' to the DEOs with the direction that the planning of disaster prevention projects and risk avoidance management systems depend on the risk levels (priority of necessity of risk management).

Check : **Inventory Survey by RO and DEO**
- Risk Level Assessment
(**Risk Level Indicators**: Potential Frequency of RCD, Annual Loss due to RCD)
-Countermeasure Alternative Planning and **Indicative Feasibility Assessment**
(**Risk Level Outcome Indicators**: Potential Frequency of RCD with countermeasures, Decrease in Annual Loss due to countermeasures)
(**Feasibility Indicators**: Benefit Cost Ratio, Economic Net Present Value, Economic Internal Rate of Return)

Establishment of RSMS Database by DPWH Central Office

Action: Update of RSMS and Improvement of Risk Management Procedure

Policy making by DPWH Central Office/ESSO*/PMO-FS**
1. Assessment of Risk Level
(Processing of Risk Level Indicator from Database)
2. Target Setting of Risk Level Indicator
3. Categorizing of Road Sections for Necessity of Risk Management
4. Environmental Impact Assessment

Reference Data for Target Setting of RSMS
Bridge Management System (**BMS**) Database
Potential Frequency of Road Closure or Potential Annual Loss due to Bridge Collapse or Deterioration
Pavement Management System (**PMS**) Database
Annual Loss (Excess of Vehicle Operation Cost of Current Condition to Paved Good Condition)

Direction to DEO via RO

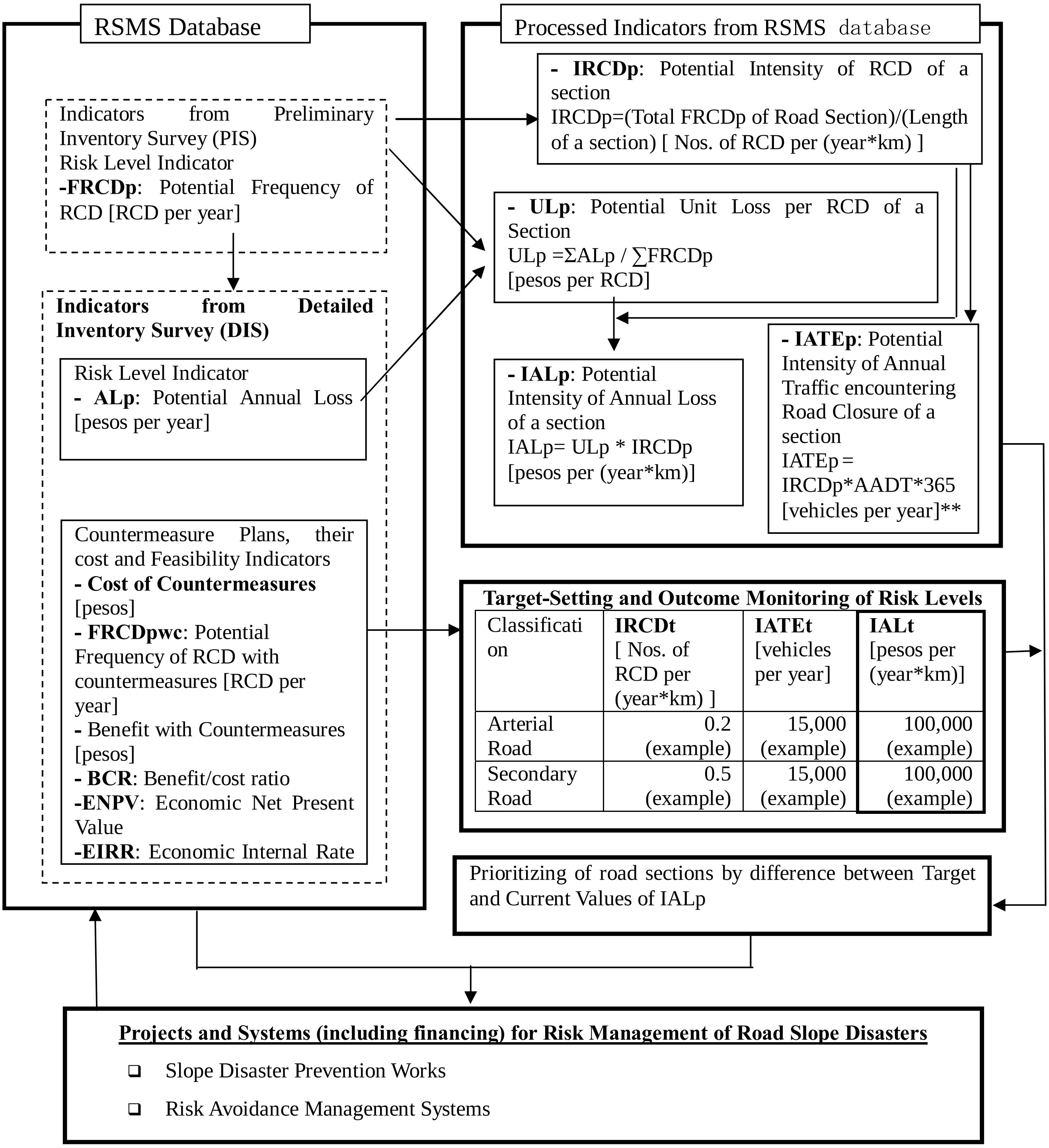
Planning of Projects and System by RO and DEO
- Slope Disaster Prevention Project
- Risk Avoidance Management Systems

