mainstreaming disaster risk reduction in subnational development

land use/physical planning in the philippines

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Message

The Medium-Term Philippine Development Plan for 2004-2010 outlines the country's goals of reducing poverty and accelerating development, and specifies the strategies and action plans to bring about a better quality of life for the citizenry. But even as these guideposts for development are in place, the attainment of these goals is hampered by the constant threat of disasters. The frequent occurrence of natural and man-made disasters in the country does not only take its toll on the economy, but has implications on our socioeconomic conditions, particularly among the poor and those in remote areas where access to services become even more difficult.

The Guidelines on Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning is envisioned to improve our capacity to prevent and mitigate disasters. It is a tool for enhancing regional and provincial planning analyses by recognizing risks posed by natural hazards and the vulnerability of the population, economy and the environment to these hazards. By introducing risk analysis in development planning, regions and provinces can strengthen their ability to identify areas at risk to disasters, ensure proper siting of development undertakings, and identify appropriate mitigation measures. This is well within track of our country's commitment to the Hyogo Framework of Action that aims to integrate disaster risk reduction into sustainable development policies and planning. Ultimately, the main goal is to enable communities to reduce vulnerability and to increase their capacity to cope with disasters.

NEDA believes that a stronger collaboration with local governments is necessary to achieve the country's desired economic growth and development. In line with this, NEDA formulated the Guidelines as part of its commitment to provide local government units with the necessary tools that can help them to effectively carry out their mandate.

I take this opportunity to thank the European Commission Humanitarian Aid Department and the United Nations Development Programme for their unwavering support to the technical assistance project that produced the Guidelines. I also commend the entire NEDA family, led by the Regional Development Office, for ably seeing through the completion of the project. Finally, I enjoin all our local government officials to use the Guidelines and maintain their vigilance in preventing and reducing the impact of disasters.

RALPH G. RECTO
Secretary of Socioeconomic Planning

Message

Due to its geographic location in the Pacific Ring of Fire, the Philippines has always been on the list of the most vulnerable countries to natural disasters and confronted to their often dramatic impact on physical and human loss. With new threats like climate change and global warming, the risks of natural disasters are intensifying and could potentially reverse the gains achieved over the years on human development and the attainment of the Millennium Development Goals.

The increasing severity of natural hazards like typhoons requires the systematic factoring of disaster risks into development planning and programming. Conventional and "business as usual" approaches are no longer sufficient. These new risks call for the involvement of all actors of society to limit their negative impact. A new development planning and programming paradigm needs to be adopted at all levels, centrally and locally, to forestall the dramatic cost of these natural disasters on the Philippine society and economy.

A very important aspect of this new paradigm is the need to take into consideration the vulnerabilities of the Philippines to natural hazards. It means coming to terms with the additional constraints posed by these hazards on the country's physical assets like land and its natural resources. This is critical in determining these assets' most optimum use and ensuring that development options will not add threats to people's lives and property. Managing disaster risks is essential to ensuring the sustainable development for any country.

Mainstreaming natural disaster risks needs to be undertaken in a systematic manner and in relevant processes such as development planning. However, this can only be done efficiently when appropriate tools are made available to those involved in development planning, hence the importance of these Guidelines on Mainstreaming Diaaster Risk Management in Subnational Development and Land Use/ Physical Planning. The Guidelines will be particularly useful in generating risk-based comprehensive land use plans (CLUPs) at the local level, which are expected to introduce least cost development options that are also disaster risk resilient.

We would like to congratulate the National Economic and Development Authority and other national partners for collaborating on these Guidelines. We are very grateful for the financial support provided by the European Union, through the EC-DIPECHO, which made this exercise possible. It is excellent support like this from its bilateral partners that has enabled the United Nations Development Programme to assist more effectively the Philippines and contribute to its efforts to improve its people's lives.

We look forward to the Guidelines' systematic use, continued improvement and most important, its positive outcome in terms of safer, more disaster-risk resilient communities!

Renaud Meyer
Country Director

EUROPEAN COMMISSION
Humanitarian Aid

Message

The European Commission Humanitarian Aid Department (ECHO) through its disaster preparedness programme (DIPECHO) assists vulnerable people living in disaster-prone regions of the world in reducing the impact of natural disaster on their lives and livelihoods.

Since 1998, the European Commission has provided funding through its DIPECHO programme for some 80 projects across South East Asia, with grants amounting to over 20 million euros (approx PhP 1.3 billion). These projects have addressed a large number of natural disaster risks and have had a significant impact, in particular in the poorest and most remote areas.

In line with the priority areas of the Hyogo Framework for Action, which the European Commission wholeheartedly supports, DIPECHO acknowledges the important role the people and local government units play in the continuing efforts to advocate safer communities. The present Guidelines give us clear examples of what national and local authorities, at all levels, can achieve if they work hand-in-hand with communities and institutions to develop their capacities to prevent, prepare for, cope with and respond to disasters.

The Guidelines on Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning, developed by NEDA through the United Nations Development Programme, will serve a wide range of purposes, from improved planning and land management to reduction of risks. Most importantly, the Guidelines will help decision-makers to elaborate and implement practical actions which will save lives and assets during natural disasters.

We hope that this tool will be very widely disseminated among local authorities, and that it will serve as a best-practice reference for the Philippines.

Alistair MacDonald
Ambassador
European Commission Delegation to the Philippines

Preface

The Guidelines for Mainstreaming Disaster Risk Reduction (DRR) in Subnational Development and Land Use/Physical Planning is the major output of the Technical Assistance (TA) on Mainstreaming Disaster Risk Management in Subnational Development and Physical Planning in the Philippines. With assistance from EC-DIPECHO and UNDP, NEDA implemented the TA in line with the National Land Use Committee's action agenda that seeks to strengthen disaster mitigation by: (a) making available hazard maps and relevant disaster information; (b) enhancing local capacity to institute preventive/mitigating measures; and (c) preparing DRR-enhanced regional and provincial physical framework plans.

Consultative and participatory approaches, including intensive review, were undertaken in the preparation of the Guidelines. NEDA organized the TA's Project Board consisting of the NEDA Regional Development Office (Chair); National Disaster Coordinating Council/Office of Civil Defense; Mines and Geosciences Bureau; Philippine Atmospheric, Geophysical and Astronomical Services Administration; Philippine Institute of Volcanology and Seismology; Department of the Interior and Local Government; Housing and Land Use Regulatory Board; and League of Provinces of the Philippines. NEDA's Regional Development Coordination Staff provided technical and administrative secretariat support to the Project Board and coordinated all project activities.

The TA started with a national consultative workshop and project launching to promote awareness and generate support for the project from the national and subnational levels as well as to gather comments and recommendations on the project scope and framework for mainstreaming DRR. Initially, a draft was prepared by a team of consultants and subsequently reviewed by a group of experts from the hazard-mapping agencies and the NEDA regional offices. The Guidelines were later used as reference material in five batches of training conducted for 281 regional and local planners and representatives from the national/regional government agencies and nongovernment organizations. The reviews and trainings generated substantive inputs that further enriched the mainstreaming DRR framework and methodology. The relevance, applicability and user-friendliness of the Guidelines were pilot-tested in Regions 1 and 13 and in Surigao del Norte and, in the process, produced DRR-enhanced development and physical framework plans. Sixteen desk exercises or case studies on disaster risk assessment for other regions and provinces as well as two policy studies on geospatial data and information for disaster risk management and on improving DRR mainstreaming in subnational planning were also prepared under the TA.

The next step is to popularize the Guidelines and advocate its use by more provinces and regions. Capacity-building activities are being lined up for planning offices at the local, regional, and national levels, which are envisioned to take the lead in mainstreaming DRR in the development processes. Refinements to the Guidelines may also be done later to include new and emerging concerns such as climate change.

We hope that the use of the Guidelines by planners and decision makers will lead to the effective integration of DRR in planning and eventually reduce or prevent the adverse effects of disasters in socioeconomic development.

AUGUSTO B. SANTOS
Deputy Director-General
Regional Development Office

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A number of institutions and individuals supported and contributed immensely in the formulation of the Guidelines on Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning:

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The Regional Development Coordination Staff of the NEDA Regional Development Office for providing overall technical and secretariat support.

SUSAN RACHEL G. JOSE
Director
Regional Development Coordination Staff

Acronyms

ADB	Asian Development Bank
ADB-OCR	Asian Development Bank-Ordinary Capital Resources
ADF	Asian Development Fund
ADPC	Asian Disaster Preparedness Center
AIP	Annual Investment Program
ALARP	As Low As Reasonably Practicable
ATO	Air Transportation Office
AusAid	Australia Agency for International Development
BAS	Bureau of Agricultural Statistics
BSWM	Bureau of Soils and Water Management
C/MPDO	City/Municipal Planning and Development Office
CARE Fund	Calamity Assistance Rehabilitation Efforts Fund
CBOs	Community Based Organizations
CIMs	Cadastral Index Maps
ClaGiBa	Claver-Gigaquit-Bacuag
CLUP	Comprehensive Land Use Plan
CPH	Census of Population and Housing
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
DepEd	Department of Education
DIPECHO	European Commission Humanitarian Aid Department Disaster Preparedness Program
DMC	Development Member Countries
DOE	Department of Energy
DOH	Department of Health
DPWH	Department of Public Works and Highways
DRA	Disaster Risk Assessment
DRF	Disaster Recovery Facility
DRM	Disaster Risk Management

DRR	Disaster Risk Reduction
EC	European Commission
EU	European Union
FA	Floor Area
FEMA	Federal Emergency Management Agency
FFWS	Flood Forecasting and Warning System
FNSP	Field Network Survey Party
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFDRR	Global Facility for Disaster Reduction and Recovery
GIF	General Insurance Fund
GIS	Geographic Information System
GOP	Government of the Philippines
GPS	Global Positioning Systems
GSIS	Government Service Insurance System
GSO	Gapan-San Fernando-Olongapo
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
GVA	Gross Value Added
HFA	Hyogo Framework for Action
HSA	High Susceptible Area
ICB	Institutional Capability Building
IEC	Information, Education and Communication
IPCC	Intergovernmental Panel on Climate Change
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
KfW	Kreditanstalt fur Wiederaufbau
KGC	Key Growth Centers
KOICA	Korea International Cooperation Agency
LGC	Local Government Code
LGU	Local Government Unit
LMS	Land Management Service
LSA	Low Susceptible Area
MCM	Million cubic meters
MDG-F	Millennium Development Goals Achievement Fund
MGB	Mines and Geosciences Bureau
MMDA	Metro Manila Development Authority
MMEIRS	Metropolitan Manila Earthquake Impact Reduction Study
MMIS	Modified Mercalli Intensity Scale
MPC	Mount Pinatubo Commission
MSA	Moderate Susceptible Area
MTPDP	Medium-Term Philippine Development Plan
MTPIP	Medium-Term Public Investment Program
NAMRIA	National Mapping and Resource Information Authority
NDCC	National Disaster Coordinating Council
NEDA	National Economic and Development Authority
NEDA-RDO	National Economic and Development Authority-Regional Development Office
NGO	Non-government organization
NLUC	National Land Use Committee
NPC	National Power Corporation
NRFA	Non-Residential Floor Area
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
OCD	Office of Civil Defense
ODA	Official Development Assistance
OFDA/CRED-EM/DAT	Office of U.S. Foreign Disaster Assistance/Center for Research of the Epidemiology of Disasters Emergency Database
OpCen	Operations Center
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAP	Potentially Affected Population
PAPr	Potentially Affected Property
PCIC	Philippine Crop Insurance Corporation
PCSO	Philippine Charity Sweepstakes Office
PDC	Provincial Development Council
PDIP	Provincial Development Investment Program
PDPFP	Provincial Development and Physical Framework Plan
PDZ	Permanent Danger Zone
PED	Project Evaluation and Development
PEIS	PHIVOLCS Earthquake Intensity Scale
PGA	Peak Ground Acceleration
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PHUMP	Pinatubo Hazard Urgent Mitigation Project
PLPEM	Provincial/Local Planning and Expenditure Management
PPA	Philippine Ports Authority

PPAs	Programs, Projects and Activities
PPDO	Provincial Planning and Development Office
PRS92	Philippines Reference System of 1992
RDP	Regional Development Plan
READY	Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management Project
RFA	Residential Floor Area
RIDF	Rainfall Intensity Duration Frequency
RIL	Rain-induced Landslide
RMF	Risk Mitigation Facility
ROW	Right of Way
RPFP	Regional Physical Framework Plan
SIA	Social Impact Assessment
SIDA	Swedish International Development Cooperation Agency
TA	Technical Assistance
TFA	Total Floor Area
UNDP	United Nations Development Programme
UN-ECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNHCR	United Nations High Commissioner for Refugees
UNISDR	United Nations International Strategy for Disaster Reduction
UTM	Universal Transverse Mercator
WGS84	World Geodetic System of 1984

Executive Summary

The National Economic and Development Authority (NEDA), with assistance from the United Nations Development Program and the European Commission Humanitarian Aid Department, formulated the Guidelines on Mainstreaming DRR in Subnational Development and Land Use/Physical Planning as an instrument to direct natural disaster risk reduction efforts in development planning processes.

The Guidelines support the comprehensive disaster risk management framework of the National Disaster Coordinating Council. In the global context, the formulation of the Guidelines is in keeping with the Hyogo Framework for Action adopted in January 2005 during the World Conference on Disaster Reduction. It serves as a tool for enhancing subnational (regional and provincial) planning analyses by recognizing risks posed by natural hazard and the vulnerability of the population, economy and the environment to these hazards.

> The Guidelines **direct** natural disaster risk reduction efforts in development planning processes

The Guidelines supplement the 2007 NEDA-ADB Guidelines on Provincial/Local Planning Expenditure Management (PLPEM), mainly the volume on the formulation of the Provincial Development and Physical Framework Plan (PDPFP). Development and physical framework plans guide future land use and physical developments and the location of programs, projects and activities in the province and region. The geographic territory of the province and region are delineated according to the following land uses: settlements land use, production land use, protection land use and transport/infrastructure land use. The integration of risks in these plans will result to:

a. Better appreciation of planning environment through the detailed information on natural hazards, the risks attendant to them and the vulnerabilities of exposed areas and communities

b. More realistic projection of demand and supply of land for settlements, production, protection and infrastructure as development are restricted in areas prone to natural hazards
c. Better understanding by decision-makers to set development goals, objectives and targets to reduce loss of life and property from natural hazards as risks of fatality and property damage are quantified
d. Identification of constraints to development arising from risk factors become part of the development issues, and the corresponding goals, objectives/ targets and strategies
e. Appropriate risk reduction measures are included in priority programs and projects, evaluated vis-à-vis quantified risks, eventually provided with budgetary resources and implemented

FEATURES OF THE GUIDELINES

Risk-based Analysis. The Guidelines provide methodologies for risk estimation and valuation. These methods assess and quantify disaster event consequences (consequence analysis) in terms of fatalities or loss of lives and the cost of property losses or damages, normally categorized as direct costs. Indirect costs, however, have not been covered in this document and thus form one of the limitations of the risk assessment as considered and used in the Guidelines.

Recognizing risks as development constraint will **lead** decision makers to set goals on reduced loss of life and property damage

Use of Geographic Information System (GIS). Another key feature of the Guidelines is the use of GIS, an objective and systematic means of carrying out the risk assessment process using map overlay techniques. Use of GIS software is suggested since the processing may be tedious; however, the Guidelines also show how computations may be done through spreadsheets.

Multihazard coverage. The natural hazards considered in the Guidelines pertain only to events of geologic and hydrometeorologic origin and do not cover the biological, technological, man-made and environmental degradation hazards. However, the Guidelines, having a quantitative comparability feature, is flexible enough to include all kinds of hazards and concomitant risks.

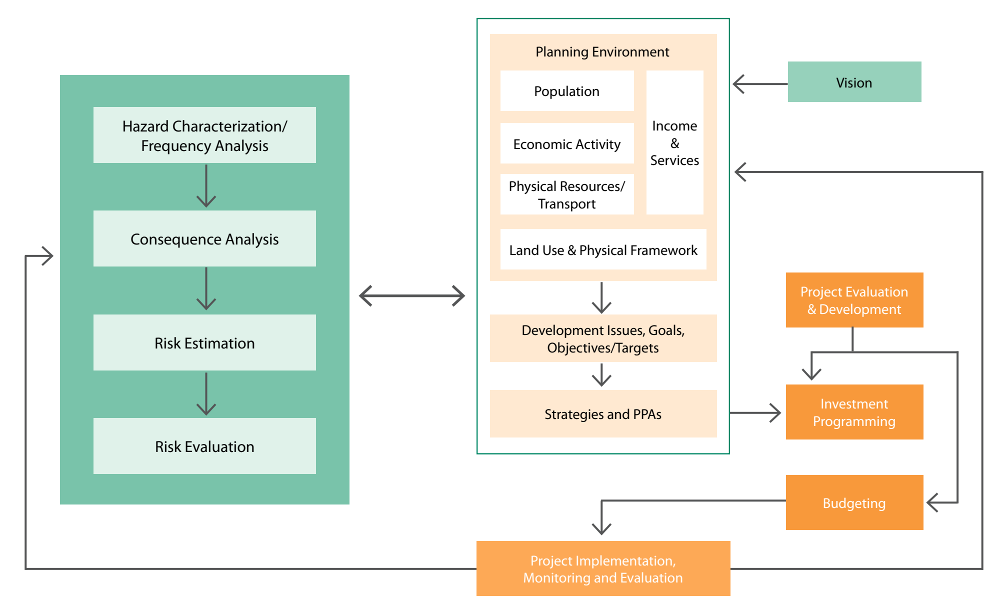
FOCUS AND APPLICATION OF THE GUIDELINES

Hazards are location-specific and **do not respect** political boundaries

The Guidelines take the provincial level as the operational unit of analysis. Hazards are location-specific and do not respect political boundaries. Provincial planning will therefore allow for intermunicipal analysis. Another reason is that the province's geographic coverage makes it possible to identify specific interventions that may not be done at the regional level. Moreover, the province will be in a position to co-opt the participation of local governments in both the planning and implementation stages. The application of the Guidelines however could be extended to the regional level since the region is the "sum of provinces" or is seen as a "bigger" province. The methodologies may also be applied at municipal and city levels; although at these levels, land use planning is more precise as these are translated into zoning ordinances. The application can likewise extend to interregional and special development areas particularly in watersheds and river basins.

MAINSTREAMING FRAMEWORK

The conceptual framework for mainstreaming DRM in subnational plans takes off from the PDPFP planning framework. It describes the steps in disaster risk assessment (DRA) and identifies their entry points in the plan formulation process.



Risk estimates are used to **prioritize** areas for further evaluation of vulnerability

Briefly, DRA involves: a) hazard characterization/frequency analysis, b) consequence analysis, c) risk estimation, and d) risk prioritization. On the other hand, the entry points in the plan are in the following: a) analysis of the planning environment; b) identification of issues and problems; c)formulation of goals, objectives and targets; d) formulation of development strategies; c) identification of programs, projects and activities.

The secondary aspect of DRR mainstreaming is in the plan implementation stage. This includes: a) the development of DRR-sensitive criteria for prioritization and ranking of programs, projects and activities (PPAs) in the investment program and project evaluation and development and b) financing options for the PPAs.

APPROACH AND METHODOLOGY

The main feature of the Guidelines is the four-step disaster risk assessment that provides for two types of risk estimates: risk of fatality and the risk of property damage. The risk of fatality essentially estimates the expected number of fatality on an annualized basis, while the risk of damage is the estimated value of property that may be damaged on an annualized basis.

The steps in undertaking risk assessment are, as follows:

a. Hazard Characterization and Frequency Analysis – involves identifying and characterizing the hazards that threaten an area using hazard maps and past damage and lost data.
b. Consequence Analysis – involves determining the probable effects or consequences of these potential hazards to exposed population and land uses expressed by the number of fatalities and cost of property damages, respectively. The estimates are based mainly on exposure (i.e., location, area affected by hazard) and best estimates of potential impact to life and property.
c. Risk Estimation - involves estimating the risk expressed as the expected annual number of lives lost, damage to property for a given area from a particular hazard. The estimates are used to prioritize areas for further evaluation.
d. Risk Prioritization - areas are prioritized by comparing the risk estimates to the acceptability criteria and assigning matching scores. The areas identified as urgent will be further evaluated by assessing conditions of the place and identifying and describing factors which contribute to their vulnerabilities.

The implications and acceptability of the risks and vulnerabilities will reveal the development issues and concerns that will be incorporated into the planning, programming, financing and project development decisions. The sequence for this stage is: a) analysis of the risk impact to the land use and physical framework; b) identifying development issues and their translation to goals, objectives and targets based on the risks identified; and c) specifying DRR measures (strategies and PPAs).

USE AND RELEVANCE OF THE GUIDELINES

The Guidelines is useful in the following:

a. Identifying areas that are highly restricted to human settlements and economic activities particularly those that: (i) are highly prone to the adverse impacts of hazards, e.g., flood-prone areas, landslide-prone areas; (ii) need to lessen the effects of hazardous events, e.g., water retention areas, lahar-playing fields, buffer zones; and (iii) need to ensure effectiveness of response activities, e.g., escape routes and staging areas;
b. Highlighting the use of development criteria or indicators as measures to identify and describe vulnerability (or resilience) and their integration in the disaster risk management framework;
c. Making differentiated decisions on land uses which may involve specifying acceptable land uses based on the risk assessment results, e.g., agricultural use of flood prone areas might be allowed but not settlements;
d. Developing disaster risk criteria in land use planning and zoning. The results of the vulnerability and risk assessment will provide clear directions to cities and municipalities in the crafting of corresponding preventive and mitigating policies and measures that address the disaster risks affecting them. These can also supplement decision-making on matters involving zoning regulations such as the prescription of more strict building codes like minimum elevation and heights of buildings, prohibition of basements and use of certain types of roof; and
e. Identifying all other appropriate risk management decisions depending on the

Developing disaster risk criteria **is necessary** in land use planning and zoning risk assessment. In general, all DRR measures and options can be classified as avoidance or elimination, reduction or mitigation, sharing or transfer of the hazard potential or disaster risk. The do-nothing option thus becomes a purely management decision.

CONTENTS AND ORGANIZATION

The Guidelines is organized as follows:

Chapter 1, Introduction, acquaints the user with the background, rationale and main features of the Guidelines. It explains the policy context and linkage to the PLPEM Guidelines, which remains as the main guide in the overall planning process. The chapter emphasizes that the DRR Guidelines enhance and do not alter the current plan formulation methodologies that planners are already familiar with. It concludes by identifying opportunities and challenges in mainstreaming DRR into planning processes and next steps.

Chapter 2, Disasters and Development: The Case for Mainstreaming DRR in Development Planning, establishes the relationship of disasters and development, and then explains how development planning can be a useful means towards reducing disaster risks.

Chapter 3, Mainstreaming Framework, discusses the steps in disaster risk assessment and identifies their entry points in the plan formulation process. The DRA results become part of the planning analysis and are later used to assess impact to the land use and physical framework and become the basis for identifying risk reduction strategies, programs and projects.

Disaster risk assessment should be part of the planning analysis

Chapter 4, Disaster Risk Assessment, demonstrates the DRA methodology showing in detail the computational and GIS techniques. Indicative look-up tables for return period and factors for fatality and property damage for various hazard events as well as a methodology for estimating cost of property damage per type of land use have been incorporated in the Guidelines. Surigao del Norte is used as case study. The hazard maps produced under the Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management (READY) Project were used.

Chapter 5, Mainstreaming Risk Assessment Results in the Plan, shows how the results of the DRA are utilized to enhance analyses in the various phases of the plan formulation exercise: from visioning to the analyses of the planning environment; identification of development issues, goals, objectives and targets; and their translation into development strategies and PPAs or what is termed as mainstreaming in the plan formulation stage. Case illustrations from the pilot DRR-enhanced PDPFP of Surigao del Norte and RPFPs of Ilocos and Caraga Regions are included.

The Guidelines include GIS-based disaster risk assessment

Chapter 6, Mainstreaming DRR in Investment Programming, Budgeting, Project Evaluation and Development, Monitoring and Evaluation, discusses the secondary entry points for DRR mainstreaming in plan implementation, namely: investment programming, budgeting, implementation and monitoring and evaluation, with project evaluation and development as an added tool to improve project design and financing. Guide questions for logically framing monitoring and evaluation during implementation are presented to reveal if planned risk reduction measures and development programs resulted to the desired outcomes and so further aid in future planning decisions.

The Guidelines also include eight technical annexes as additional reference materials that can aid in the preparation of the DRR-enhanced plans.

Annex 1, Natural Hazards: An Overview, explains how, why, and when hazards occur. It familiarizes the users of the Guidelines on the science and behavior of natural hazards, and enables them to analyze and interpret hazard maps.

Annex 2, Probabilistic Treatment of Hazards, explains the concepts of frequency analysis, return period and the probability of occurrence of hazard events and their application in estimating annual risks.

Annex 3, Assigning Return Periods, presents in greater detail how the default return periods for geologic, volcanic and hydrometeorologic hazards were derived.

Annex 4, Measuring Direct and Indirect Impact of Natural Disasters in the Philippines, explains the direct and indirect economic impacts of disasters. Direct losses occur from physical damage to assets while indirect losses refer to declines in production capacity, reduced income, and increased costs due to damaged infrastructures and lifelines.

Annex 5, Deriving Factors for Fatality and Factors for Property Damage, elaborates the steps and assumptions in estimating the probable proportion of fatalities to the population and probable proportion of damage to properties from a hazard event.

Annex 6, GIS-based Disaster Risk Assessment, introduces the basic concepts of GIS, explains the framework and assumptions in conducting DRA under a GIS environment, and demonstrates the step-by-step procedure in performing DRA, from hazard analysis to risk prioritization using a sample GIS dataset.

Annex 7, Characteristics of Resilience, summarizes the components of resilience, characteristics of a resilient community, and characteristics of an enabling environment.

Annex 8, Selected ODA Disaster Risk Reduction Programs and Policies, lists a number of programs and projects available to local government units in financing DRR measures.

1 Introduction

Introduction

The National Economic and Development Authority (NEDA), with assistance from the United Nations Development Programme and the European Commission's Humanitarian Aid Department through its disaster preparedness program (DIPECHO), formulated this set of Guidelines on Mainstreaming Disaster Risk Reduction (DRR) in Regional and Provincial Development and Physical Framework Plans as an instrument to direct DRR efforts in development planning processes. The Guidelines introduce a disaster risk assessment methodology that uses the resulting risk estimates in enhancing planning analyses and decision making.

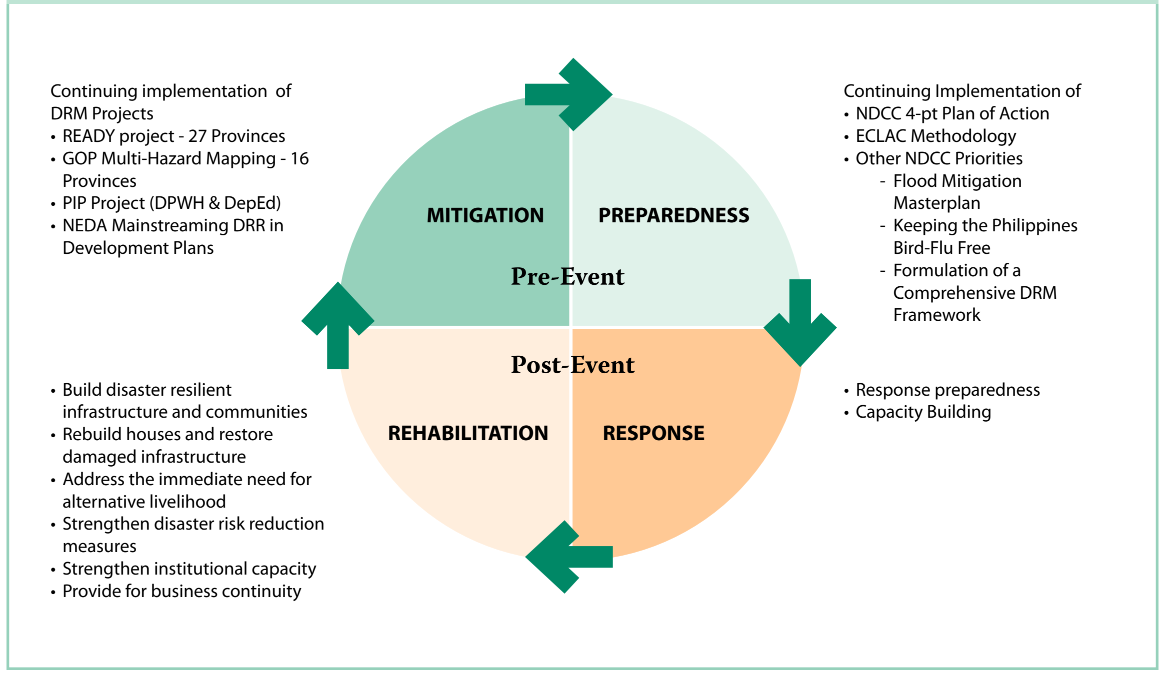
This introductory chapter provides an overview and acquaints the user with the background, rationale and main features of the Guidelines. The rationale for mainstreaming DRR into the development planning process is discussed in Chapter 2. The conceptual framework or the theoretical underpinnings of the approach are discussed in Chapter 3 while the application or operational methodology is elaborated in Chapter 4. Chapter 5 discusses how the results of disaster risk assessment is mainstreamed into the plan and how appropriate DRR measures are selected. Chapter 6 shows how the risk-sensitive plan is mainstreamed in the other phases of the development planning cycle, specifically, in investment programming, budgeting and project evaluation and development.

A. POLICY CONTEXT

The NEDA-Regional Development Office, through the National Land Use Committee which it chairs, adopted in March 2006 an action agenda that aims to contribute to the reduction of risks associated with natural disasters. Specifically, the agenda sets to put in place preventive measures to mitigate or totally avoid the damaging effects of disasters. These measures include supporting mapping activities to characterize natural hazards in a specific area and delineate their geographic impact coverage, augmenting development and physical framework plans with analysis of hazard and potential risks, and enhancing capacity of local government units (LGUs) in instituting DRR measures.

The Guidelines also provide critical inputs to the National Disaster Coordinating Council framework (NDCC) (Figure 1.1), which lays out the government's priorities to respond and hasten reconstruction/rehabilitation after a disaster, and defines mitigation and preparedness activities that can reduce damage before disasters happen.

Figure 1.1 The National Disaster Coordinating Council Framework

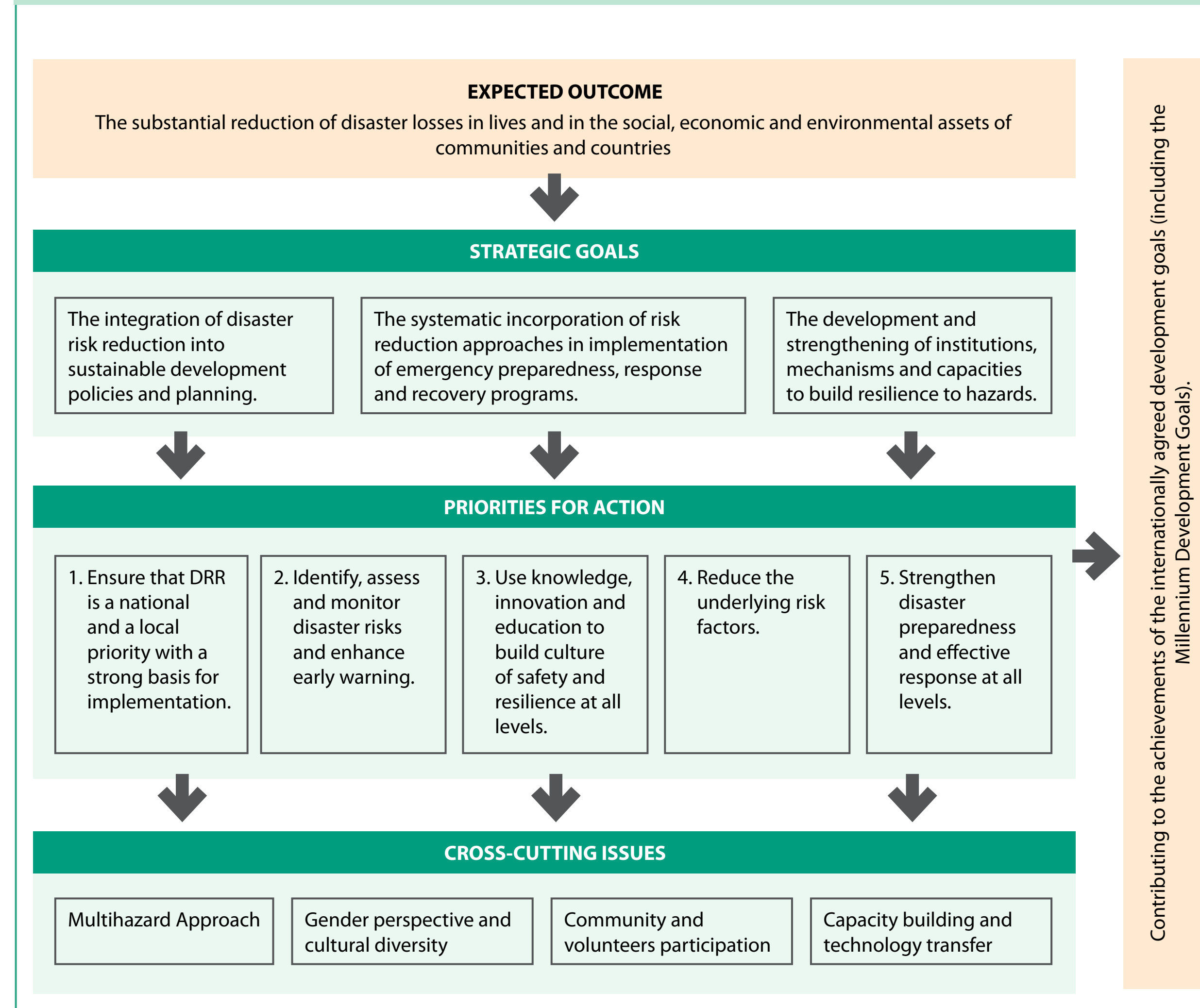


Source: NDCC, 2007

The preparation of these Guidelines complements the Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management (READY) Project of the Office of Civil Defense (OCD), Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Philippine Institute of Volcanology and Seismology (PHIVOLCS), Mining and Geosciences Bureau (MGB), and National Mapping and Resource Information Authority (NAMRIA). The READY Project has three components: multihazard identification and assessment; community-based disaster preparedness; and mainstreaming of risk reduction into the local development planning process.

In the global context, the Guidelines were prepared in keeping with the Hyogo Framework for Action (HFA) adopted in January 2005 during the World Conference on Disaster Reduction. The HFA calls for the effective implementation of DRR efforts to substantially reduce disaster losses by 2015 in terms of lives and in the social, economic, and environmental assets of communities and countries, as an essential condition for sustainable development. The HFA specifically called on governments to mainstream risk reduction within development and land use planning, ensure that scientific inputs influence risk assessment processes and that risk factors are addressed through sound environmental and natural resource management and social and economic development practices, among others.

Figure 1.2 Hyogo Framework for Action: 2005-2015
Building the Resilience of Nations and Communities to Disasters



Source: www.unisdr.org/eng/hfa/hf-summary.htm

B. LINKAGE WITH THE 2007 NEDA-ADB GUIDELINES ON PROVINCIAL/LOCAL PLANNING AND EXPENDITURE MANAGEMENT (PLPEM)

These Guidelines supplement the PLPEM (Box 1.1), particularly the volume on the preparation of the Provincial Development and Physical Framework Plan (PDPFP). By introducing DRR concepts and principles and risk assessment techniques in the plan formulation methodologies of the PDPFP, planning analyses and decision making are enhanced.

Box 1.1 NEDA-ADB Provincial/Local Planning and Expenditure Management Guidelines

The PLPEM Guidelines, developed under Phase 1 of the NEDA-ADB Technical Assistance on Strengthening Provincial and Local Planning and Expenditure Management, consist of the following five volumes: Integrated Framework; Provincial Development and Physical Framework Plan; Investment Programming and Revenue Generation; Tools and Techniques on Budgeting and Public Expenditure Management; and Project Evaluation and Development. The PLPEM Guidelines aim to help provinces to plan more effectively by identifying, preparing and prioritizing critical programs and projects, and raising and allocating resources to finance these programs and projects. The Guidelines also emphasize the importance of: (a) horizontal linkages that view planning-investment programming-budgeting as phases of a single cycle; and (b) vertical linkages that ensure that the province could contribute to the attainment of regional and national development objectives and could support intermunicipal development initiatives.

C. FEATURES OF THE GUIDELINES

1. RATIONALE

These Guidelines serve as a tool to enhance subnational (regional and provincial) planning analyses by recognizing risks posed by natural hazards. The specific plans where mainstreaming will be done are the PDPFP and the Regional Physical Framework Plan (RPFP). The PDPFP already merges the traditionally separate Provincial Development Plan and Provincial Physical Framework Plan. At the regional level, the RPFP and the Regional Development Plan (RDP) remain separate. However, the RDP is seen as an implementing instrument of the RPFP, thus, a risk-sensitive RPFP will be able to enrich the medium-term socioeconomic agenda of the RDP.

Mainstreaming DRR into the PDPFP and RPFP is strategic since both plans provide the framework for planning and managing land use. The PDPFP, in particular, allows the provincial government to gather and analyze information about the sustainability of land for development, so that the limitations of hazard-prone areas are understood by policymakers, potential investors and community residents.

The integration of risk assessment in these plans will result in:

a. Enhanced understanding of the planning environment through knowledge on natural hazards and the vulnerabilities of exposed communities, their social and economic fragilities and their lack of resilience or ability to cope with or recover during times of disaster;
b. More realistic projections of demand and supply of land for settlements, production, protection and infrastructure. Development, as a matter of policy that needs to be promulgated, should be discouraged and restricted in areas prone to natural hazards;
c. Increased awareness among decision makers in setting development goals and targets on reduced loss of life and property from natural hazards as risks of fatality and property damage are quantified;
d. Identification of constraints to development arising from risk factors as part of the development issues and goals;
e. Inclusion of appropriate risk-reduction measures in priority programs and projects as evaluated vis-à-vis quantified risks, and eventually provided with budgetary resources and implemented; and
f. Monitoring and evaluation of disaster risks and their corresponding reduction measures.

2. RISK-BASED ANALYSIS

A unique feature of the Guidelines is risk estimation. This involves estimating and imputing costs on the possible loss, damage and disruption that may arise when a disaster occurs. In general, the computations should lead to the identification of areas of high risks and indicate how a disaster affects the total economy or the society as a whole.

The Guidelines provide a method to assess consequences of a disaster event (consequence analysis) in terms of fatalities or loss of lives and the cost of property loss or damage, normally categorized as direct costs. Indirect costs, however, have not been covered in this document and thus form one of the limitations of risk assessment. Examples of indirect costs involve the costs of disruption to economic activities or the nondelivery of vital services.

The resulting cost estimates should reveal the magnitude of loss and damage when a disaster happens. They are also useful in the assessment and justification of interventions that will mitigate and reduce the negative effects of the disaster as well as the responses to enhance the resilience of communities. Ideally, the costs of such risk reduction interventions are justified when these are far less than the estimated costs of damages and losses.

The quantification or estimation of risks therefore will provide the bases for the social and political acceptability of DRR proposals.

3. USE OF GEOGRAPHIC INFORMATION SYSTEM (GIS)

Another key feature of the Guidelines is the use of GIS, an objective and systematic means of carrying out the risk assessment process that uses map overlay techniques. The use of GIS for risk assessment has the following advantages:

a. Puts structure and organization to the complex and numerous input planning variables as it allows ease in the integration of the various data sets coming from different sources;
b. Serves as a powerful visualization and evaluation tool to provide rapid and concise means of presenting assessment results and hence facilitate decision making and policy formulation; and
c. Provides reusable sets of information and data sets that can be utilized for other planning related purposes.

The methodologies, however, would largely be dependent on the availability of data sets required, particularly, hazard-related information and maps from knowledgeable mandated agencies such as PHIVOLCS, PAGASA and MGB.

Normally, the level of analyses in regional planning require map scales of 1:250,000 while at the provincial planning level, the analyses require map scales from 1:50,000 to 1:100,000. Current work in base mapping and hazard mapping by mandated agencies, especially through the READY project, is producing input sets of information at larger scales of 1:10,000 to 1:50,000.