Review of Plan, Budget Allocation by Central Office/BOD/BOMESSO*/PMO-FS
- Review of Plans, - Annual planning and budget allocation

Do
Implementation of Projects/ Management Systems by RO/DEO (In the Project Management Office with foreign assistance, in some cases)

* ESSO: Environment & Social Safeguard Office
** PMO-FS: Project Management Office_ Feasibility Studies

Figure 4.20 Cycle of Slope Risk Management utilizing the RSMS Database



Classification	IRCDt [Nos. of RCD per (year*km)]	IATEt [vehicles per year]	IALt [pesos per (year*km)]
Arterial Road	0.2 (example)	15,000 (example)	100,000 (example)
Secondary Road	0.5 (example)	15,000 (example)	100,000 (example)

Figure 4.21 Outputs from RSMS and their Relationships

Abbreviation of **bold-faced** entries is explained in Table 4.1

Table 4.3 Explanation of Indicators as Output from RSMS

Abbreviation	Full name	Unit	Object	Explanation
Risk Level Indicators from RSMS database (Inventory Survey)				
FRCDp	Potential Frequency of RCD	RCD per year	slope	The number of estimated occurrences of RCD per year in the future. This is estimated on inventory sheet 2
ALp	Potential Annual Loss	pesos per year	slope	ALp is estimated on inventory sheet 5
FRCDpwc	Potential Frequency of RCD with countermeasures	RCD per year	slope	FRCDp is estimated on inventory sheet 5 FRCDpwc = RRR * FRCDp where RRR=risk reduction ratio
Feasibility Indicators from RSMS database (Inventory Survey)				
BCR	Benefit/cost Ratio	ratio	slope	Indicative Indicators of the countermeasures' benefit and cost streams. These are estimated assuming a 20 year project life:
ENPV	Economic Net Present Value	pesos	slope	
EIRR	Economic Internal Rate of Return	%	slope	
Risk Level Indicators processed from RSMS database (Inventory Survey)				
IRCDp	Potential Intensity of RCD of a section	Nos. of RCD per (year*km)	section	IRCDp=(Total FRCDp of Road Section)/(Length of Road Section)
ULp	Potential Unit Loss per RCD of a section	pesos per RCD	section	Average Loss per RCD in a road section
IATEp	Potential Intensity of Annual Traffic encountering RCD of a section	Vehicles per year	section	IATEp = IRCDp* AADT *365
IALp	Potential Intensity of Annual Loss of a section	Pesos per (year*km)	section	IALp = ULp * IRCDp
Target Risk Level Indicators				
IRCDt	Target Intensity of RCD of a section	Nos. of RCD per (year*km)	section	Target of IRCDp
IATEt	Target Intensity of Annual Traffic encountering RCD of a section	Vehicles per year	section	Target of IATEp
IALt	Target Intensity of Annual Loss	Pesos per (year*km)	section	Target of IALt

4.5.2 Risk Management Planning by Regional Offices and District Engineering Offices

(1) Outline

The Regional Offices (RO) and District Engineering Offices (DEO) will plan 'Slope Disaster Prevention Projects' and 'Risk Avoidance Management Systems' based on the list of road sections of the various risk management priority classifications and the slope inventory.

(2) Planning of Slope Disaster Prevention Projects

(a) Target Road Section

The target road section should have an IALp greater than the target level, as specified in the list of roads as prioritized through application of the 'Necessity of Risk Management.' Road sections with existing road slope improvement projects are also target sections, but in these sections individual slopes for which countermeasures are planed are excluded from the new planning targets.