For other data sets like socioeconomic attributes, the level of disaggregation may be up to the barangay level. The availability of this information makes it possible for regions to undertake analysis at the municipal level and, similarly, for provinces to pursue barangay level analysis. In any case, combining old and new sets of information in digital maps at different scales are facilitated with use of GIS mapping utilities.

The Guidelines do not endorse a specific GIS software package and any mention of names and brands in the Guidelines is related more to their availability and specific uses.

4. MULTIHAZARD COVERAGE

The natural hazards considered in the Guidelines pertain to events of geologic and hydrometeorologic origin. Among many hazards of such origins, covered are earthquake-related hazards, namely: (1) earthquake-induced landslide, (2) ground shaking, (3) ground rupture, (4) liquefaction, and (5) volcanic eruptions; (6) flooding; (7) storm surge; and (8) rain-induced landslide. These natural hazards are usually the extreme natural events that occur in any part of the Philippines and posing some threat to people and their assets. Such events may occur in very short time spans of seconds (e.g., when it comes to earthquake-related hazards) or weeks (e.g., for flooding).

Not covered as yet are biological hazards (e.g., outbreak of epidemic diseases, insect plagues); technological (industrial pollution, dam failures, transport or industrial accidents like fires, oil spills); or hazards brought about by acts of terrorism, armed conflict and similar events.

Hazards influenced by climatic variations, such as climate change and desertification, have not been included in the Guidelines, although these can also pose threats or trigger the seven natural hazards earlier mentioned. Risk reduction and adaptation measures related to them can also be part of the long-term intervention that may be considered.

5. FOCUS ON THE PROVINCE

Hazards are location specific but they do not respect political boundaries. Thus, it could be more efficient to address hazard issues at the subnational level particularly at the province rather than at the individual city or municipality. In fact, most hazards directly affect contiguous areas across several LGUs in a province or some LGUs across two or more provinces. Analysis at the regional level is necessary in this case, although the "zonation" of common hazards and risk-reduction options should be considered. Furthermore, province-focused analysis is beneficial since: (a) key lifelines like access roads, power and communication lines and even hospital services are designed to cover wider areas; (b) more specific interventions can be designed at this level; and (c) participation of local governments and communities are critical for key interventions to succeed.

The application of the Guidelines can be extended to a region, since the region is the "sum of provinces" or may be considered as a "big" province. The methodologies may also be applied at municipal and city levels; although at these levels, land use planning measures are more precise given the zoning powers of these LGUs. The Guidelines can also be applied to interregional and special development areas, such as watersheds and river basins.

6. SCOPE AND LIMITATION

The methodologies herein were based on currently available data and information sets, including hazard maps provided by agencies such as PHIVOLCS, PAGASA and MGB that identify areas susceptible to a particular hazard.

Probability matrices and look-up tables were prepared based on such available information, which represent the best estimates to depict hazard events and their corresponding consequences. The methodology and assumptions used should be refined as more information becomes available, such as return periods of occurrences of different hazard events and data on damage to property and loss to life.

7. USE AND RELEVANCE

The main uses of disaster risk assessment results are the following:

a. Identifying areas where human settlements and economic activities are highly restricted particularly those: (a) highly prone to hazards, e.g., flood-prone areas, landslide-prone areas; (b) needed to lessen the effects of a hazardous event, e.g. water retention areas, lahar-playing fields, buffer zones; and (c) needed to ensure effectiveness of response activities, e.g., escape routes and staging areas;
b. Highlighting the development criteria or indicators that are used as measures to identify and describe vulnerability (or resilience) and their integration in the DRR framework;

c. Making differentiated decisions or restrictions on land uses such as specifying acceptable land use types according to the risk assessment results, e.g., agricultural use of flood prone areas might be allowed but not settlements;
d. Developing disaster risk criteria in land use planning and zoning. The results of the vulnerability and risk assessment will provide clear directions to cities and municipalities in the crafting of corresponding preventive and mitigating policies and measures that address the disaster risks affecting them. These can also supplement decision making on matters involving zoning regulations such as the prescription of strict building codes like specification of minimum elevation and heights of buildings, prohibition of basements in flood prone areas, and the use of certain types of roofing construction in areas covered by possible volcanic debris fallouts; and
e. Identifying all other appropriate risk-reduction decisions depending on the risk assessment. In general, all DRR measures and options can be classified as avoidance or elimination, reduction or mitigation, sharing or transfer of the hazard potential or disaster risk. The do-nothing option thus becomes a purely management decision.

D. DRR-ENHANCED PDPFP AND RPFP

1. PURPOSE

The Guidelines seek to enhance the planning outputs – the PDPFP, RPFP and by extension, the RDP. In general, it will highlight how disaster risk assessment is undertaken and how the resulting risk estimates may be evaluated and used to improve all aspects of the plans. A DRR-enhanced plan will significantly contribute to risk reduction efforts and help make societies more resilient to natural hazards, and at the same time ensuring that development efforts shall not be compromised by these hazards.

The DRR-enhanced plan will:

a. Provide a firmer basis for sectoral plans especially those that relate to the physical aspects of development like land, natural resources, and infrastructures as well as the socioeconomic dimensions that aim to lessen vulnerabilities and improve resilience of communities to disasters;
b. Reconcile and rationalize land use and development proposals among

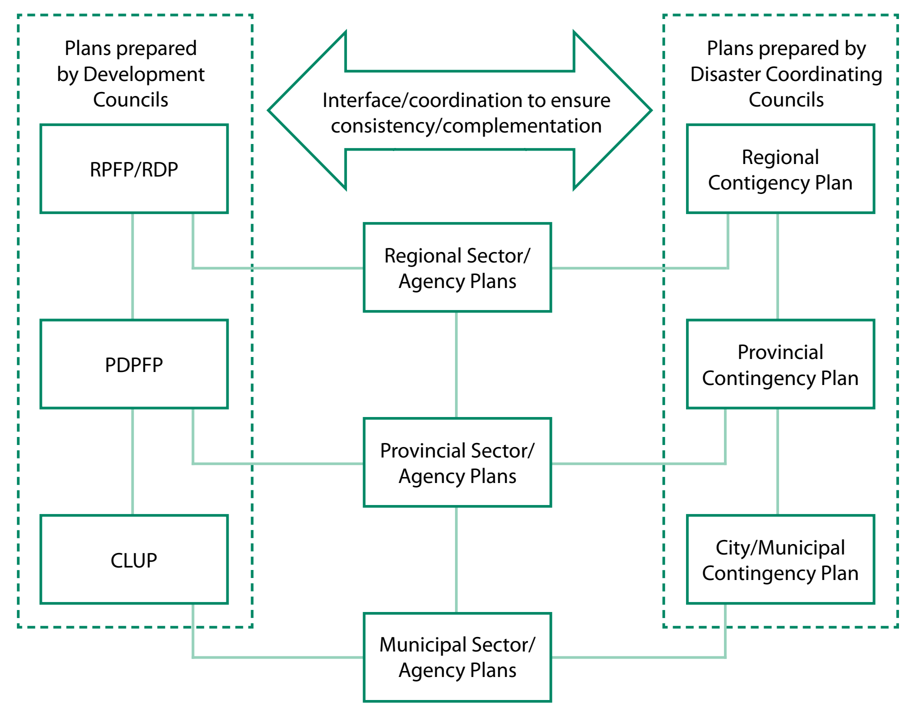
adjoining localities and with higher level framework plans. For example, contiguous areas across several LGUs that are hazard prone should be commonly delineated (e.g., as high risk zones) and the corresponding complementary risk reduction options identified and mutually agreed upon;

c. Guide government agencies and private developers, particularly those undertaking large-scale projects, on the proper project location and the implementation of the necessary mitigation works; and
d. Provide a basis for adjudicating conflicts arising from the implementation of land use plans, development projects, and similar activities that straddle the boundaries of two or more municipalities within the province.

These features may also be adopted by the enhanced RDPs or RPFPs particularly on the resolution of interprovincial concerns.

2. LINKAGES WITH OTHER PLANS

Figure 1.3 Linkages of DRR-Enhanced Plans



Note: The NEDA-ADB PLPEM Guidelines advocate the preparation of sectoral action plans rather than sectoral plans per se at the provincial level since the Provincial Development and Physical Framework Plan already captures the sectors and areas relevant to the development of the province.

In general, the enhanced plans are prepared to guide detailed development planning work, be it in local level planning, i.e., preparation of comprehensive land use plan, and/or sectoral planning of line agencies. It should be understood that the planning outputs, enhanced by this mainstreaming approach, consist of policy options and generalized programs and projects which the next level stakeholders can work on in their subsequent more detailed planning work. In general, the desired outcomes should be towards safer and more resilient communities.

The DRR-enhanced plans are also expected to complement and be consistent with the disaster management plans or contingency plans[1] of the provinces or of the regions. The databases and maps developed for these plans will be useful for preparedness activities like identifying general locations for temporary shelter facilities, evacuation routes, etc.

In terms of institutional responsibilities and linkages, the DRR-enhanced plans are prepared within the processes of the Regional and Provincial Development Councils while the contingency plans through the Regional and Provincial Disaster Coordination Councils. It is therefore important that the preparation and implementation of these two distinct sets of plans be synchronized to ensure the desired complementation and consistency.

In the long-run, however, it is desired that disaster management and contingency plans are mainstreamed into the development and physical framework plan with the Development Councils and Disaster Coordinating Councils involved in the preparation.

E. PLANNING CHALLENGES

The following are the challenges in mainstreaming DRR into the planning processes:

a. ***Limited knowledge on the frequency of occurrence and the consequence or severity of hazards.*** Available data are still incomplete or inaccurate. Planners need to continually consult with engineers, geologists, hydrometerologists, social scientists and economists to improve planning analyses and decision making;
b. ***Changing risks are difficult to account for.*** Hazards can change and so could

[1]A contingency master plan would provide an overview of the situation, policies and objectives, plans and procedures for feedback needed to prepare before and during natural disaster situations. Source: UNHCR-NDCC, 2003

the communities and the environment that are affected. With climate change, risks from hydrometeorologic hazards could be compounded and would need scientific information for adaptation;

c. ***Existing land use is often very difficult to change.*** Land use decisions, however, must seek a balance between individual needs and the good of the entire community. For example, the decision to restrict settlements from the delineated high risk zones would imply the resettlement of affected families to other areas or the implementation of the attendant structural measures that should ensure the safety of the rest of the families within the bigger community;
d. ***Lack of integration of jurisdictional boundaries.*** Dealing with the impacts of disasters requires the necessary integration of various jurisdictional boundaries, particularly where cumulative impacts occur. Such impacts are very difficult to foresee and plan for all possible contingencies; and
e. ***Getting local ownership support and implementation.*** It is very important that the communities affected are able to know the disaster risks that they are confronted with so that they are in a better position to decide on the appropriate mitigation and coping options. At the very least, they can come to realize the consequences of not treating the risks.

F. CONCLUSION

The disaster risk assessment (DRA) methodology introduced in the Guidelines was developed based on availability of data on natural hazards. The results provide the initial approximation of the disaster risks confronting a province or region and become the bases for appropriate measures to mitigate, reduce or totally eliminate such disaster risks. Definitely, more elaborate and accurate data sets are preferable in order to better identify and assess disaster risks and have the firmer basis for the appropriate DRR options. Closer collaboration among various stakeholders (the affected communities, decision makers, planning professionals, those involved in disaster coordination, the scientific community and the academe) is thus important in order to have better estimates and appreciation of the risks involved. Moreover, the collaborations when institutionalized should lead to continued benchmarking work and the conduct of more specific vulnerability studies. Workable institutional arrangements should thus be forged towards a more efficient and cost-effective disaster risk information generation, sharing and management system.

The ultimate use of the risk estimates is to provide the bases, as shaped by existing

factors and situations, for the corresponding risk reduction options. The results of the analysis would eventually be used to select and prioritize DRR decisions. The focus of the estimates should not be on the value or costs per se, but rather on the general guidance they provide for decision making.

It is evident that disaster risk assessment, particularly its approaches and methodologies, would benefit from further refinement. Research and development should be encouraged, particularly in risk and vulnerability assessment and the development of compatible approaches for assessing the probability of occurrence and consequence of specific hazards.

In summary, the planning practice benefits from the application of the methodologies and procedures presented in these Guidelines. Further enhancements can be done in the future particularly on the following study areas:

a. Formulation of standard planning nomenclatures in relation to natural disaster risks, i.e., terminology, notation and symbols, both in texts and on maps;
b. Establishing common databases on the natural environment, general land uses, vulnerability parameters as required by the DRA methodology including the specification of compatible map scales, preferably identical if not the same base maps among mandated agency generators and users;
c. Establishing comparable probabilities of frequencies of occurrence and consequences for various types of natural hazards and their impact on more specific categories of the different elements at risk;
d. Establishing levels of tolerable or acceptable risks among communities and local governments;
e. Benchmarking and identifying best practices on DRR measures and options; and
f. More detailed integration of climate change risk reduction and adaptation measures

The planning frameworks and procedures will be effectively improved with the mainstreaming of DRR into the PDPFP and RPFP. These DRR-enhanced plans will significantly contribute to the resiliency of our country's societies by ensuring that the negative effects of natural hazards are lessened, if not totally mitigated. In general, the strategies may relate to the following situations:

a. Increased resilience of the province/region to natural disasters

Programs, projects and activities that increase resilience (i.e., poverty alleviation, food security, access to health services, etc.) may already have been addressed in the sectoral development goals and objectives, but the importance attached to their objectives (and related criteria) may be changed in view of the vulnerabilities and risks, which highlight the role of increased resilience in DRR.

b. Reduced exposure of populations and assets through appropriate DRR measures

Programs, projects and activities related to reducing human and property exposure to hazard (i.e., early warning, preparedness, structural mitigation, community based risk management, asset protection through insurance, etc.) are more likely to compete with other interests in the use of limited public funds. Its importance in the overall development framework will depend on the value placed by decision makers on risk assessment especially in the way DRR strategies complement development objectives.

2 Disasters and Development: The Case for Mainstreaming Disaster Risk Reduction

Disasters and Development: The Case for Mainstreaming Disaster Risk Reduction (DRR)

This chapter presents the importance of mainstreaming DRR in subnational plans. It first establishes the relationship of disasters and development, and then explains how development planning can be a useful means towards reducing disaster risks.

A. DISASTERS AND DEVELOPMENT

Natural hazards act as triggers to disasters and place areas at risk. A natural disaster results when a natural hazard causes serious disruption, causing human, material, economic or environmental losses that exceed the ability to cope of those affected.

1. NATURAL HAZARD EXPOSURE

The Philippines is one of the countries in the world that is prone to natural hazards. It recorded a total of 373 disaster events triggered by natural hazards from 1905 to 2006 or about 4 incidents per year (OFDA/CRED, 2006).

The country's exposure to disaster is largely due to its location and geographic landscape. Composed of 7,107 islands, it is one of the world's largest archipelagos. It has a long coastline which makes it vulnerable to sea-level rise from climatic conditions. The Philippines is located along the Pacific Ring of Fire, making it vulnerable to earthquake, tsunamis and volcanic hazards. It has 220 volcanoes, 22 of which are classified as active. It lies along the Western Pacific Basin, a generator of climatic conditions such as monsoons, thunderstorms, intertropical convergence zones, typhoons and El Niño. On the average, 20 tropical cyclones cross the Philippine area of responsibility annually. The damaging elements of tropical cyclones are high winds, storm surges and floods.

2. IMPACT OF DISASTERS

The impact of disasters in terms of lives lost and damage to property is staggering. Deaths from natural disasters in the 1990 decade and in 2000-2006 have increased compared with the 1980 decade levels. A significant number of deaths are caused by tropical cyclones. The National Disaster Coordinating Council (NDCC) has estimated that an average of 500 people are killed each year due to tropical cyclones during the period 1970-2002. The high number of deaths in the 90s was mainly due to the 1990 earthquake that struck Luzon and the 1991 Mt. Pinatubo eruption wherein lives lost numbered about 2,000 and 6,200 respectively. The NDCC recorded a total number of 36,019 deaths caused by natural disasters from 1980 to 2006 (Table 2.1).

Table 2.1 Deaths from Natural Disasters in the Philippines: 1980-2006

Years	1980-1989	1990- 1999	2000-2006
No. of Deaths	3,217	24,247	8,555

Source: NDCC

The average cost of direct damage from natural disasters from 1970 to 2006 is estimated at PhP15 billion at 2000 prices (Table 2.2). Direct damage covers damage to agricultural crops, public infrastructure and private homes. Damage is highest at about PhP70 billion in 1978 when 15 disasters struck the country. Other major disasters with high direct damage are the Luzon earthquake in 1990 (about PhP66 billion), the Mt. Pinatubo eruption in 1991 (about PhP33 billion) and the droughts in 1984 and 1987. As a result, the declines in gross domestic product (GDP) were estimated at: (a) 1.2 percent due to the 1990 Luzon earthquake; (b) 0.9 percent due to the Pinatubo eruption; and (c) 0.5 percent average due to typhoons every year.

Table 2.2 Estimated Damage of Disasters in Million Pesos at 2000 Prices

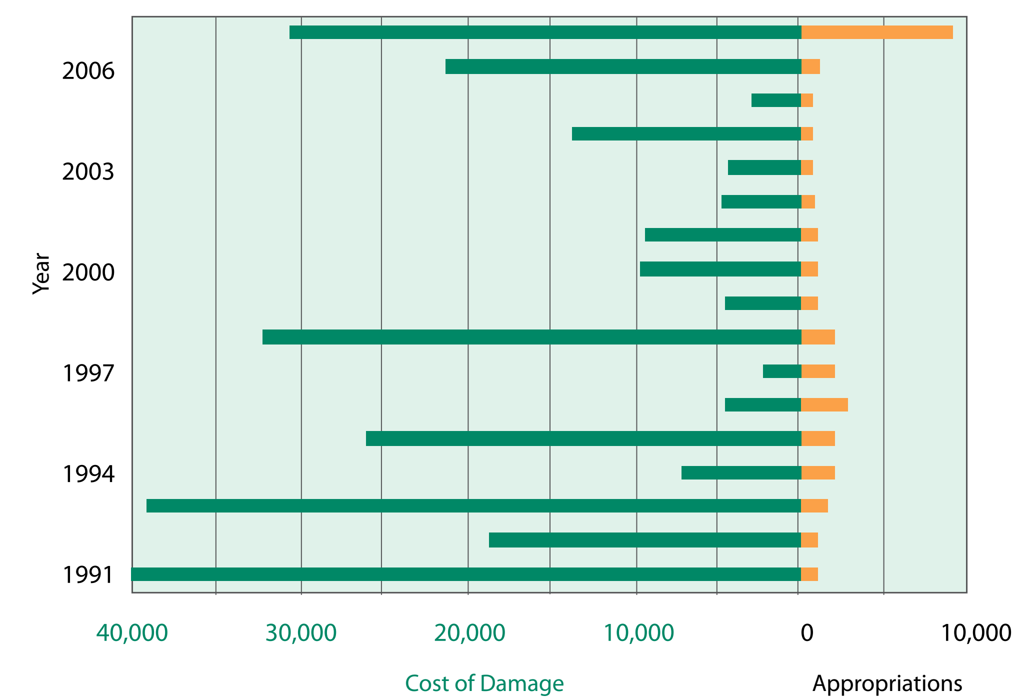
Years	1970-1979	1980-1989	1990- 1999	2000-2006
Cost of Damage	119,076	140,570	223,303	61,911

Source: NDCC

Natural calamities strain the national budget. Limited budgetary resources meant to finance basic services such as farm-to-market roads, school buildings, and low cost housing are instead rechanneled to reconstruction and rehabilitation efforts. To illustrate, the NEDA Regional Development Coordination Staff estimates that a calamity fund of PhP1 billion (at 2007 prices) can already construct 2,500 elementary level classrooms or 2,174 secondary level classrooms or 161.29 kilometers of new farm-to-market roads or 20,000 core resettlement units or 50,000 household covered

with Level III water supply projects. What further aggravates the situation is the financing gap, i.e., the difference in the level of annual appropriation of the calamity fund vis-à-vis the costs of damage (Figure 2.1). Disasters, therefore, erode the country's development gains. They do not only result to economic losses, but also hamper the provision of programs and services that should have improved the living conditions of communities. The money intended for pursuing planned development interventions are instead devoted to disaster response as well as to rehabilitation and reconstruction endeavors. This in turn reduces the capacity of communities or individuals to cope.

Figure 2.1 Calamity Fund Appropriations vs. Cost of Direct Damage, 1991-2007



Note: 2007 appropriations include 8 billion CARE fund
Source: NDCC, General Appropriations Act, 2007

3. DISASTER AND DEVELOPMENT LINKS

Disasters can interrupt the development process just as much as the pathways taken towards achieving development goals can lead to disaster. Development though plays a major role in reducing risks by overcoming vulnerability.

Disaster and development links are further explained by Table 2.3.

Table 2.3 Disaster-Development Nexus

	Economic Development	Social Development
Disaster limits development	• Destruction of fixed assets • Loss of production capacity, market access or material inputs • Damage to transport, communications or energy infrastructure • Erosion of livelihoods, savings and physical capital	• Destruction of health or education infrastructure and personnel • Death, disablement or migration of key social actors leading to erosion of social capital
Development causes disaster risk	• Unsustainable development practices that create wealth for some at the expense of unsafe working or living conditions for others or degrade the environment	• Development paths generating cultural norms that promote social isolation or political exclusion
Development reduces disaster risk	• Access to adequate drinking water, food waste management and a secure dwelling increases people's resiliency • Trade and technology can reduce poverty • Investing in financial mechanisms and social security can cushion against vulnerability	• Building community cohesion, recognizing excluded individuals or social groups (such as women), and providing opportunities for greater involvement in decision making, enhanced educational and health capacity increases resiliency

Source: UNDP, 2004

Disasters set back social and economic growth as development efforts are disrupted by natural disasters. Frequent disasters increase poverty and affect the achievement of the Millennium Development Goals (Table 2.4). Injuries and death as well as physical damage to infrastructure, agricultural crops, machinery and stocks and other livelihood activities may result in increased poverty and decline in welfare. Limited government resources intended to finance development activities are diverted to emergency response and relief leaving fewer resources for rehabilitation and reconstruction.

Disaster risk could also be a product of inappropriate development choices. Inappropriate land use practices and the lack of preparedness lead to greater disaster risks. The poor siting or location of settlements, economic activities and infrastructures, inappropriate use of resources, and rapid urban growth exert pressure on scarce land and other resources.

Development, however, reduces risks from disasters. An area marked by low levels of poverty, high employment opportunities, and adequate health care, education facilities and other basic infrastructures become more resilient or has greater capacity to cope with and recover from hazard events. The link among hazards, disasters and development is vulnerability. A natural hazard becomes a disaster when it affects a vulnerable population. From the vulnerability perspective, disasters result not from the hazard alone but also for the quality and quantity of elements exposed to the hazard on one hand and the vulnerability of the population on the other. Vulnerability of the population may be defined by their geographic location, assets, gender, and age, among others.

Table 2.4 Impact of Disasters on Achieving the Millennium Development Goals

GOAL 1: Eradicating extreme poverty and hunger. Extreme poverty and hunger have many consequences for the human condition in general and specifically in relation to disaster risk reduction. These broadly include the increased likelihood of population living in more hazard-prone areas, less protection against disaster impact, lowered coping capacity during and after the hazardous event, and severely hampered recovery period.
GOAL 2: Achieving universal primary education. Disasters greatly hamper the education process in many ways, through human loss and injury, social upheaval, school property damage and closings, and often with children having to leave school in the recovery period since their families would be needing their help in meeting basic needs.
GOAL 3: Promoting gender equality and empowering women. During and after disasters, women play a primary role in providing assistance to the family and community in disaster prevention activities. They are frequently, disproportionately and negatively affected by disaster impact and can also face exploitation in the aftermath of disasters.
GOAL 4: Reducing child mortality (children below the age of five). Infants and young children are among the most vulnerable segments of any given population. Young children became even more susceptible to physical and emotional trauma in the aftermath of disasters, interrupted basic infrastructure, stretched emergency and health care facilities, the outbreak of disease epidemics, and the loss or injury of care givers and income earners.
GOAL 5: Improving maternal health. In households where basic needs are hardly met, the pressure of post-disaster impact can eliminate the possibility of adequate maternal care as stretched resources can only cover immediate survival requirements. In many cases, gender inequity gives women less access to household income and assets.
GOAL 6: Combating HIV/AIDS, malaria and other diseases. Economically and socially marginalized and usually highly disadvantaged infected populations often suffer even greater impact during a hazard event, and in its aftermath, than others in their community. With basic infrastructure damaged and interrupted, water-borne and insect vector diseases can escalate rapidly, which severely hampers recovery and development efforts.
GOAL 7: Ensuring environmental sustainability. The link between environmental degradation and disaster occurrence and impact is well documented. Deforestation and soil erosion increase mudslides, landslides and flash flooding. Desertification increases drought. Climate change and variability is one of the causal factors of extreme weather events. Degradation of the resource base leads directly to less access to resource-based livelihoods, migration to marginal and often more hazard-prone areas, rural-urban migration - often into increasingly more vulnerable urban slums.
GOAL 8: Developing a global partnership for development. Mainstreaming disaster risk reduction continues to gain momentum at all levels with development efforts increasingly including risk reduction considerations – and with risk reduction initiatives also further incorporating wider development viewpoints.

Source: UNDP, 2005

B. MAINSTREAMING DRR IN DEVELOPMENT PLANNING

While natural hazards cannot be prevented from happening, the vicious cycle of disasters and underdevelopment can be reversed. This can be done through "mainstreaming" DRR in the development process. The UN-ISDR defines DRR as the "concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events." DRR therefore has a two-fold aim: one, "addressing vulnerability in order to be resilient to natural hazards" and two, "ensuring that development efforts do not increase vulnerability to these hazards."

Reducing disaster risks is more affordable than repairing damage or totally replacing damaged structures. The US Federal Emergency Management Authority estimates that every dollar spent on hazard mitigation generates an estimated four dollars on the average in future benefits. In the Caribbean, the World Bank also noted that spending one per cent of a structure's value on vulnerability reduction measures reduces by around a third the probable maximum loss from hurricanes.

"Mainstreaming" DRR into development means "to consider and address risks emanating from natural hazards in medium-term strategic frameworks and institutional structures, in country and sectoral strategies and policies and in the design of individual projects in hazard-prone countries" (Provention, 2007).

The lack of disaster risk considerations in the development processes, including rehabilitation efforts following major catastrophes, leads to investments in "constructing and reconstructing risks" which perpetuate the conditions for unsustainable human development. As a result, the achievement of poverty alleviation, good governance, and other related goals becomes more difficult.

1. DEVELOPMENT PLANNING AS VEHICLE FOR DRR

The aim of planning, both as a profession and as a process, is to make sure that people are better off, or at least they are not worse off than they were before. In mainstreaming DRR in planning, one can guide development and allocate resources toward the protection of life and assets, restoration of productive systems and livelihoods, regaining market access, and rebuilding social and human capital and physical and psychological health. Development plans therefore take on a critical role in disaster risk management.

The development planning process is comprehensive, multisectoral, and integrative in nature. As shown in the Figure 2.2, the process covers plan preparation, investment programming, project evaluation and development, budgeting, implementation, and monitoring and evaluation.

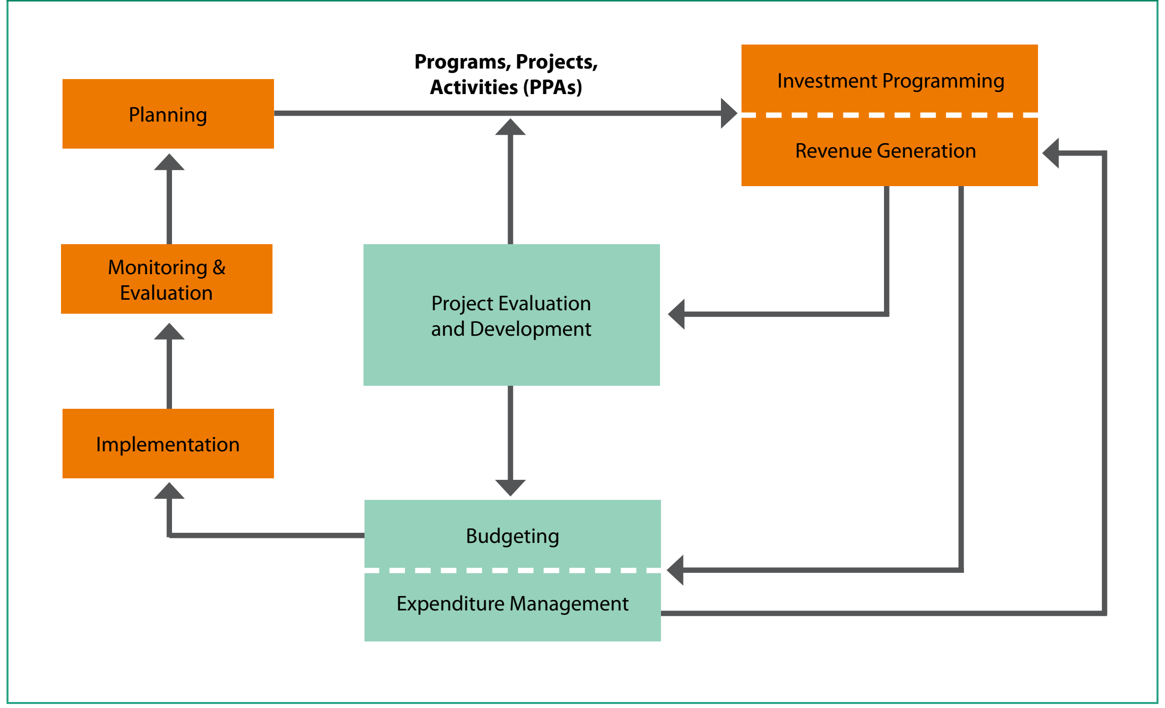
It starts with identifying development strategies based on an analysis of the region or province. These are translated into programs, projects, and activities (PPAs) that serve as the main inputs into the investment programming processes. Based on a predetermined set of criteria, these PPAs are further screened and ranked to produce the multiyear investment programs and the annual investment program. The investment programs, aside from ranking the priority PPAs, indicate the year(s) in which each PPA will be implemented and at what cost. Should available funds be insufficient to implement a PPA, measures to generate additional revenues to finance

the PPA can be identified. Funds are then allocated and the implementation proceeds for the target year. Programs and projects are evaluated to determine their costs and benefits, feasibility and prospective contributions to society, among others. When implemented, PPAs are monitored and evaluated and the results will be inputs to the next cycle of planning. (Refer to Volume 2: Provincial Development and Physical Framework Plan of the NEDA-ADB Guidelines on Provincial/Local Planning and Expenditure Management for more details).

With DRR assessment conducted within subnational planning, planners may: (a) take a comprehensive view of the physical, economic, social, environmental and institutional interrelationships and understand what constitutes the susceptibility of a region or province to risks from natural hazards; (b) integrate DRR management decisions in the spatial framework, i.e., risk mitigation, risk prevention, risk transfer and risk retention; and (c) carry out the DRR-enhanced PPAs in their investment programs that are:

- designed with consideration for potential disaster risks and to resist hazard impact;

Figure 2.2 Development Planning Process



Source: NEDA-ADB, 2007

- designed not to increase vulnerability to disaster in all sectors: social, physical, economic and environment; and
- designed to contribute to developmental aims and to reduce future disaster risks.

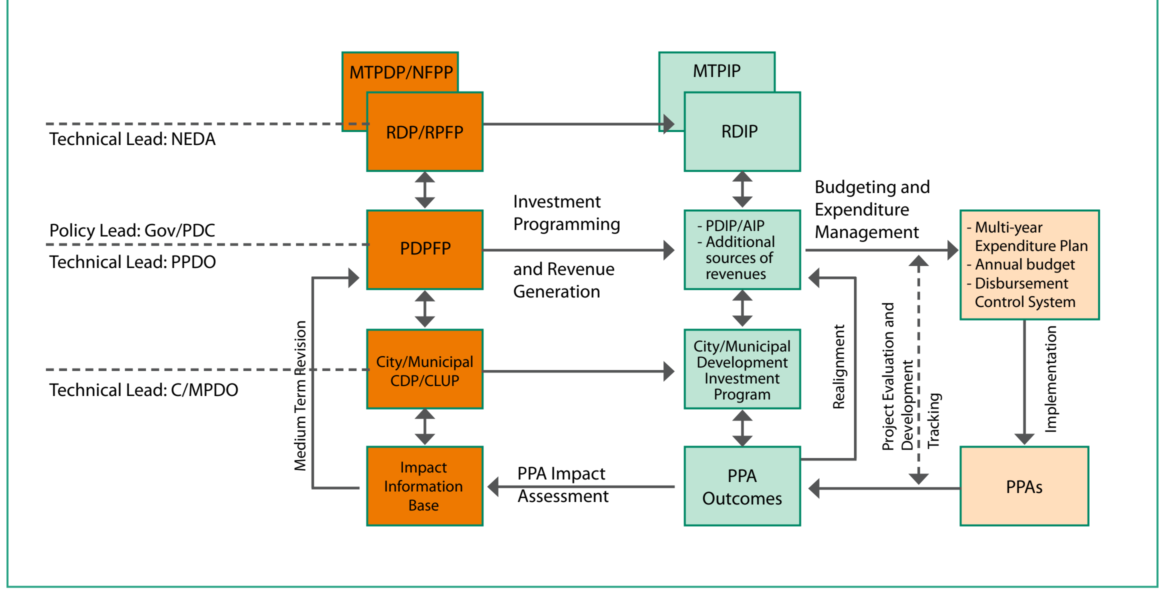
2. OPPORTUNITIES FOR MAINSTREAMING DRR IN SUBNATIONAL PLANS

While existing plans may have DRR components, there is still a need to integrate disaster risk and vulnerability assessments and more specific DRR strategies and measures. The existing development planning system and outputs (Figure 2.3) provide the opportunity for mainstreaming DRR in planning, particularly at the regional and provincial levels, since it is at these levels where linkages in plan processes are well defined. Furthermore, the geographic coverage of regions and provinces allow for a fairly comprehensive analysis of hazards beyond local boundaries.

As mentioned in Chapter 1, the usefulness of mainstreaming DRR in the Provincial Development and Physical Framework Plan (PDPFP) are as follows: (a) it provides a basis for other sectoral plans especially those that have something to do with land, natural resources, and infrastructure facilities; (b) it reconciles and rationalizes land use proposals among adjoining localities and with higher level framework plans; (c) it guides government agencies and private developers, particularly those that undertake large-scale projects, on the proper location of their projects and the implementation of the necessary mitigation works; and (d) it provides a basis for adjudicating conflicts arising from the implementation of the land use plans, development projects, and mitigation proposals that straddle the boundaries of two or more municipalities within the province.

The same utility may be said of the Regional Physical Framework Plan particularly pertaining to interprovincial concerns. In general, these plans are prepared to guide detailed development planning work later, be it in local level planning of the lower level local government units and/or sectoral planning of line agencies. Planning outputs can offer policy options and generalized programs and projects which the next level stakeholders, particularly the municipalities, can work on in their subsequent more detailed planning work. In general, the outcomes should be safe and more resilient communities.

Figure 2.3 Development Planning System and Outputs in the Philippines



Source: NEDA-ADB, 2007

C. SUMMARY

This chapter established the relationship of disasters and development, and explained why DRR should be mainstreamed into the development planning process. In this context, mainstreaming DRR addresses disaster issues as a cross-cutting dimension of development and goes beyond hazard impact mitigation to a more comprehensive analysis of its implications to development. Existing planning structures and processes provide an opportunity for mainstreaming DRR in subnational development and physical planning. This is a good venue to identify areas needed to ensure effectiveness of response activities and to formulate DRR-enhanced programs and projects.

3

Mainstreaming Framework

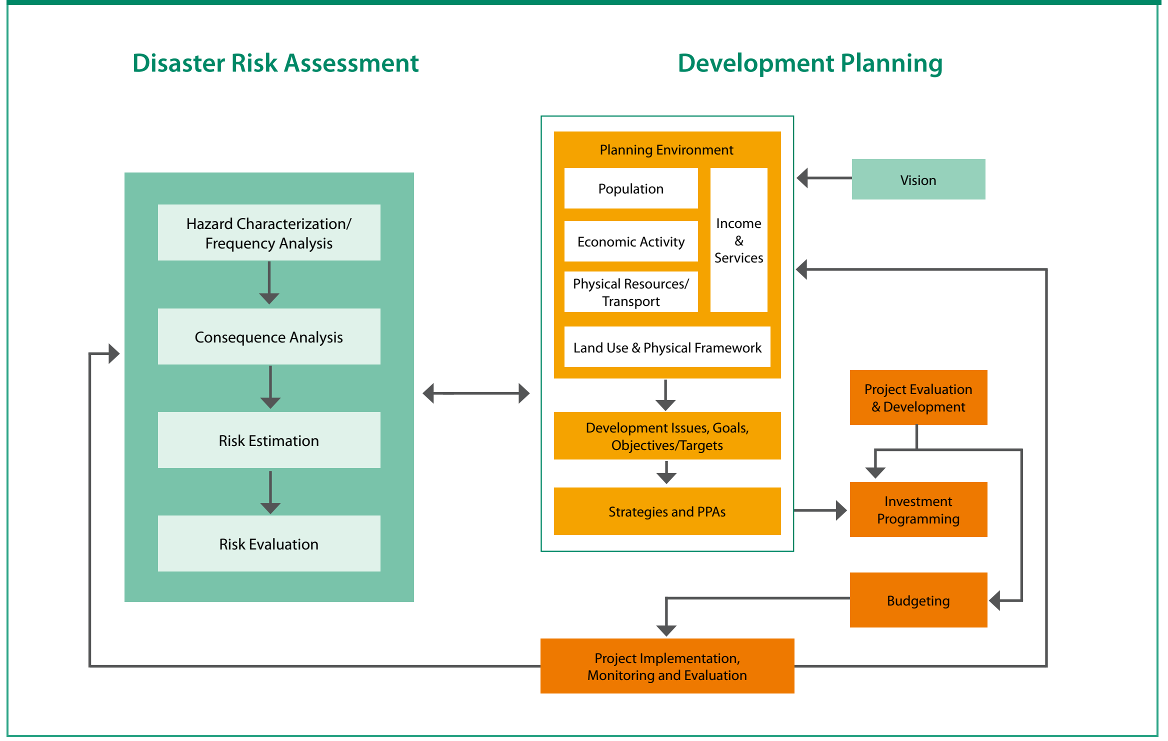
Mainstreaming Framework

The mainstreaming framework involves two processes. The first is disaster risk assessment (DRA) which analyzes the hazards of a place together with the risks to exposed elements. The second process concerns how the results of risk assessment enhance the development planning analysis leading to better design and prioritization of interventions that are intended to reduce risks to and vulnerability of exposed population and property.

A. DISASTER RISK ASSESSMENT AND DEVELOPMENT PLANNING

The framework for mainstreaming DRR is shown in Figure 3.1. It illustrates how disaster risk assessment (or simply risk assessment as may be interchangeably used in these Guidelines) is undertaken and how the results of the assessment are used to enhance all aspects of the planning process: from visioning, analysis of the planning environment, derivation of development potential and challenges and their translation into the corresponding goals, objectives and targets, and finally to the specification of the appropriate strategies and programs, projects and activities (PPAs). These are the primary focus of the Guidelines and are represented by the light beige boxes in Figure 3.1. The PPAs derived from the plan formulation stage are the main inputs into the succeeding phases of the development planning process, namely, investment programming, budgeting, project evaluation and development, project implementation and monitoring and evaluation (represented by the orange boxes). PPA outcomes and impacts that are determined during and post implementation should be able to reveal reduction in risks to population and property by increasing resilience or reducing vulnerability of these elements at risk.

Fig 3.1 Framework for Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning



B. FUNDAMENTAL CONCEPTS

Before proceeding any further, it is important to define the fundamental concepts on disaster, hazard, elements at risk, vulnerability and risk. These terminologies may be differently used and understood but have very specific meanings in these Guidelines. Their basic definitions have been adopted from the United Nations International Strategy for Disaster Reduction (UNISDR).

Disaster

A serious disruption of the functioning of a society, causing widespread human, material or environmental losses which exceed the ability of affected society to cope using only its own resources. Natural disaster would be a disaster caused by nature or natural causes.