(b) Selection of Countermeasure Alternatives and Multi-Year Implementation Plans

- The DEO will select a reasonable countermeasure alternative based on the feasibility indicators shown in the slope inventory. When the IALp of a road section does not reach the target level after implementation of the countermeasure, the countermeasure should be revised, and be subjected to an evaluation which may select an alternative with a greater risk reduction ratio.

- In the event that the execution/implementation of countermeasure(s) will take two or more years, then budget scheduling shall be evenly distributed every year. Road sections with high FRCDp will generally be given the highest priority for implementation; however this can be affected by other requirements.

(c) Budget Planning

The DEO will estimate the annual cost of the following items:

(1) Construction Cost

(2) Maintenance Cost for Countermeasures

(3) Potential Reopening Cost

4.6 Outline of Technical Guides

4.6.1 General

Three kinds of technical guides have been prepared by the Study Team to support implementation of RSMS, namely:

1) Risk Management Planning (Guide I);

2) Inventory Survey and Risk Assessment (Guide II); and

3) Design of Countermeasures (Guide III).

The drafts of the above-mentioned guides are prepared as Volume II, III, and IV and are summarized in Table 4.4.

Table 4.4 Contents and Users of Guide

Volume No. of Draft Final Report	Title of Volume	Contents	Main Users in DPWH
II	Guide I Risk Manageme nt Planning	1. Formulation and utilization of road slope management database 2. Target setting and programme formulation for risk management management 3. Project formulation for disaster prevention	Central Office (Information & Communication Technology Service, Planning Service, Bureau of Maintenance) Regional Office District Engineering Office
III	Guide II Inventory Survey and Risk Assessment	4. Procedures for the inventory survey - Assessment of Potential Road Closure Disasters (FRCDp) - Assessment of disaster magnitude and other disaster situations - Alternative Countermeasure planning and cost estimates - Indicative Feasibility Assessment (IFA)	Central Office (Planning Service, Bureau of Maintenance) Regional Office (Planning and Design Division, Maintenance Division) District Engineering Office (Planning and Design Section, Maintenance Section)
IV	Guide III Road Slope Protection	7. Countermeasure design methods 8. Countermeasure design examples 9. Temporary treatments for road slope disasters and quality control for restoration work	

4.6.2 Guide I Risk Management Planning

This Guide is being prepared for risk management planning using the RSMS database. Risk management planning is subdivided into 'Slope Disaster Prevention Projects' and 'Risk Avoidance Management Systems'.

The guide describes the methodology of establishing policies and programmes for road slope risk management and for formulation of slope disaster prevention projects using the RSMS database system.

The guide contains the following Chapters:

Chapter 1:

The purpose and necessity of practical risk management and the cycle and flow of risk management in coordination with the pavement and bridge management systems are described.

Chapter 2:

The inventory survey and RSMS database that produce and contain the basic data of Risk Management Planning is described.

Chapter 3:

This chapter describes the basic procedures of risk management planning.

Chapter 4:

The procedure for target setting of risk levels for national highways is given utilizing risk level indicators such as Potential Frequency of RCDs (FRCDp) and Potential Annual Loss (ALp), data made available by the Inventory Survey, reference to risk and quality level standards of foreign countries, and risk and quality levels of pavement and bridges in the Philippines. The procedure for priority-ranking of road sections for risk management is also described.

Chapter 5:

The procedure for project-planning of disaster prevention works is given, including budget planning, by presenting actual planning examples. Also, the implementation system and roles of concerned DPWH units are laid out.

4.6.3 Guide II Inventory Survey and Risk Assessment

This Guide is prepared for the implementation of the Inventory Survey designed by the Study

Team to collect information on road slope conditions of the national highways in the Philippines.

This guide contains the following chapters:

Chapter 1:

The Framework of the Methodology for the Inventory Survey and salient features of the methodology to evaluate the risk of road slopes and indicative feasibility of various countermeasures are described.

Chapter 2:

The Methodology for the Preliminary Inventory Survey (PIS) is described in detail, including the PIS procedures, evaluation method of the risk level of road slopes, preparatory works for PIS, designation of survey sections and methods to identify disaster types.

Through the instructions provided, inventory formats applied in the actual PIS can be properly utilized.

Chapter 3:

The Methodology for the Detailed Inventory Survey is given in this chapter. This is composed of the identification of disaster causes using the sketch of road slopes, countermeasure planning methods, and the method for conducting indicative feasibility assessments.