Hazard

Hazard is generally understood to be a threatening event such as earthquake or flood. Natural hazards would be considered a hazard that is produced by nature or natural processes, which should exclude hazards stemming or resulting from human activities.

Hazard is also referred to as the probability of occurrence of a potentially damaging phenomenon within a given time period and area. It is mathematically expressed as the probability of occurrence or frequency of occurrence of a given magnitude of event.

Elements at Risk

The people, buildings and structures, infrastructure, economic activities, and public services exposed to hazards in a given area.

Vulnerability

Vulnerability generally refers to conditions which define how elements exposed to risk are affected by a hazard. Vulnerable population may refer to groups of people who need special care to cope with impacts of natural hazards such as the poor, physically challenged, elderly, children, women and others.

Physical vulnerability of an area will depend on the exposure of vulnerable structural elements within an area such as buildings, dwellings, critical facilities, and other infrastructures; economic vulnerability will come from the area's wealth, income, potential for growth, among others; social vulnerability stems from the characteristics of individuals or groups in the area that determine their well-being in terms of their income and access to basic services such as education and health; and environmental vulnerability refers to the state of the environment (UNDP, 2004).

The opposite of vulnerability is resiliency which is the quality that reduces the vulnerability of people and property. Resilience is not simply the absence of vulnerability; it is also the capacity to prevent losses, maintain normal living conditions when damage occurs, and manage recovery from the impact (Buckle, et. al., 2000).

Mathematically, vulnerability is the degree of loss (from 0 to 100 percent) resulting from a potentially damaging event.

Risk

Risk is the expected losses (of lives, persons injured, property damaged and economic activity disrupted) due to a particular hazard for a given area and reference period. The unit of measure of risk could be number of fatality or value of damaged property.

Risk is mathematically expressed as:

Risk = Hazard x Elements at risk x Vulnerability

C. DISASTER RISK ASSESSMENT

Disaster risk assessment is the process of studying risks caused by natural hazards and their effects on elements at risk, namely, the people, buildings and structures, infrastructure, economic activities and public services exposed to hazards in a given area. More specifically, risk assessment is the process of quantifying and evaluating risk. Quantified risk may be expressed as the number of elements lost (e.g., fatalities), proportion of elements affected (e.g., 25% of road network) and monetary value of damaged property.

The essential prerequisite for DRA is identifying the existing range of natural hazards and calculating or estimating the measures of risk generated by those hazards. As shown in Figure 3.1, risk assessment involves four steps: (a) hazard characterization and frequency analysis; (b) consequence analysis; (c) risk estimation; and (d) risk prioritization.

a. Hazard characterization and frequency analysis – involves identifying and characterizing the hazard(s) that threaten an area. Hazard is expressed as the probability of occurrence or the inverse of return period.
b. Consequence Analysis – involves determining the elements at risk and their vulnerability. In the absence of damage ratios, factors for fatality and property damage are derived and applied to actual population and property exposed to hazard.
c. Risk Estimation - involves estimating the risk (annual basis) expressed as the expected annual number of lives lost, and annual damage to property (in monetary value).

d. Risk Evaluation – involves determining priority areas based on risk estimates. These priority areas are further evaluated by assessing conditions of the place and identifying and describing factors which contribute to their vulnerabilities.

In the succeeding sections, each of these steps will be covered. The basic concepts in theory and practice are discussed in the main text while the indented green-colored text describes how these concepts were applied in the Guidelines, given the Philippine setting, particularly on the availability of data.

1. HAZARD CHARACTERIZATION AND FREQUENCY ANALYSIS

Hazard characterization or hazard analysis is the in-depth study and monitoring of hazards to determine their potential, origin (i.e., geologic or hydrometeorologic), geographic extent, hazard impact characteristics including their magnitude-frequency behavior, historical behavior and initiating (or triggering) factors. For each type of hazard, specific hazard events are generally analyzed. For example, for flooding, hazard events may be categorized as 10-year flood or 20-year flood which generally refers to the frequency or the measure of return period of certain flood events that exhibited the same characteristics such as depth measured in meters.

Information on hazards generally come from agencies mandated to: (a) collect data, study and map hazards; (b) monitor and report to the public critical information relative to the hazard; and (c) recommend and/or undertake actions to minimize the impact of hazards. Specific sources are instrumental records, historical records, geologic and geomorphic investigations, geotechnical investigations, modeling, triggering agent analysis, and experts' judgment.

Analysis can be carried out at the national, subnational, provincial, municipal or site levels. It can focus on present conditions, or can extend into the future to take account of changing environmental conditions (e.g., climate change) or social conditions (e.g., population growth or new settlements). As a result, both actual and potential hazards may be identified.

> Under these Guidelines, the effects of climate change are considered under the hydrometeorologic hazards. As indicated by the Intergovernmental Panel on Climate Change (IPCC), frequency and intensity of weather-related events are likely to increase due to climate change. Using the risk assessment methodology in these Guidelines, risk estimation of climate

change scenarios can be undertaken. Said analysis should be supported by baseline data for climate change parameters.

However, data limitations may lead to the analysis of susceptibility rather than the hazard itself. Analysis of susceptibility results in the identification of areas that are prone to the impact of the hazards but usually does not extend to characterization in terms of the frequency and/or magnitude of a potentially damaging event. Knowing that an area is likely to experience hazards is a valuable starting point but, ultimately, information on hazard magnitude, frequency and expected consequences are relatively more important for hazard management and risk reduction.

Ideally, hazard maps should already contain information on return period or frequency of occurrence given the magnitude. However, hazard maps generated in the Philippines include information only on level of susceptibility, i.e., areas are classified as high susceptible area (HSA), moderate susceptible area (MSA) and low susceptible area (LSA); or prone and not prone. An overview of hazards and hazard mapping in the Philippines is presented in Annex 1.

As defined, hazard is mathematically expressed as the probability of occurrence of a threatening event. This is the scope of frequency analysis. Frequency analysis may use quantitative or qualitative estimation. Ultimately, quantitative estimation provides an objective measure of hazard that can be compared and evaluated along with similarly estimated hazards. Where there is insufficient data, it may only be possible to produce a qualitative estimation, based on analogy with similar areas or by using expert judgment. Initial qualitative estimates can be augmented by calculated risk as more scientific evidence becomes available.

Probability of occurrence is the quantitative measure of hazard. The probability of occurrence is related to the return period, T, by 1/T. An example of quantitative estimation of hazard, specifically its frequency or probability of occurrence is shown in Box 3.1.

A detailed discussion on the probabilistic treatment of hazards is presented in Annex 2.

Box 3.1 Quantitative and Qualitative Frequency Analysis

Frequency with respect to natural hazards is calculated from the number of events of a given size per unit time (e.g., the number of earthquakes of magnitude greater than 5.9 per 100 years). The reciprocal of frequency is the return period, the average interval between events of a given size. For example, the return period of a magnitude 6 earthquake may be 75 years (i.e., the frequency is 1.33 per 100 years). This represents an annual probability of 1.33 percent, often expressed in order of magnitude of probabilities, e.g., 1.33×10^{-2}.

Qualitative measures of likelihood used by the Australian Geomechanics Society, 2000 are presented below:

Level	Descriptor	Description	Indicative Annual Probability
A	Almost certain	The event is expected to occur	$\geq 10^{-1}$
B	Likely	The event will probably occur under adverse conditions	$= 10^{-2}$
C	Possible	The event could occur under adverse conditions	$= 10^{-3}$
D	Unlikely	The event might occur under very adverse conditions	$= 10^{-4}$
E	Rare	The event is conceivable but only under very exceptional circumstances	$= 10^{-5}$
F	Not credible	The event is inconceivable or fanciful	$\leq 10^{-6}$

Source: Tonkin and Taylor Ltd., 2006

These Guidelines used quantitatively-derived return periods for hazards of geologic origin and qualitative estimates for hazards of hydrometeorologic origin. Both estimates are considered crude or preliminary as an initial attempt to come up with quantified risks. The estimates are presented in Chapter 4 and Annex 3.

Occurrence of hazards is generally classified as:

a. Frequent – Many events are frequent over a lifetime
b. Likely - A single event is likely over a lifetime
c. Rare - A single event is rare over a lifetime

The general assumption is that frequent hazard events or occurrences are of lower intensity or magnitude and conversely for rare events.

2. CONSEQUENCE ANALYSIS

Consequence analysis is determining or defining the elements at risk from a given hazard and defining their vulnerability.

The elements at risk are ideally obtained by survey (or inventory), or by using records such as census or primary surveys (particularly useful for getting a quick idea as to economic values). If a measure of economic risk is required, then a value must be established for the elements (e.g., resale value or replacement cost). This may be obtained from valuation records or other sources.

Vulnerability is limited to fatality and property damage under these Guidelines since these are the two indicators that have been evaluated to be feasible for quantification in terms of probable risks. This is referred to as a "macro" vulnerability assessment in these Guidelines. A qualitative and more detailed or "micro" vulnerability assessment is further undertaken of the high risk areas identified during risk prioritization as input to the planning decisions and formulation of DRR measures.

Vulnerability is mathematically measured as the proportion of damage expected from exposure to hazards and is expressed on a scale from 0 (no damage) to 1.0 (total damage), or 0 percent damage to 100 percent damage. It is referred to as the damage ratio in cases of quantifiable loss. It should be noted that these values are usually unavailable for most hazards in the country.

Under these Guidelines, the above damage ratio is referred to as factor for damage, specifically, factor for fatality and factor for property damage. These factors will be applied respectively to the actual population and property exposed to the hazard in computing the risk.

A detailed discussion on the derivation of factors for fatality and property damage are presented in Annex 5.

Other aspects that are considered in consequence analysis are:

a. **Spatial impact** – If a hazardous event occurs, it may only affect some parts of the study area. Thus, the extent of the spatial impact must be determined. This can be estimated based on hazard mapping, analysis of historical data and literature study. The spatial factor is the ratio of the area affected by the hazard to the study area.

In these Guidelines, the spatial factor (i.e., factor for fatality and factor for property damage) makes reference only to the susceptible areas

defined in hazard maps. These areas are taken as the entire possible set of areas from which the risks can be computed. Outside of these areas, no risks are computed. A first estimate of the risks makes use of the different susceptible areas using a range of hazard events that are likely to impact such places. Hence the initial assumption follows this logic: (a) HSA are affected by frequent events; (b) HSA and MSA are affected by likely events; (c) HSA, MSA, and LSA are affected by rare events.

In subsequent analysis, spatial factors need to be defined in hazard maps based on the extent of the affected areas from various degrees of hazard events to refine the risk estimates.

b. **Temporal impact** – Buildings are always 100 percent (all day, all year) exposed to the threats of natural phenomena; people are not. When the elements at risk are mobile (e.g., persons on foot, in cars, buses and trains) or where there is varying occupancy of buildings (e.g., between night and day, week days and weekends, seasonal) it is necessary to make allowance for the probability that persons (or a particular number of persons) will be in the area affected by the hazard event. For varying occupancy it is simply a calculation of the proportion of a year (0 to 1.0) which the number of persons being considered occupy the building. Methodologies are also available for calculating the probability of a vehicle being affected by a hazard. Another factor that should be considered is the likelihood of evacuation or escape. This arises depending on the location of the person with respect to the hazard area, and whether the person may have sufficient warning to evacuate or escape the area.

In these Guidelines, the temporal factor is a static figure which assumes that population and properties are exposed to natural hazards 100 percent of the time.

c. **Seasonal occurrence** – Natural phenomena may occur within specific seasons only (e.g., rainy season). Therefore, the factor for seasonal occurrence of the natural phenomena needs to be ascertained. Expressed in terms of probability, an estimate can be based on analysis of historical events.

In consideration of climate variability, the seasonal occurrence factor makes reference to the element at risk. For example, different crops have different growth stages and may not be harvestable in specific seasons of the year.

Hence, it may be assumed that all areas are taken as harvestable (factor of one) or part of the areas are not (factor less than one).

Under these Guidelines, no factors where developed to consider the seasonal changes.

2.1 Consequence in terms of fatality

The consequence in terms of fatality is estimated by: (a) identifying the potentially affected population; and (b) determining the factor for fatality.

To identify the potentially affected population, the population map is overlayed with the hazard map. Ideally, the population map should have actual plot (or complete inventory) of houses, buildings and structures together with data on occupancy (i.e., number of persons living or working inside the structure).

Under these Guidelines, the population density map at the barangay level is deemed as sufficient parameter to describe the element at risk for the calculation of fatalities. Estimation of affected population is based on hazard exposure and population densities.

The factor for fatality is determined by: (a) exposure and vulnerability of the population; and (b) exposure and vulnerability of the structure which may bring about the loss of life of the persons inside the structure.

Under these Guidelines, the *factors for fatality*, which were developed based on past hazard exposures, are provided for the estimation of the probable proportion of fatalities to the population affected by a hazard event. The *factors for fatality*, shown using a series of matrices, were estimated from disaster damage and loss averages at the national level and from comparisons of different hazard events. As such, the numbers are basically indicative.

It is further assumed that likelihood of fatality is affected by concentration of population (i.e., population density) in the hazard prone areas. Thus, the table will result in less dense areas having lower fatality as compared to highly dense areas.

2.2 Consequence in terms of property damage

The consequence in terms of property damage is estimated by: (a) identifying the potentially affected property and the corresponding monetary value; and (b) determining the factor for property damage.

To identify the potentially affected property, the land use map is overlayed with the hazard map. Ideally, the land use map should have actual plot of houses, buildings, roads, bridges, power lines, facilities, crops together with data on the corresponding monetary values.

Under these Guidelines, the land use map is used to describe the elements at risk for the calculation of property damage. Estimation of affected property is based on hazard exposure and land use.

However, since existing land use maps do not reflect the actual plot and the corresponding monetary values of the structures, crops and other elements, the monetary values were computed based on the cost of replacing the elements at risk, particularly the built-up areas and the agricultural crops only. Other elements and indirect costs such as disruption to economic activities or the nondelivery of vital services were not imputed.

The factor for property damage is determined by exposure and physical vulnerability of the properties. Also, it is based on understanding the nature of damage from specific hazard events using damage curve studies, observations from past events and historical damage data.

Under these Guidelines, the *factor for property damage* were developed based on past hazard exposures and are provided to allow for the estimation of the probable "*proportion*" of damage to various properties affected by a hazard event. The *factors*, shown using a series of matrices, were estimated from *"disaster damage and loss averages at the national level"* and from comparisons of different hazard events. As such, the numbers are basically indicative.

It is further assumed that potential or likelihood of damage is affected by the *aggregate* property value of an area. Thus, the table will result in areas with *less property values* having lower proportionate damage as compared to *high property value* areas.

3. RISK ESTIMATION

Risk estimation involves the integration of the results of *hazard characterization and frequency analysis* (or *hazard analysis)* with *consequence analysis* to derive an overall measure of risk. Recall that the mathematical expression of risk is:

Risk = Hazard x Elements at risk x Vulnerability

The estimated risks are expressed in number of fatalities per year and the monetary value of the damaged properties per year. An example of a quantitative calculation of risk to property is shown in Box 3.2

Box 3.2 Quantitative Calculation of Risk

An example of calculation of property risk (from the Australian Geomechanics Society, 2000) is as follows:

The problem: calculate the risk of a given highway subject to landsliding

E the element at risk is a stretch of highway that runs along the base of a range of hills from which landslides periodically impact the highway. The highway replacement value is estimated at $10,000,000.

$P_{(H)}$ is hazard; research has shown that there have been five landslide events affecting the highway in the last 100 years. The average return period of this is one event in 20 years. The chances of this occurring in any one year are 1/20, i.e., 0.05 probability; in other words, a five percent chance of occurrence in any one year.

$P_{(S:H)}$ is the spatial probability of the contact of landslide with the highway. In other words, in this sort of events for example, 30 percent of the highway's length is affected by landslides, i.e., 0.3.

V is the vulnerability of the highway when hit by a landslide. In other words, in the places where the landslides impact the road, it is the proportion of the affected stretch of highway damaged. Complete (100 %) damage would be given a value of 1.0. The value in this example is 0.6, i.e., 60 percent damage to the value.

The risk to property, $R_{(Prop)}$, or the annual loss in the dollar value of the highway is calculated as follows:

$R_{(Prop)}$ $= P_{(H)} \times P_{(S:H)} \times V \times E$
= 0.05 x 0.3 x 0.6 x $10,000,000
= $90,000

Source: Tonkin and Taylor Ltd., 2006

In instances where there is paucity of data, qualitative risk estimation may be undertaken. The general approach for qualitative risk estimation combines qualitative evaluations of probability of occurrence and qualitative evaluation of consequence. The hazard is assigned a score to provide an opportunity to rank and compare hazards and risks. Box 3.3 gives a qualitative calculation of risk. The ranking will give an idea on areas needing risk reduction.

The advantage of quantitative risk estimation, however, is the resulting *value*s for gauging gaps between estimated damage and the resources available to the region or

Box 3.3 Qualitative Calculation of Risk and Ranking System of the Federal Emergency Management Agency of the United States of America

In calculating risk, FEMA uses the following parameters and corresponding weight. For each parameter, the criteria, class and score are identified. (Crozier et. al., 1999)

Parameter: History Description: The occurrence of a potentially damaging event Weight: x 2		
Criteria	**Class**	**Score**
0-1 time in past 100 years	Low	2
2-3 times in past 100 years	Med	5
4 or more times in past 100 years	High	10
Parameter: Vulnerability Description: People and property: interpreted as the percentage damage to those affected by the event under consideration Weight: x 5		
Criteria	**Class**	**Score**
< 1 %	Low	2
1 – 10 %	Med	5
> 10 %	High	10
Parameter: Maximum threat Description: % of district/community affected Weight: x 10		
Criteria	**Class**	**Score**
< 1 %	Low	1
1 – 4.9 %	Low	2
5 – 25 %	Med	5
>25 %	High	10
Parameter: Probability Description: Chances per year of an event expressed per 1000 Weight: x 7		
Criteria	**Class**	**Score**
< 1	Low	1
1 – 4.9	Med	3
5 – 9.9	Med	7
10 – 19.9	Med	8
20 – 100	Med	9
>100	High	10
Parameter: Trend of Occurrence Description: Changes for physical reasons over next 50 years Weight: x 2		
Criteria	**Score**	
Likely to increase	10	
Possible increase	5	
Stay the same	0	
Possible decrease	-5	
Likely to decrease	-10	

For hazard *x* in a specific area, the sample calculation is presented below:

Parameter	Class	Raw Score		FEMA Weight		Weighted Score
History	0-1/100 years	2	X	2	=	4
Vulnerability	> 10 %	10	X	5	=	50
Maximum threat	< 1 %	1	X	10	=	10
Probability	1-4.9/1000	3	X	7	=	21
Trend	No change	0	X	2	=	0
					Total	85

The same calculations can be undertaken for the various hazards. The weighted scores are then compared and ranked. The ranking will indicate areas where risk reduction is required.

Source: Tonkin and Taylor, Ltd., 2006

province, prioritizing areas that need urgent attention, and identifying and designing risk reduction measures. Also, this quantitative method is flexible enough to include other variables should additional data be generated in the future. This method can be undertaken through GIS or spreadsheet calculations.

Under these Guidelines, the *hazard* variable is obtained in the *hazard characterization and frequency analysis* step while the variables of *element at risk* and *vulnerability* were computed in the *consequence analysis* step. Taking into consideration the adjustments made on consequence analysis, the Guidelines use the following equations for risk estimation:

Risk of fatality

$R_F = P \times C_F$

where R_F = risk of fatality (fatality/year)
P = probability of occurrence of hazard event
C_F = consequence in terms of fatality per hazard event

$C_F = P_{AP} \times F_F$

where C_F = consequence in terms of fatality per hazard event (fatality/event)
P_{AP} = potentially affected population
F_F = factor for fatality

Risk of property damage

$R_{PrD} = P \times C_{PrD}$

where R_{PrD} = risk of property damage (PhP/year)
P = probability of occurrence of hazard event
C_{PrD} = consequence in terms of cost of property damage per hazard event

$C_{PrD} = P_{APr} \times F_{PrD}$

where C_{PrD} = consequence in terms of cost of property damage per hazard event (PhP/event)
P_{APr} = potentially affected property
F_{PrD} = factor for property damage

4. RISK PRIORITIZATION

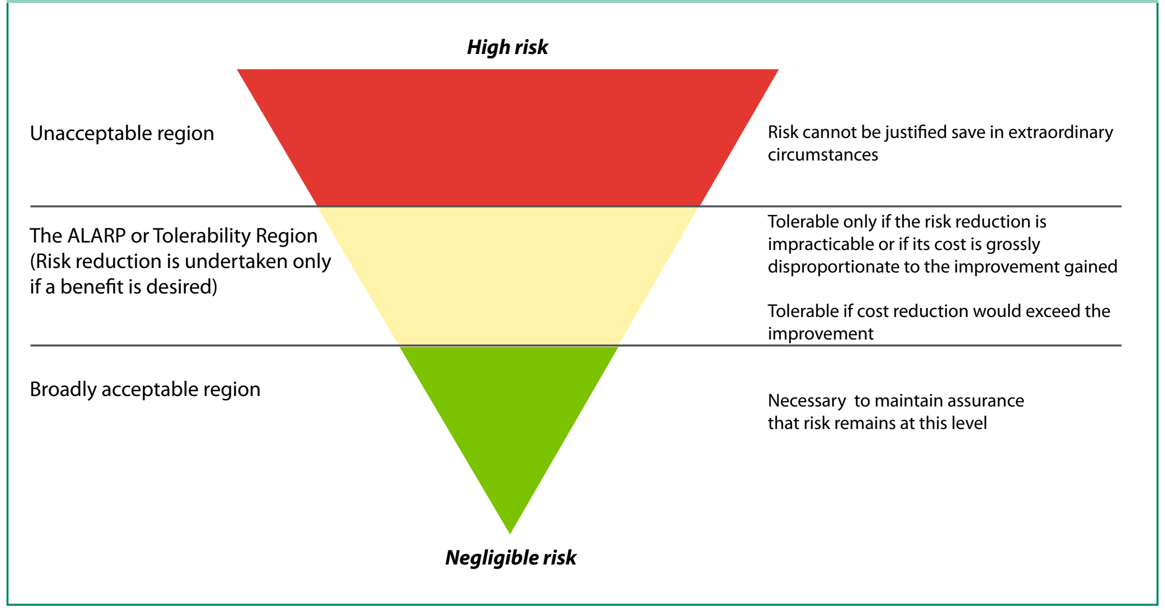
Resources may not be enough to implement DRR measures in all high-risk areas at the same time. Thus, risk prioritization is undertaken to guide the identification of areas needing urgent attention. Risk prioritization can be based exclusively on risk levels. It can also be based on risk levels complemented with risk perceptions, vulnerability and/or other factors.

In these Guidelines, risk prioritization uses a composite prioritization scoring which combines the risk of fatality and the risk of property damage for built-up and agricultural areas. This prioritization process should reveal high risk areas which will be subjected to further assessment of their vulnerability using indicators of population, social infrastructures, service infrastructures, transport and access, economy and environment (earlier cited as "micro" vulnerability assessment).

The first step in prioritization is to compare the estimated risks to acceptability criteria and assign a matching score.

For some hazards (e.g., landslide in Australia, industrial safety in European countries), standards are available for establishing the acceptability of risks. The most common approach is represented by the ALARP (As Low As Reasonably Practicable) principle, which involves weighing a risk against the effort, time and money needed to reduce it. In graphical form, the concept is presented in Figure 3.2.

Figure 3.2 ALARP Principle



Source: AS/NZS, 2004b

The diagram identifies an upper threshold above which risks are generally unacceptable, and a lower threshold below which risks are generally acceptable and require no action. Between these two thresholds is a region where risks are tolerated only on the basis that they are kept *As Low As Reasonably Practicable.*

> In these Guidelines, the risk acceptability criteria for risk of fatality are conceptually based on the ALARP principle. Computed risks are categorized into high to very high/moderate/very low to low and are given corresponding risk scores. The lowest acceptable computed risk is in the order of 10^{-5} which is higher than the internationally accepted standard of 10^{-6}.
>
> For risk of property damage, risk acceptability criteria were based on the National Disaster Coordinating Council (NDCC) criteria for declaring a state of calamity but simplified and limited to: (a) when at least 20 percent of dwelling units are damaged and dwelling units will be represented by the residential floor area value; and (b) when at least 40 percent of the means of livelihood are damaged and agricultural crop values will be the base for estimating damage to livelihood.

> A composite score for both risk of fatality and risk of property damage will be the basis for determining very high/high risk areas needing urgent interventions.
>
> The prioritization approach is discussed in detail in Chapter 4.

The urgent areas will be assessed further using vulnerability indicators of population, social infrastructures, service infrastructures, transport and access, economy and environment (earlier cited as "micro" vulnerability). The "micro" vulnerability will provide details why such areas are urgent than others and reveal the other factors that contributed to the risk.

D. MAINSTREAMING DISASTER RISK ASSESSMENT RESULTS IN PLAN FORMULATION

The plans contain the following information: vision, analysis of the planning environment, development issues, goals, objectives and targets, strategies and PPAs.

The risk assessment results could first be treated as part of the individual sectoral analysis in describing the planning environment or in the land use and physical framework portion.

By definition, the physical framework sets the spatial parameters by which future growth and development, including PPAs, can take place. Hence, the disaster risk estimates may be used as bases in specifying where developments should be encouraged or discouraged as well as where PPAs could be better located. The procedure will entail identifying high risk or priority areas that would require corresponding DRR measures to be instituted. For each of the high risk areas, factors that contribute to the risks or to the vulnerabilities of the place are examined. The implications and acceptability of the risks and vulnerabilities will reveal the development issues and concerns that will be the subject of planning.

The sequences for this stage are:

a. analysis of the risk impact to the land use and physical framework;
b. identifying development issues and their translation to goals, objectives and targets based on the risks identified; and
c. specifying DRR measures (strategies and PPAs).

1. ANALYZING THE RISK IMPACT TO THE LAND USE AND PHYSICAL FRAMEWORK

The risk assessment results or the risks information become more meaningful if they are placed side by side with the development framework of the province or region.

Two queries can be made, as follows: *Should a development strategy be pursued despite the risks revealed by the risk analysis? What changes may be adopted so that the development strategy will be worth pursuing?*

Specific planning considerations may be adopted such as the rethinking of the roles and functions of the settlement or development clusters and hence land uses, and the need to make alterations to the service and facility requirements given the renewed roles and functions that respond to the attendant risks. Another important planning concern given the risks is to ensure the functionalities and linkages (physical and economic) within and among the development clusters as well as with key development areas outside the region or province (i.e., to neighboring provinces, regional hierarchy, national system). Likewise, a key planning consideration is to look at how the disaster risks impact on the socioeconomic fragilities of the areas or elements at risk, or how the risks affect specific vulnerable sectors and population groups (e.g., the poor, the elderly, women and children).

The output of this phase should be an enhanced or revised land use and physical framework which presents the spatial features of the desired settlements, production and protection land use, and major infrastructures supporting the desired development scenario of the province or region.

2. IDENTIFYING DEVELOPMENT ISSUES, GOALS, OBJECTIVES AND TARGETS BASED ON THE RISKS

Development issues and concerns are derived from the analysis of the risk impact to the land use and physical framework. These issues serve as basis for the specification of development goals, objectives and targets and the eventual identification of DRR measures that aim to reduce the threat of natural hazards.

The development issues and concerns that are derived may either be existing or potential land use conflicts attributed to the risks (e.g., settlements in high risk areas, production systems or critical infrastructures located in high risk areas) as well as the impact of the disaster risks to the overall development scenario of the province or region that will require intervention measures.

Again, the aim of DRR mainstreaming is to ensure that the plans formulated contribute to disaster risk reduction which aims to reduce (if not to eliminate) the attendant risks, make societies become more resilient to natural hazards, and ensure that all development efforts being pursued do not increase the risks and vulnerabilities to these hazards.

Since the vision will serve as the overall guide to the planning process, then this is where integration should first take place. To do this, one should appreciate the DRR goals of reducing disaster losses (lives, properties, livelihoods, etc.), building resilience of communities to hazards, enhancing socioeconomic development and not contributing to increasing risks are very important and critical to the development of the province or region. Once this is accepted, then the vision statement should contain the desired state reflecting such features. As an example, the vision statement may include some phrases about having safe, prepared and resilient communities against natural hazards.

Aligned with the vision and derived from the development issues and concerns, broad statements that respond to the general problem and more specific focus of objectives and targets are set. This step should enhance the development goals and objectives by making the treatment of disaster risks a development prerogative.

The output of this stage is an enhanced set of development issues, goals, objectives and targets. It should also be noted, however, that at the regional or provincial development framework level, it may be very difficult to be very specific and hence detailed objective setting or target specification may not be possible at all unless the data sets available for analysis allow it.

3. IDENTIFYING DRR MEASURES

Once the significance and priority of the risks are ascertained and the manner by which they should be responded to as elaborated by the goals, objectives and targets, the next step is to identify the corresponding DRR measures or intervention approach or option in order to treat or control the disaster risks.

The DRR measures may be classified into four major categories and their subcategories as follows:

a. **Risk avoidance or elimination** - removing a risk trigger by not locating in the area of potential hazard impact, not purchasing vulnerable land or building; or denying a risk by creating an activity or simply refusing to engage in functions that could potentially be affected by risks;

b. **Risk reduction or mitigation** - reducing the frequency of occurrence or the severity of the consequence by changing physical characteristics or operations of a system or the element at risk. It can take on the following subcategories:
   - Risk prevention;
   - Risk or loss reduction by mitigation;
   - Risk or loss reduction by preparedness;
   - Segregation of exposure by duplication or redundancy; and
   - Segregation of exposure by separation.

c. **Risk sharing or risk transfer** – shifting the risk-bearing responsibility to another party, often involving financial and economic measures particularly the use of the insurance system to cover and pay for future damages. In some literature, the segregation of exposure by separation is considered as a risk-spreading or risk-transfer option; and

d. **Risk retention or acceptance** - this is the "do-nothing" scenario where risks are fully accepted and arrangements are made to pay for financial losses related to the hazard impact or to fund potential losses with own resources

It has to be noted that DRR is wide-ranging, and there is potential in mainstreaming it in every development sector. Depending on the types of risks, one can provide for a range of options to respond to such risks. The choice of DRR measure or approach to adopt will depend on the decision-making process of the province/region. The selected DRR measure or approach shall be the result of a participative process involving all stakeholders particularly the communities and people that are affected by the risks and the eventual implementation of the DRR measure.

E. SECONDARY ENTRY POINTS FOR MAINSTREAMING

Mainstreaming of DRR does not end in the plan formulation process, but should be promoted towards plan implementation stages, that is, the remaining stages of the development planning cycle, as follows:

a. investment programming;
b. budgeting/financing;
c. project evaluation and development; and
d. project implementation and monitoring and evaluation

Financing through the budget and other alternative schemes must also be studied carefully to ensure that DRR PPAs are financed and implemented. Monitoring and evaluation will provide the tool for measuring reduction in risks and vulnerability in succeeding planning cycles. These are discussed in greater detail in Chapter 6.

F. CONCLUSION

Understanding the causes of risk and severity of impact from natural hazards has changed significantly with scientific advances in the study and monitoring of hazard events. While there may be incomplete data for perfect quantitative calculation of risks, the Guidelines provide a starting point for estimation of hazards (expressed in probability of occurrence), vulnerability (expressed in factors for fatality and property damage) and risk (expressed in number of lives lost and monetary value of damaged property). Quantification allows for a more objective analysis, comparability and measurability in terms of risk reduction and net benefits of risk reduction PPAs or PPAs that have internalized risks in their design.

4

Disaster Risk Assessment

Disaster Risk Assessment

This chapter details the disaster risk assessment procedure, particularly the objectives, outputs and process of each step. As a case study, the actual application of the process to Surigao del Norte is presented. The derivation of return period, factors for fatality and property damage, valuation of damage to property and the methodology for prioritizing areas based on risk estimates are also discussed.

A. HAZARD CHARACTERIZATION AND FREQUENCY ANALYSIS

Objective: To identify natural hazards that threaten a province/region and understand its origin, characteristics such as magnitude or intensity, geographic location and extent, frequency, and its relation to site conditions that may influence impacts of hazards (e.g., topography, soil, slope).

Output/s: Inventory of the hazards including description of characteristics in table and map forms.

Process:

1. Prepare an inventory of all hazards that threaten the province/region.
    - 1.1 Collect hazard information and maps relevant to risk assessment from mandated agencies
    - 1.2 Prepare hazard inventory matrix
2. Determine return period for each hazard event
    - 2.1 Estimating Return Period for Earthquake-Related Hazards
    - 2.2 Estimating Return Period for Volcanic Hazards
    - 2.3 Estimating Return Period for Hydrometeorologic Hazards
    - 2.4 Prepare Summary Frequency Table

1. PREPARE HAZARD INVENTORY

1.1 Collect information and maps relevant to risk assessment from mandated agencies

The hazard inventory contains a list of all hazards affecting a region or province. To determine which among the many types of hazards should be included in the list, the planner is strongly advised to consult mandated agencies. List of hazards and possible sources of hazard information is presented in Table 4.1.

Table 4.1 List of Hazards and Possible Sources of Information

Geologic	Responsible Agency	Hydrometeorologic	Responsible Agency
Earthquake-related • Ground shaking • Liquefaction, subsidence • Landslide, debris flow • Fault rupture • Tsunami	PHIVOLCS	• Extreme rainfall • Tropical cyclone • Storm surge • Tornado • Thunderstorm • Flood - Riverine floods - Coastal floods - Flashfloods • Drought - Low river flows - Agricultural - Domestic water supply - Groundwater • Sea-level change	PAGASA
Volcanic Activities • Ballistic projectile • Pyroclastic flow • Lava flow • Steam explosion • Ashfall • Debris avalanche, sector collapse • Lahar • Volcanic gas	PHIVOLCS	• Rain-induced landslides • Ground subsidence/ settlement • Coastal and inland erosion and aggradation	MGB
Others • Sinkhole formation • Ground subsidence	PHIVOLCS		

Hazards covered by these Guidelines are categorized into two types: geologic and hydrometeorologic. For internal geologic processes (e.g., earthquake and volcanic related), the Philippine Institute of Volcanology and Seismology (PHIVOLCS) is the agency mandated to collect information, generate maps, and monitor hazards. For external geologic processes (e.g., landslide and erosion related) the Mines and Geosciences Bureau (MGB) is the lead agency, while the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) is the lead agency for hydrometeorologic hazards (e.g., storm surge). These agencies should be able to tell what hazard threatens the concerned region or province.

To prepare the inventory, get the hazard maps prepared by those mandated agencies. Hazard maps can be obtained in paper or electronic form, usually through a written request. Some agencies charge a minimal fee to cover cost of printing or reproduction of digital copies.

The hazard maps not only show what hazards affect the region or province, but also the extent of impact in terms of area coverage. Table 4.2 shows the various levels of susceptibility the region or province may have for each type of hazard. For purposes of estimating risks, these Guidelines have adopted a common reference for susceptibility of areas to hazards, as follows: high susceptible areas (HSA), moderate susceptible areas (MSA), and low susceptible areas (LSA).

In Table 4.2 (under Hazard Characterization and Frequency Analysis) High Susceptible Areas (HSA), Moderate Susceptible Areas (MSA), and Low Susceptible Areas (LSA) have been delineated.

The level of susceptibility of each province or municipality is defined by the intensity of the earthquake-related hazard affecting a province or municipality, or by frequency of occurrence of rain-induced hazard.

For hydrometeorologic hazards, it is assumed that *frequent* hazard event will affect HSA area only, while a *likely* hazard event will affect HSA and MSA areas, and, a *rare* hazard event will affect all HSA, MSA, and LSA areas. The categories of frequent, likely, or rare, are based on considerations on relationships of basin size, time of concentration, intensity, duration of rainfall and frequency of events experienced in the country.

For earthquake-related hazards, earthquakes of Magnitude 4.9-6.1 are assumed to affect HSAs; Magnitude 6.2-6.9 affect, both the HSAs and MSAs; while Magnitude 7 and above will affect all HSA, MSA, and LSA. The general assumption in earthquake-related hazards is that HSAs are more frequented by earthquake-induced hazards, but of lower intensity or magnitude. In low susceptible areas, hazards occur less frequently, but the magnitude (or intensity) is higher. To illustrate, earthquakes occur frequently in the order of intensity 5 or lower. Earthquakes close to magnitude 7 (or higher) are rare; but can be strong and damaging. The three range of values and intervals of earthquake magnitude were devised based on groupings by Thenhaus et. al., 1994 for various seismic zones in the country.

See Annex 3 for details.

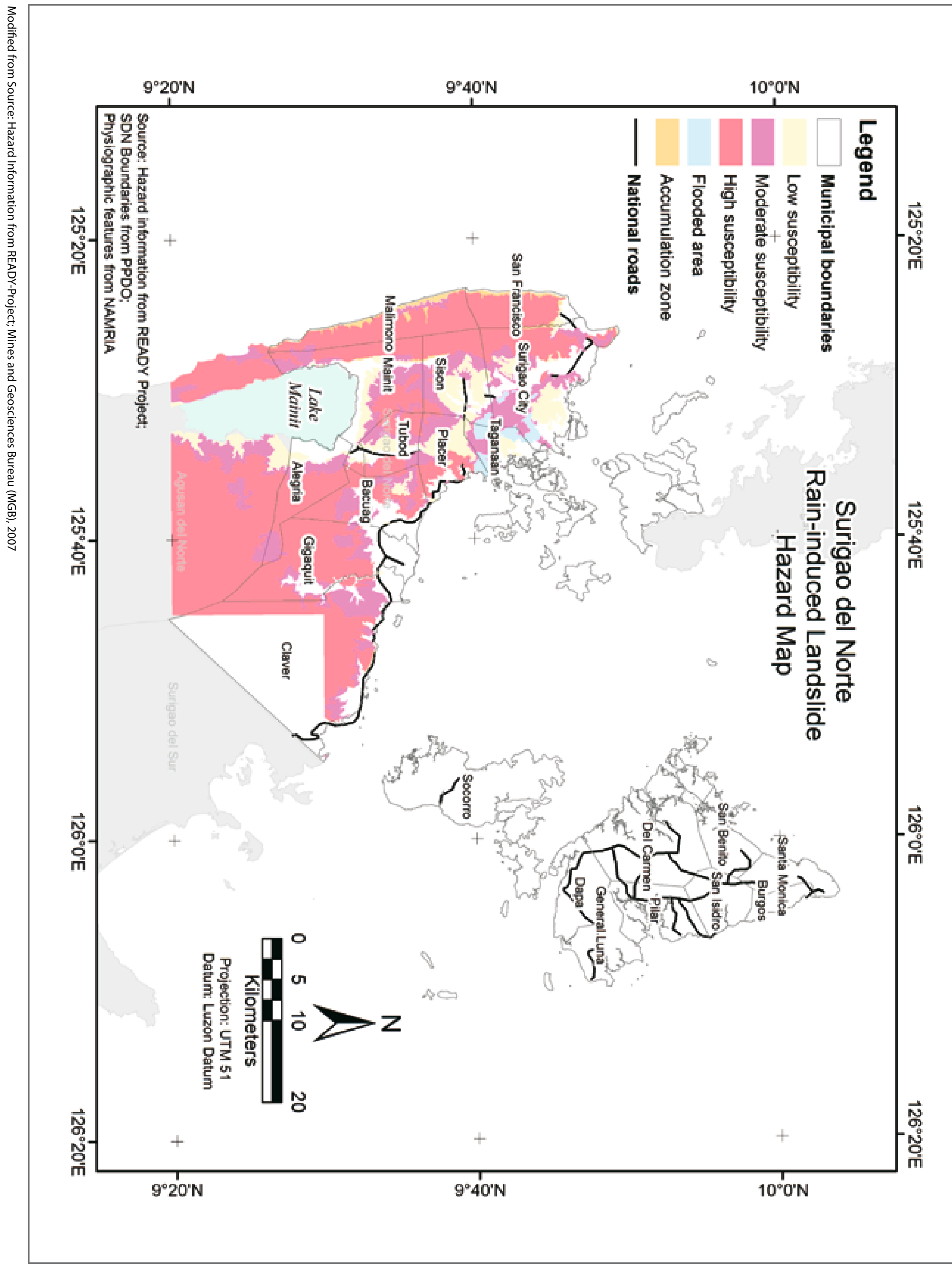
Table 4.2 Inventory of Hazards and their Descriptions

Hazards	Hazard Description /Susceptibility or Proneness Levels	
	READY Maps	Guidelines
Rain-induced landslide	High Susceptibility	High Susceptible Area (HSA) (with accumulation zone)
	Moderate Susceptibility	Moderate Susceptible Area (MSA)
	Low Susceptibility	Low Susceptible Area (LSA)
	Not Susceptible	None
	Possible Areas Prone to Landslide Accumulation	(included in HSA)
Flooding	Prone to flooding	Prone to flooding
	Not prone to flooding	Not prone to flooding
Storm surge	Inundation 1m and below height	HSA
	Inundation of >1m to >4m height	MSA
	Inundation of >4m height	LSA
Tsunami	Inundation area	None
Ground rupture	Active fault: Solid Line: Trace Certain	HSA
	Active fault: Dash Line: Trace approximate	LSA
Earthquake-induced landslide	Areas with high susceptibility to earthquake-induced landslides; Deposition areas	HSA
	Areas with moderate susceptibility to earthquake-induced landslides; Deposition areas	MSA
	Areas with low susceptibility to earthquake-induced landslides; Deposition areas	LSA
	Areas not susceptible to earthquake-induced landslides	None
Liquefaction	High prone	HSA
	Moderate prone	MSA
	Less prone	LSA
Ground shaking	Intensity ≥8	LSA
	Intensity 7	
	Intensity 6	MSA
	Intensity ≤ 5	HSA

Source: NDCC-OCD

Map 1 shows an example of a rain-induced landslide hazard map obtained from MGB. It shows the susceptibility or proneness to rain-induced landslide of each municipality

Modified from Source: Hazard Information from READY-Project; Mines and Geosciences Bureau (MGB), 2007



Map 1 Rain-induced Landslide Map of Surigao del Norte

in the province of Surigao del Norte (i.e., high, moderate and low susceptibility). From the map, the following can be observed:

- Municipalities of San Francisco, Malimono and Alegria have greater areas that are highly susceptible to rain-induced landslides;
- Southeast portions of Sison have areas that are moderately susceptible to rain-induced landslides;
- Municipality of Placer and Surigao City have greater areas that are least susceptible to rain-induced landslides; and
- Areas with possible accumulation zones are areas that are likely to be affected by transported landslide materials.