With the use of this manual, the PIS for a total of 332 km and DIS for a total of 61 km sections of national highways has been carried out successfully on a pilot basis, and the pilot implementation of the DIS for the 61 km has been undertaken. The guide was revised during the survey based on discussions with the Counterpart Team and requirements of DPWH engineers.

4.6.4 Guide III Road Slope Protection

The Guide for Road Slope Protection for each disaster type is being prepared for use in road management by DPWH and includes such activities as inventory surveys, disaster mitigation planning, feasibility studies and detailed design. The Guide consists of eleven chapters including the selection process for countermeasures, design procedures and methodology for each disaster category to be detailed in Chapters 3 to 9 and examples of designs in the proposed Chapter 10. The disaster types considered are those used in the RSMS, namely: 1) soil collapse, 2) rock slope collapse, 3) landslides, 4) road slips, 5) debris flow, 6) river erosion and 7) coastal erosion. The outline is summarized in Table 4.5

Table 4.5 Contents of Road Slope Protection Guide

Chapter		Outline of Contents
1.	Introduction	- Background of the Guide - Policy and Outline
2.	Basic Approach to Mitigation of Road Slope Disasters	- Classification of Road Slope Disasters by Type - Damage Modes, Features and Mechanisms of Road Slope Disasters by Type
3.	Countermeasures against Soil Collapse	- Classification and Description of Appropriate Countermeasures - Process for Selection of Appropriate Countermeasures - Explanation of Design Procedures, Logic and Methodology
4.	Countermeasures against Rock Slope Collapse	
5.	Countermeasure against Landslides	
6.	Countermeasures against Road Slips	
7.	Countermeasures against Debris Flows	
8.	Countermeasures against River Erosion	
9.	Countermeasures against Coastal Erosion	
10.	Examples of Countermeasure Designs	- Introduction of Design Examples by Drawings and Calculation Processes by Disaster Category.
11.	Temporary Treatments for Road Slope Disasters	- Explanation of Temporary Measures for the Prevention of Damage and Post-Disaster Remedial Works

4.7 Risk Avoidance Management

4.7.1 General

Risk avoidance management is undertaken using the Standard Operating Procedures (SOPs) based on Department Order No. 36 of 1988 as described in Section 3.3.4.

Risk management by providing early warnings and regulation of traffic is applied in some national road sections such as Kennon Road during heavy rainfalls. The procedure for risk avoidance management for national roads is not described in the aforementioned Department Order. It seems that early warnings and regulation of traffic are not being applied to most sections of the national roads in the Philippines.

The purpose of early warnings and regulation of traffic is to protect human lives. When disasters that have been warned of do not occur, management might be considered ineffective for incurring costs, such as for the mobile patrols during abnormal weather. In case of early warnings and regulation of traffic during heavy rainfall, saving of human lives and detour cost are tradeoffs. Therefore, reasonable and effective risk avoidance management methods should be established using the RSMS database and other information such as rainfall data.

The basic methods to establish reasonable risk avoidance management is proposed in this section.

4.7.2 Target Road Sections

Target road sections for risk avoidance management are RCD prone road sections, which are prioritized based on the difference between target and current values of the Potential Intensity of Annual Loss (IALp).

4.7.3 Flow of Risk Avoidance Management Planning

Risk avoidance management planning can be implemented using the following activity flows:

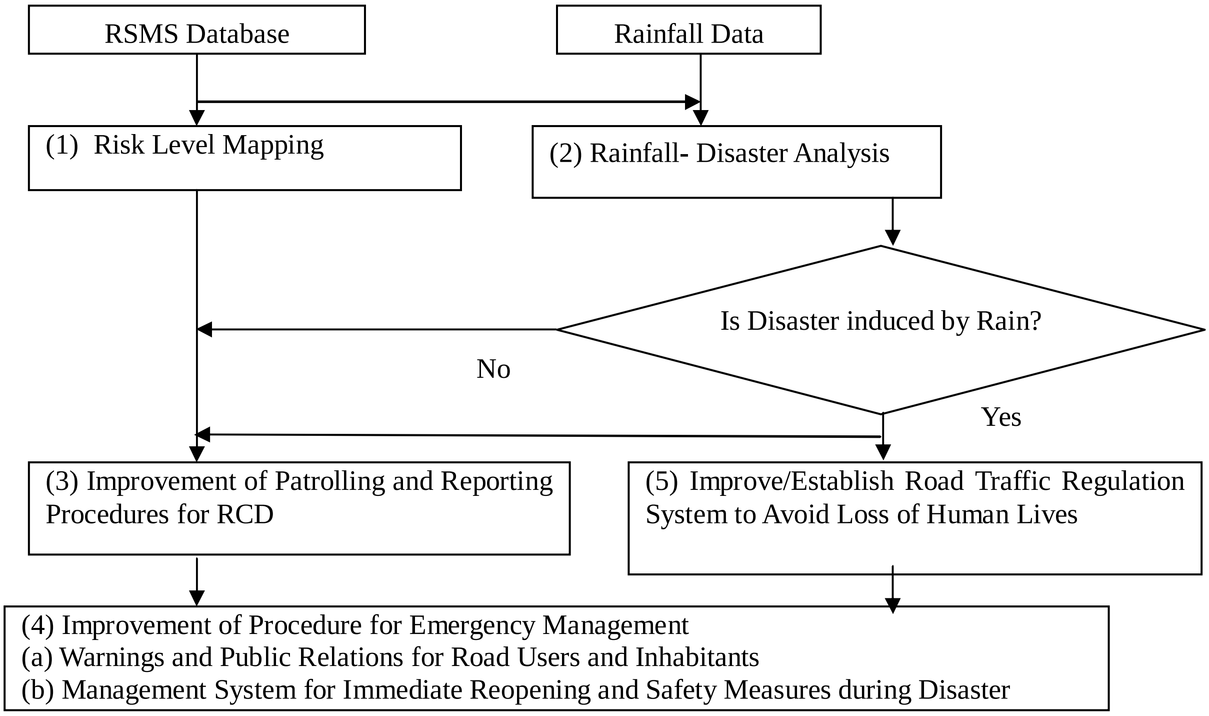


Figure 4.22 Flow of Risk Avoidance Management Planning

4.7.4 Procedures for Risk Avoidance Management Planning

(1) Risk Level Mapping

The following items should be shown on road maps for risk avoidance planning and public relations:

- Potential Intensity of RCD (IRCDp of sections)

- Disaster Type and FRCDp

(2) Rainfall-RCD Relationship Analysis

Disaster occurrence and rainfall indicators such as 24 hour rainfall records should be analyzed. Rainfall data for a period covering at least the last ten years should be used in producing the rainfall indicator, which should be arranged from highest to lowest values. The relationship between RCD occurrence and the rainfall indicator should be shown as in Table 4.6 and Figure 4.23.

The rainfall data is not applicable if the rain gauge is more than ten km from the target road section.

Table 4.6 Rainfall Indicator-RCD Relationship (Example)

Rank of intensity in the last ten years	12-hour rainfall			24-hour rainfall		
	Date	Rainfall indicator [mm]	RCD Occurrence	Date	Rainfall indicator [mm]	RCD Occurrence
1	23 July 2005	260	Yes	23 July 2005	380	Yes
2	23 Aug 1996	206	Yes	23 Aug 1996	300	Yes
3	5 June 2003	150		5 June 2003	260	
4	7 Oct 2001	110		7 Oct 2001	235	Yes
5	8 July 1998	107	Yes	8 July 1998	210	

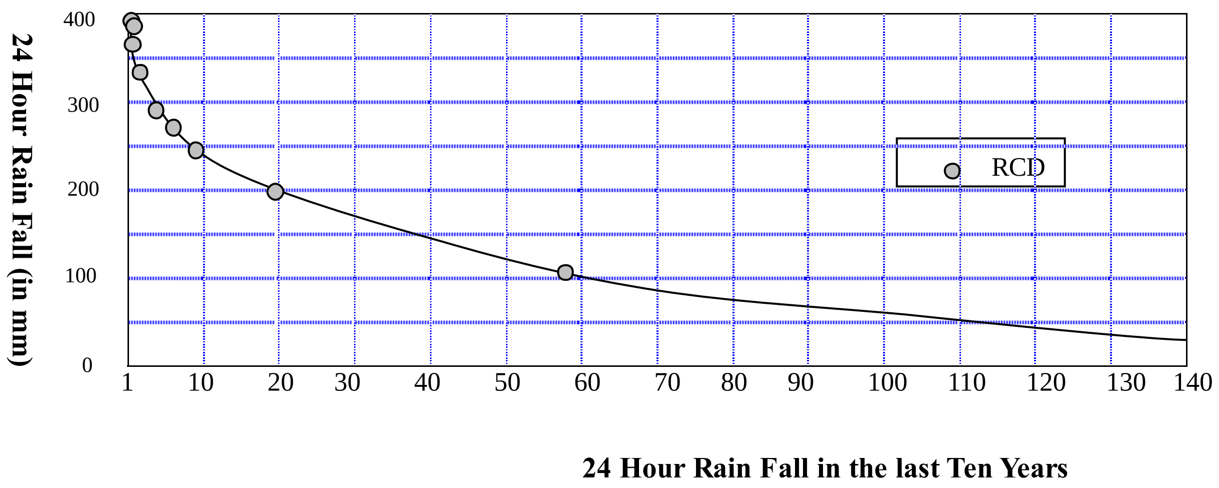


Figure 4.23 Rainfall Indicator-RCD Relationship (Example)