From these observations, the inventory can now be prepared.

1.2 Prepare hazard inventory matrix

Follow the format in Table 4.3. Indicate in the last two columns the levels of susceptibility given in the hazard map and the areas covered. These High, Moderate, and Low Susceptible Areas (HSAs, MSAs, LSAs) will be used later when assigning the return period and computing for the risks.

Notice that the second to fourth columns derive their information from the hazard map (i.e., source, scale and format/date/reference). These information are important so that it would be easier to catalogue the maps and build the database later.

For maps in digital formats, list the following: source, datum/geographic reference, projection, data file format (e.g., shape files, jpeg, etc). These information are important so that maps can be viewed, and modified with several layers of information under a geographic information system (GIS). The risk assessment procedures described in these Guidelines are GIS-based (see Annex 6 for details).

Table 4.3 Inventory of Hazards and their Descriptions (sample table)

Hazards (1)	Map Availability			Hazard Description Susceptibility/Proneness	
	Source (2)	Scale (3)	Format/Date/ Reference System (4)	Levels (5)	Areas covered (6)
Rain-induced landslide	MGB	Non-scale	Digital/NA/UTM51, Luzon Datum	HSA (with accumulation zone)	San Francisco Malimono Alegria
				MSA	Sison (southeast)
				LSA	Surigao Placer

The Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management, or the READY Project, produces maps at a 1:50,000 scale for earthquake or volcanic hazards and a 1:10,000 scale for floods and rain-induced landslides. READY maps indicate the *susceptibility* of the area to a given hazard. In the absence of READY maps, use similar hazard maps prepared by mandated agencies. However, hazard maps need to be revalidated by the mandated agencies as to their accuracy and limitations.

Maps produced prior to the READY project may have different formats from maps under the READY project; however, they would more likely have the same content but may require updates from their source agencies. For areas without hazard maps, assistance in production should be requested from mandated agencies.

NDCC-OCD serves as repository of the maps and resulting database.

2. ASSIGN RETURN PERIOD FOR EACH HAZARD EVENT

The second important component of understanding what hazards affect a locality is to know the frequency or how often hazards of a particular event occur in the region or province. This will not only help anticipate or plan out an emergency response better (at least for some hazards), but will also provide information on return periods which is required to estimate risks.

Ideally, hazard maps should already contain information on return period, intensity, magnitude and levels of susceptibility. However, hazard maps generated in the Philippines, including those under the READY Project, include information on level of susceptibility only. In the absence of this information, these Guidelines suggest a methodology for estimating return period for volcanic/geologic hazards and for hydrometeorologic hazards. Return periods for earthquake-related hazards could be estimated depending on the location of a particular province but return period for hydrometeorologic hazards are suggested default values.

Note: Consult mandated hazard mapping agencies (i.e., PHIVOLCS, PAGASA, etc.) in assigning return period values specific to an area. The default values are suggested values.

The return periods were estimated based on magnitude or intensity in the case of geologic hazards, and frequency of occurrence in the case of hydrometeorologic hazards. An elaboration on how these return periods were derived is in Annex 3.

In order to use the default values, which will be derived in the next section, the following information should be available:

a. Areas that fall under HSA, MSA, and LSA (which should be derived from the hazard maps); and
b. Frequency of occurrence of hydrometeorologic or geologic hazards or magnitude of earthquakes that affect the HSA, MSA, and LSA.

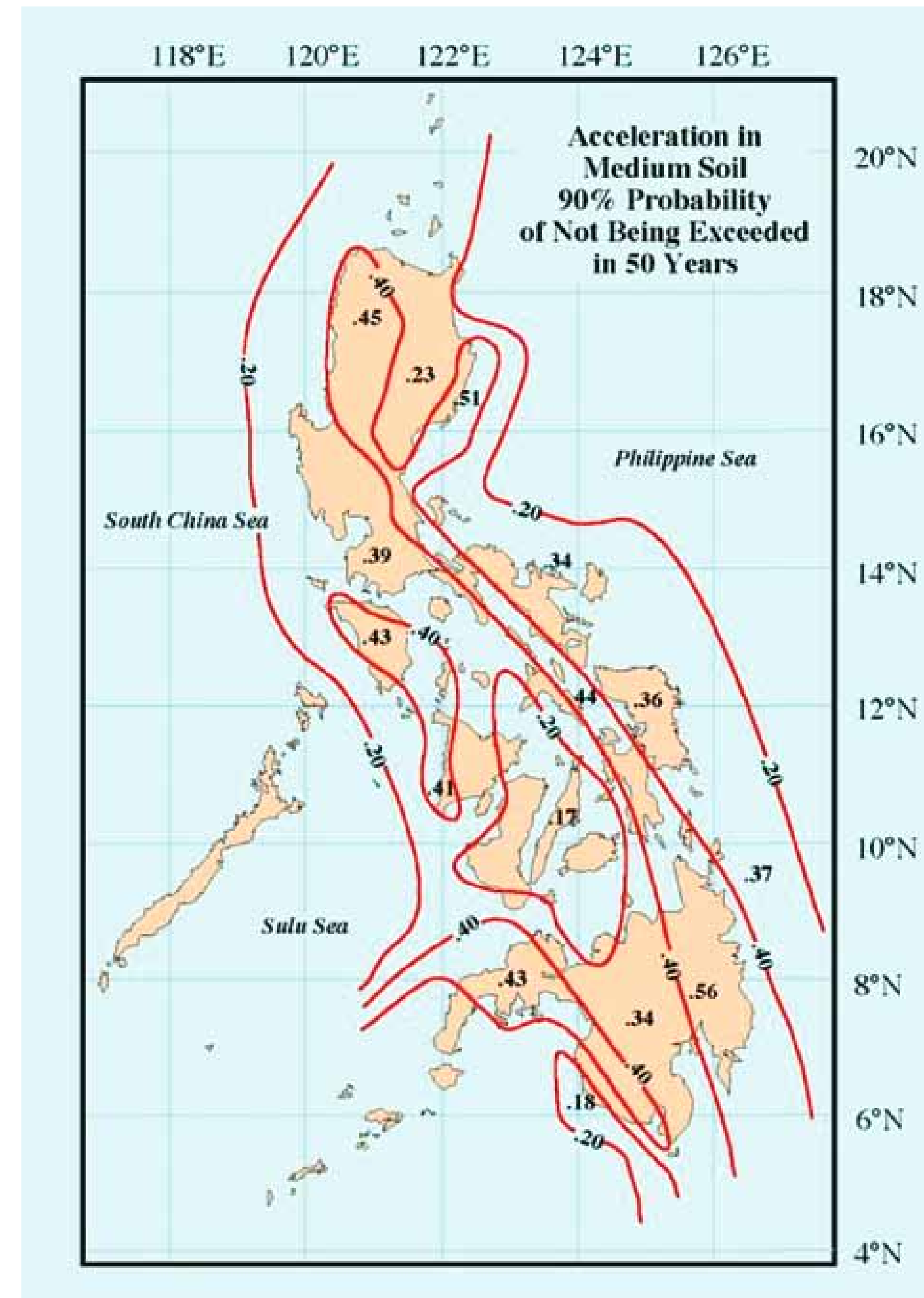
In most cases, however, item b) is not available. How then can one determine what magnitude of earthquake affects the HSA, MSA, or LSA? How does one determine how often rain-related hazards impact HSA, MSA, or LSA? The following steps will help derive this information to be able to assign return periods.

2.1 Estimating Return Period for Earthquake-related Hazards

The return periods that will be assigned for the HSA, MSA, and LSA will depend on the *peak ground acceleration* (PGA), most commonly known as the *g value*, and on the *earthquake zone generator* or *zone*, nearest the area. The concept of *g value* and zones is explained in Annex 3.

a. Identify the *g value* of the province in Map 2, PGA Amplitude Map for Medium Soil. For a region, analysis will be per province. It is assumed that the zone where province is located is also the source of the earthquake.

Map 2 PGA Amplitude Map for Medium Soil



Source: Thenhaus, et al, 1994

Example: Surigao del Norte g value is 0.4

b. Using Table 4.4 identify the equivalent magnitude of the value (if *g value* is greater than 0.21 or less than 0.36, use 0.36-0.53 *g value*).

Table 4.4 Peak Ground Acceleration (*g values*) and Equivalent Magnitude

g value	PEIS	MMIS	Magnitude, Ms
≤0.21	VI-VII	VI-VII	4.9 – 6.1
0.36 -0.53	VIII	VIII,IX	6.2 – 6.9
> 0.53	IX-X	X,XI	> 7.0

PEIS VI-VII corresponds to strong to destructive events
PEIS VIII corresponds to very destructive events
PEIS IX-X corresponds to devastating events

c. Identify in which earthquake zone the province or region is located from Map 3, Seismic Zone Map. If the area overlaps within two or three seismic zones, choose the zone which corresponds to higher return period (Table 4.5).

Example: Surigao del Norte is located in Zone 3.

d. Now that the magnitude for the province and the seismic zone are available, look for the corresponding return period in Table 4.5. If the magnitude overlaps in two ranges in Table 4.5, use the upper value in the magnitude range.

Example: Surigao del Norte, located in Zone 3, and g value of 0.4 equivalent to Magnitude 6.2-6.9 (Table 4.4). The corresponding return period therefore is 13.4.

Table 4.5 Derived Return Period For Each Earthquake Magnitude Interval Per Zone in the Philippines

Zone	5.2aMs<5.8	Return Period	5.8aMs<6.4	Return Period	6.4aMs<7.0	Return Period	7.0aMs<7.3	Return Period	7.3aMs<8.2	Return Period
1	0.30526	3.3	0.11331	8.8	0.04288	23.3	0.01607	62.2	0.00602	166.1
2	0.22282	4.5	0.08351	12.0	0.03130	31.9	0.01173	85.3	0.00440	227.3
3	0.52997	1.9	0.19863	5.0	0.07444	13.4	0.02791	35.8	0.01946	51.4
4	0.14769	6.8	0.05536	18.1	0.02075	48.2	0.00778	128.5	0.00291	343.6
5	0.01789	55.9	0.00971	103.0	0.00251	398.4	0.00094	1063.8	0.00035	2857.1
6	0.16699	6.0	0.06259	16.0	0.02346	42.6	0.00879	113.8	0.00329	304.0
7	0.33713	3.0	0.12636	7.9	0.04735	21.1	0.01775	56.3	0.00665	150.4
8	0.32081	3.1	0.12024	8.3	0.04505	22.2	0.01689	59.2	0.00633	158.0
9	0.06367	15.7	0.02387	41.9	0.00894	111.9	0.00335	298.5	0.00126	793.7
10	0.15240	6.6	0.06442	15.5	0.02724	36.7	0.01151	86.9	0.00488	204.9
10a	0.06307	15.9	0.02666	37.5	0.01127	88.7	0.00467	214.1	0.00202	495.0
10b	0.03743	26.7	0.01582	63.2	0.00669	149.5	0.00283	353.4	0.00120	833.3
11	0.23881	4.2	0.08951	11.2	0.03354	29.8	0.01257	79.6	0.00471	212.3
12	0.15595	6.4	0.05845	17.1	0.02191	45.6	0.00821	121.8	0.00308	324.7
13	0.13050	7.7	0.04891	20.4	0.01833	54.6	0.00687	145.6	0.00257	389.1
14	0.08423	11.9	0.03157	31.7	0.01183	84.5	0.00444	225.2	0.00166	602.4
15	0.41920	2.4	0.15712	6.4	0.05888	17.0	0.02207	45.3	0.00827	120.9
16	0.07380	13.6	0.02535	39.4	0.00871	114.8	0.00299	334.4	0.00103	970.9
17	0.90212	1.1	0.30990	3.2	0.10646	9.4	0.03658	27.3	0.01256	79.6
18	0.24471	4.1	0.08406	11.9	0.02887	34.6	0.00991	100.9	0.00341	293.3
19	0.04165	24.0	0.01430	69.9	0.00492	203.3	0.00169	591.7	0.00058	1724.4
20	0.12550	8.0	0.04311	23.2	0.01481	67.5	0.00508	196.9	0.00175	571.4
21	0.19292	5.2	0.06628	15.1	0.02276	43.9	0.00782	127.9	0.00269	371.7

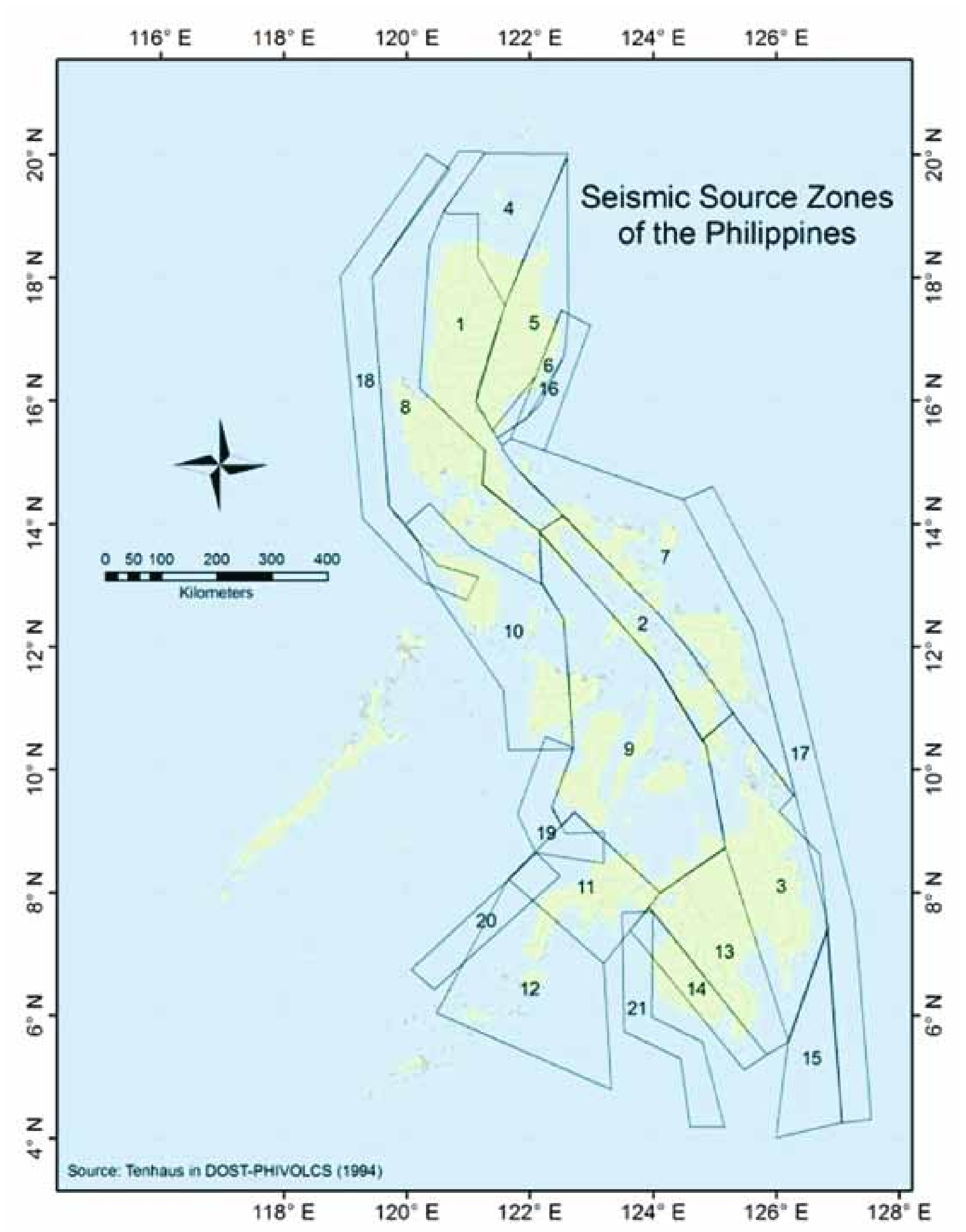
e. Assign the return period of all hazard events following the template in Table 4.6.

Table 4.6 Return Period of Earthquake-Related Hazards and Affected Areas

Ms, Earthquake Magnitude	Indicative Return Period in years	Susceptibility Level	Affected Areas
4.9 – 6.1	5	HSA	HSA
6.2 – 6.9	13.4	MSA	HSA, MSA
> 7.0	51. 4	LSA	HSA, MSA, LSA

The return period derived from step d) will be assumed as the worst case scenario. It means the event is capable of affecting all of the susceptible areas. In the case of Surigao del Norte, its worst case scenario is a 6.2-6.9 magnitude earthquake, with 13.4 years return period.

Map 3 Seismic Source Zones of the Philippines



Source: Thenhaus, et al, 1994

If the area comprises two susceptible areas HSA and MSA, the damage estimates have to be done for both the areas. If the area comprises three susceptible areas, i.e., HSA, MSA, and LSA, the damage estimates should be done for these three areas. In case of Surigao del Norte, the READY hazard map shows three susceptible areas thus consequence analysis should include HSA, MSA, and LSA and using a corresponding return period of 51.4 years.

To fill up the return period of the lower intensity hazard event, refer again to Table 4.5. Using the upper value of the magnitude 6.1, the return period (Zone 3) is 5.

To fill up the return period of the higher intensity hazard event, refer again to Table 4.5. Using the upper value of the range Magnitude 7.3Ms<8.2, the return period (Zone 3) is 51.4.

2.2 Estimating Return Period for Volcanic Eruptions

Volcanic hazards arise from active and potentially active volcanoes in the Philippines. *Active* volcanoes are those that erupted within historical times (within the last 600 years) such that, accounts of these eruptions have been documented. Further, volcanoes that erupted within geological times (less than or equal to 10,000 years) are also classified as active volcanoes. *Potentially active* volcanoes are morphologically young looking but with no historical records of eruption. An *inactive* volcano has no recorded eruptions in the last 10,000 years. Volcanic hazards may be coming from various possible activities like those resulting from eruption: ash falls, ballistic bombs, pyroclastic flow, subsidence, fissures, rolling incandescent rocks and other wind and rain-induced movements, like ash curtains and lahars.