(3) Improvement of Patrolling and Reporting Procedures for RCD

Considering the characteristics of disasters, the following, detailed procedures should be improved/implemented:

- Routine patrols;
- Patrols during abnormal weather and earthquakes;
- Partnership with community-based disaster coordinating councils; and
- Encouraging reporting of signs and occurrences of disasters by local communities/inhabitants, bus companies/jeepney drivers, etc.

(4) Improvement of Procedures for Emergency Management

(a) Warnings and Public Announcements for Road Users and Inhabitants

After referring to the RSMS database including the disaster record, Risk Level Maps, and Rainfall-RCD Analysis, the warning criteria should be revised/established to improve the RCD “Hit Rate” and “Capture Rate”.

- Correct prediction ratio = No. of RCDs occurring after Warnings/ No. of Warnings
- RCD Acquisition Rate = No. of RCDs occurring after Warnings/ No. of RCDs

Public announcements based on Risk Level Maps and Rainfall-RCD Analysis Charts should be implemented properly to inform road users and inhabitants of the probability of the occurrence of RCDs.

(b) Improvement of Management System for Immediate Reopening/ Safety Measures during Disasters

After referring to the RSMS database (disaster magnitude and frequency predictions), Risk Level Maps and Rainfall-RCD Analysis, the management system for immediate road reopening/ safety measures during disasters should be improved using the following procedures:

- Emergency communication procedures;
- Timing of preparedness workers; and
- Deployment of construction equipment.

(6) Improve/Establish Road Traffic Regulation Systems to Avoid Loss of Human Lives

After referring to the Risk Level Maps and Rainfall-RCD Analysis, the need for a traffic regulation system should be studied and the criteria should be revised to improve the RCD “Hit Rate”, ‘’Capture Rate’’ and “Detour Cost- Human Lives Loss Chart” for appropriate tradeoffs in the relationship between human lives lost and detour costs.

- Hit Rate = No. of RCDs occurring during the application of Traffic Regulation/ No. of Warnings
- Capture Rate = No. of RCDs occurring during the application of Traffic Regulation/ No. of RCDs

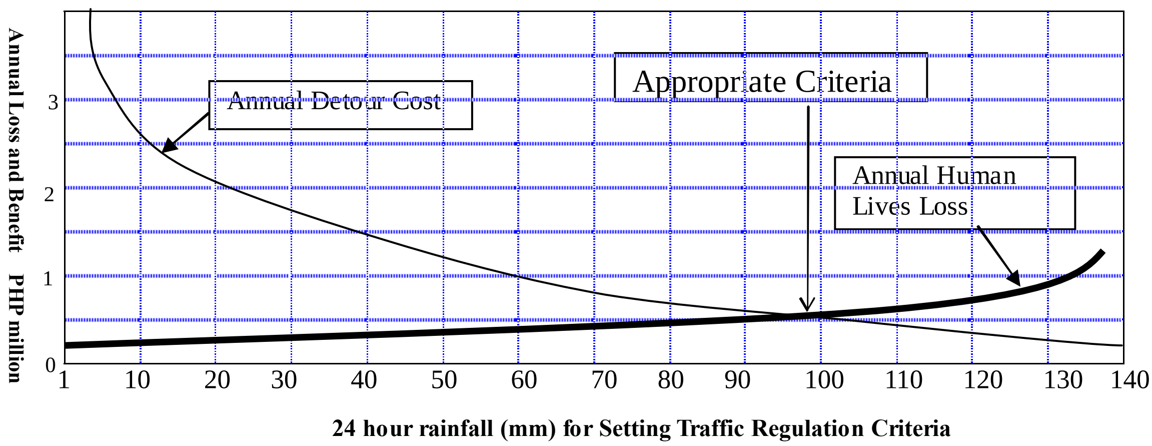


Figure 4.24 Chart of Traffic Regulation Criteria (Example)