> Based on information from NDCC-OCD and PHIVOLCS, some volcanic activities have longer return periods. Iriga Volcano in Camarines Sur only had a single eruption since 1628, which makes it 380 years dormant. Mt. Banahaw in Quezon, Laguna has only erupted once since 1730, which makes it 278 years dormant. Mt. Pinatubo had erupted in 1991 after more than 600 years of dormancy.
>
> There were 52 recorded eruptions (1616-2006) from Mt. Mayon in Albay, Bicol Region. Mt. Bulusan, in the same region recorded about 15 eruptions with the latest in 2006-2007. Mt. Kanlaon in Negros Oriental has shown regular volcanic activities from mild to strong eruption at least once in a decade. Taal Volcano in Batangas had 33 eruptions with the latest in 1977.

Using the definition of active volcanoes as the condition to identify rare events, the matrix shown in Table 4.7 is divided into frequent (300 years and below), likely (300-600 years) and rare (above 600 years). The assignment of the return period and the coverage of susceptible areas will depend on specific areas where volcanoes are located, as earlier described. Compared to hydrometeorologic hazards, the susceptible areas under volcanic hazards are typically more confined near the source of eruption.

Table 4.7 Indicative Return Period for Volcanic Events

Hazard Occurrence	Indicative Return Period in Years	Susceptibility	Affected Areas
Many events are frequent over a lifetime (Frequent)	300 and Below	HSA	HSA
A single event is likely over a lifetime (Likely)	Above 300 -600	MSA	HSA,MSA
A single event is rare over a lifetime (Rare)	Above 600	LSA	HSA, MSA, LSA

2.3 Estimating Return Period for Hydrometeorologic Hazards

In flood maps, areas may be defined simply as susceptible and not susceptible. In this case, a return period will be assigned to the susceptible area. Other rain-induced hazards have three defined susceptible areas.

Rainfall distributions as recorded in available Rainfall Intensity Duration Frequency (RIDF) tables such as for Surigao del Norte as shown in Table 4.8 were used to guide in developing return period intervals.

In the rainfall intensity duration frequency table shown, the highest rainfall intensity (in mm/hr) occurs in short durations (e.g., 5 min, 120 min) while low intensity rainfall occurs over longer durations (e.g., 12 hrs, 24 hrs). Further, it is noted in the RIDF table that the intensity of rainfall (mm/hr) increases with increase in return periods (25 yrs, 50 yrs, 100 yrs).

a. For flood hazards, when the duration of the rainfall is equal or longer than the travel time of surface flow water from the farthest point up until an outlet point (e.g., a downstream point), most areas of the drainage area contributes to the peak flow. In big drainage areas, longer duration rainfall creates this condition, while in smaller drainage areas, short duration but intense rainfall can produce this condition. As the event becomes rarer (i.e., higher return period of say 25, 50 or more years), the volume of rain increases and flood volume increases and reaches wider areas. Hence, we initially assign smaller rainfall return periods (below 10 yrs) with smaller drainage areas (e.g., urban drainage areas, 100 hectares or so) as HSA in hazard maps where higher flood flows can be expected, and higher return periods (above 10 years) to cover wider areas defined by all susceptible areas, i.e., HSA, MSA, and LSA. This size may vary from 100 hectares to flood plain sizes 10,000 hectares and beyond (Ponce).
b. For rain-induced landslides, the return period depends on the return period of rainfall and site conditions. Steep slopes are more susceptible than those areas with moderately steep slopes or flat terrain. Nonetheless, 150 to 200 millimeters of rainfall per day, in general, may be enough to trigger landslides, based on an investigation by PHIVOLCS and PAGASA.
c. An intense, short duration rainfall is likely to create landslides in HSAs; and longer duration rainfall is likely to increase landslide occurrences in wider areas (i.e., MSA and LSA).

Table 4.8 Surigao Del Norte Rainfall Intensity-Duration-Frequency Data (based on 36 year record)

Computed Extreme Values (in mm) of Precipitation

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	16.3	24.7	31.8	37.8	47.5	57.4	64.2	74.5	83.8	90.8	100.1	108.6	143.5	177.9	204.8
5	24.5	37.2	48.2	56.9	71.1	85.4	95.2	111.0	125.5	136.8	151.5	164.6	216.8	269.1	308.9
10	29.9	45.5	59.0	69.6	86.8	104.0	115.8	135.2	153.1	167.3	185.6	201.7	265.4	329.4	377.8
15	32.9	50.2	65.1	76.7	95.6	114.5	127.3	148.8	168.6	184.5	204.8	222.6	292.8	363.5	416.7
20	35.0	53.5	69.4	81.7	101.8	121.8	135.5	158.3	179.5	196.5	218.2	237.2	311.9	387.3	443.9
25	36.7	56.0	72.7	85.6	106.5	127.5	141.7	165.7	187.9	205.8	228.6	248.5	326.7	405.7	464.9
50	41.8	63.8	82.8	97.4	121.2	144.9	161.0	188.4	213.8	234.3	260.5	283.2	372.2	462.3	529.5
100	46.8	71.6	92.9	109.2	135.8	162.1	180.1	210.8	239.5	262.6	292.2	317.7	417.4	518.4	593.6

Equivalent Average Intensity (in mm/hr) of computed extreme values

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	195.6	148.2	127.2	113.4	95.0	76.5	64.2	55.9	139.7	45.4	40.0	36.2	23.9	14.8	8.5
5	294.0	223.2	192.8	170.7	142.2	113.9	95.2	83.3	209.2	68.4	60.6	54.9	36.1	22.4	12.9
10	358.8	273.0	236.0	208.8	173.6	138.7	115.8	101.4	255.2	83.7	74.2	67.2	44.2	27.5	15.7
15	394.8	301.2	260.4	230.1	191.2	152.7	127.3	111.6	281.0	92.3	81.9	74.2	48.8	30.3	17.4
20	420.0	321.0	277.6	245.1	203.6	162.4	135.5	118.7	299.2	98.3	87.3	79.1	52.0	32.3	18.5
25	440.4	336.0	290.8	256.8	213.0	170.0	141.7	124.3	313.2	102.9	91.4	82.8	54.5	33.8	19.4
50	501.6	382.8	331.2	292.2	242.4	193.2	161.0	141.3	356.3	117.2	104.2	94.4	62.0	38.5	22.1

Source: Hydrometeorological Investigation and Special Studies Section, Flood Forecasting Branch, PAGASA

d. Assign return period for hydrometeorological hazards and fill out Table 4.9.

Table 4.9 Indicative Return Period for Hydrometeorologic Events

Hazard Occurrence	Indicative Return Period in Years	Susceptibility	Affected Areas
Many events are frequent over a lifetime (Frequent)	5	HSA	HSA
A single event is likely over a lifetime (Likely)	25	MSA	HSA,MSA
A single event is rare over a lifetime (Rare)	100	LSA	HSA,MSA, LSA

3. PREPARE SUMMARY FREQUENCY TABLE

The results should be summarized using the following tables:

Table 4.10 Summary Frequency Table

Origin	Hazards	Hazard Occurrence	Return Period[1/]
Geologic	Earthquake-related Earthquake-induced landslides Ground shaking Ground rupture Liquefaction	4.9 – 6.1 (Frequent)	5
		6.2 – 6.9 (Likely)	13.4
		> 7.0 (Rare)	51.4
	Volcanic eruptions	Frequent	300 and Below
		Likely	Above 300 -600
		Rare	Above 600
Hydrometeorologic	Rain-induced landslide Storm Surge	Frequent	5
		Likely	25
		Rare	100
	Floods [2/]	Frequent	≤10
		Likely	>10

1/ The figures for geologic hazards except volcanic eruptions are for Surigao del Norte. Each province should compute for their return periods based on their *g value* and zone, as described in these Guidelines.

2/ These are only applicable to areas prone to flooding as reflected in flood susceptibility maps or flood hazard maps. It will be up to the planner to assess flooding in the area based on past occurrences to determine whether they are frequent or likely events with the corresponding return period of ≤10 or >10, respectively. In the computations for Surigao del Norte, where floods are likely events, a return period of 100 years was used.

B. CONSEQUENCE ANALYSIS

Objective: Given the hazard characteristics (type, intensity, frequency), estimate the consequence in terms of *fatality* and *property* damage.

Output/s: Estimated fatality and damage to property (in tabular and map forms) per hazard

Process: The working equations for *Consequence Analysis* are:

For estimating fatality: $C_F = P_{AP} \times F_F$

where C_F = consequence in terms of fatality per hazard event (fatality/event)
P_{AP} = potentially affected population
F_F = factor for fatality

For estimating property damage: $C_{PrD} = P_{APr} \times F_{PrD}$

where C_{PrD} = consequence in terms of cost of property damage per hazard (PhP/event)
P_{APr} = potentially affected property
F_{PrD} = factor for property damage

1. Determine the potentially affected elements (P_{AP} and P_{APr}) for every hazard (e.g., flood) and corresponding hazard event (e.g., 5-year flood, 10-year flood, 50-year flood).

2. Compute for the consequence in terms of *fatality* and *cost of property damage* per hazard event by multiplying the potentially affected elements (P_{AP} and P_{APr}) and the factors.

3. *Step 2* is repeated for other hazard events. And, the entire iteration (*steps #1* and *#2*) is repeated for other hazards.

In hazard characterization, one is able to know what hazards affect a region or province, where, and how often. The next step is to know *who* and *what* are affected, or the *elements at risk*.

Elements at risk refer to the population, aggregated built-up areas (residential and nonresidential) and agricultural areas. These elements at risk formed the bases of the estimation of fatality and cost of property damage.

The use of aggregated groups (e.g., population instead of families and land use categories, such as built up areas instead of individual buildings or household plots) are deemed sufficient for framework planning, and more detailed sets of information will be needed for city or municipal planning.

For each hazard event, two parameters are calculated in the consequence analysis: (1) the *potentially affected* elements (i.e., potentially affected population for estimation of fatality and potentially affected properties for estimation of property damage); and (2) the *estimated loss* (i.e., fatality and cost of property damage).

Use of GIS software is suggested since the processing may be tedious; however, presentation herein shows how computations may be done through spreadsheets.

1. DETERMINE THE POTENTIALLY AFFECTED ELEMENTS

1.1 Determine the Potentially Affected Population (P_{AP})

a. Compute for the population density of the concerned region or province. Density is computed by dividing the total population by the total land area. The latest NSO population census data should be used to allow for aggregation of figures in higher level plans. Locally-generated data may be used, but the Guidelines make use of official population counts. In any case, do not forget to indicate the source of data.

   For regional plans, the *municipality* is the basic unit of analysis while the *barangay* is used as the unit of analysis for provincial plans. The working table for this exercise is as follows:

Table 4.11 Sample Table of Population Density, by Municipality and Barangay

City/ Municipality (A)	Barangay (B)	Land Area (Km²) (C)	Population 2007 (D)	Population Density (E) = D/C
Surigao City	Talisay	16.32	1823	111.70
	Mat-i	11.30	4304	380.88
	Taft (Pob.)	1.17	16917	14,458.97
	Cabongbongan	3.53	608	172.24
	Punta Bilar	0.72	830	1,152.78
Xxx	Yyy			
	Zzzz			
	www			

Source: NSO, 2007

b. Prepare the population density map.

This map is produced by overlaying the administrative boundary map which contains the size of each municipality or barangay, and the population map which contains the number of person per unit area (sq km) in each administrative unit.

For consistency, it is encouraged that the administrative boundary map (at 1:50,000 scales) of NAMRIA be used. At the minimum, regional map scales of 1:250,000 and provincial map scales of 1:50,000 are sufficient for analysis.

c. Determine the Potentially Affected Population (P_{AP}) for every hazard

Potentially affected population will be calculated based on the intersection of the overlays of the hazard map and the population density map. The table prepared for assigning the return period may also be combined. The specific activities are as follows:

(i) Overlay the population density map on a hazard map. The intersections in the composite map will indicate the affected areas for each susceptibility level (HSA, MSA, LSA), as well as how many people are potentially affected by the hazard in each of the three levels of susceptibility;

(ii) Following the format in Table 4.12, calculate the size of the area that fall under HSA, MSA, and LSA and reflect the figures in columns F, G, and H;

(iii) Calculate the potentially affected population (P_{AP}) for each hazard event by multiplying the population density of all municipality or barangay (depending on the unit of analysis), and the size of the area affected in HSA, MSA, and LSA.

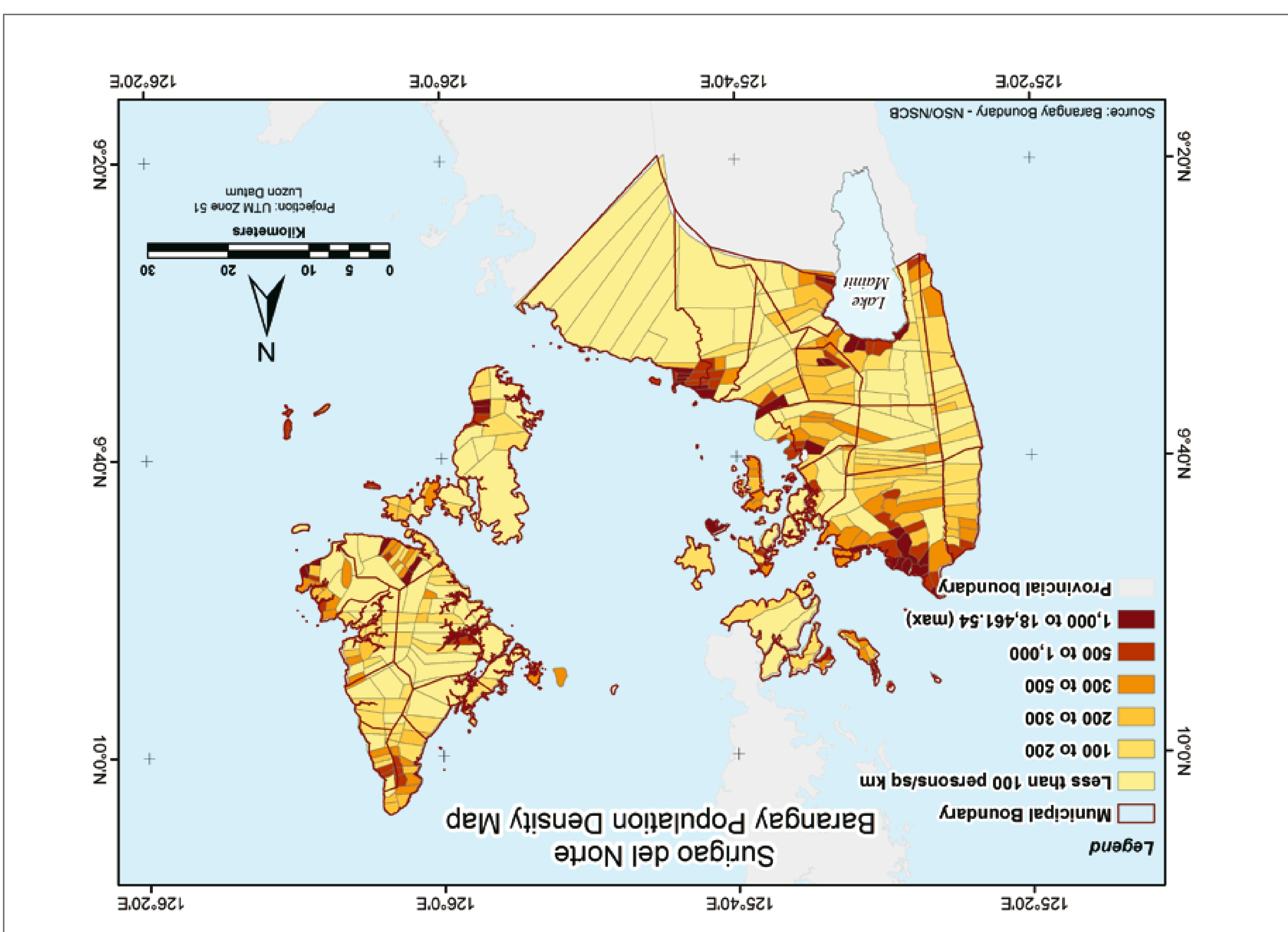
- for a Frequent hazard event, the P_{AP} is the product of the size of the HSA (column F) and the population density (column E);
- for a Likely hazard event, the P_{AP} is the product of the size of both HSA, MSA (columns F + G) and the population density (column E); and
- for a Rare hazard event, the P_{AP} is the product of the size of HSA, MSA and LSA (columns F + G + H) and the population density (column E).

(iv) Repeat steps b) and c) for all other hazards. A table of potentially affected population, P_{AP}, should be produced per each type of hazard. Mapping for potentially affected population may be helpful for visualizing its spatial distribution.

Table 4.12 Sample Working Table, Potentially Affected Population, Rain-induced Landslide, Surigao del Norte

Municipality/ City (A)	Barangay (B)	Land Area (sq km) (C)	Population (D)	Pop. Density (person/sq km) (E) = D/C	Affected area (sq km)			Potentially affected population (P_{AP}) by event		
					HSA (F)	MSA (G)	LSA (H)	Frequent (I)=F×E	Likely (J)=(F+G)×E	Rare (K) =(F+G+H)×E
Surigao City	Talisay	16.32	1823	111.70	0.00	0.00	0.00	0.00	0	0
	Mat-i	11.30	4304	380.88	4.09	2.97	0.73	1557.80	2689.01	2967.06
	Taft (Pob.)	1.17	16917	14,458.97	0.12	0.26	0.00	1735.08	5494.41	5494.41
	Cabong-bongan	3.53	608	172.24	0.93	0.30	0.40	160.18	211.86	280.75
	Punta Bilar	0.72	830	1152.78	0.37	0.30	0.00	426.53	772.36	772.36
Municipality B	…									
Municipality C	…									
Surigao del Norte - Total	…									

NOTE:
Columns (F), (G) and (H) are the intersection areas of the overlays of the *population map* and the *hazard map*.
Column (F) represent the area of barangay (column B) covered by the HSA zone of the hazard map.
Column (G) represent the area of barangay (column B) covered by the MSA zone of the hazard map.
Column (H) represent the area of barangay (column B) covered by the LSA zone of the hazard map.



Map 4 Sample Population Density Map

1.2 Determine the Potentially Affected Property (P_{APr}) for each type of hazard

The potentially affected property is estimated indirectly using the value established for each land use category. Under this approach, each land use category will be assigned a value reflecting the cost of replacing the lost asset or property.

a. Prepare a property valuation table to establish the unit cost of each property category, i.e., built-up areas, agricultural areas.

The numbers in Table 4.13 serve as proxy values to estimate replacement costs for properties in the different land uses in Surigao del Norte. They are further explained in Annex 4. Each province is expected to come up with its own estimates.

Table 4.13 Working Table (Property Valuation Table) for Surigao del Norte

Description of Property Classification		Unit Value (PhP)
Property by Residential Floor Area(RFA) (In 2007 third quarter prices)		5,534,000,000/sq km (5,534.0/sq m)
Total Floor Area (TFA)- Residential and Nonresidential Urban area (2007 3rd quarter prices)		7,509,000,000/sq km (7,509/sq m)
Agricultural crops (2007 3rd quarter price)	All Rice	30,486/hectare
	All Corn	17,112/hectare
	Fruits (taken from pineapple)	61,670/hectare
	Coffee and Cacao	25,228/hectare
	Vegetables (taken from eggplant)	98,367/hectare

The unit cost for built up areas (PhP7,509/sqm) was based on the average cost of building construction per unit floor area in Surigao del Norte as provided by NSO for 2007.

The unit cost for agricultural areas was computed using the cost of producing crops (Tables A4.8 to A4.11 in Annex 4). About 90,000 hectares (BAS, 2007) were devoted to coconut in Surigao Del Norte; however, it was not included here since coconut is a perennial crop and its growth stages vary across areas. It was assumed that impact by floods and rainfall induced landslides are indirect damages.

Municipal distribution of root crops and vegetables and fruits, coffee and cacao were not available. Their aggregated harvest areas (provincial) were estimated to be about 3,956 hectares.

The land area per municipality planted with specific crops has to be determined. If the total land area in a province devoted for a crop type is known but its distribution across municipalities is unknown, a proportionality factor equal to the ratio of land area of the municipality to the provincial area may be used.

For example, in the case of Surigao City, rice, corn, fruits, coffee and cacao and fruits were the main annual crops planted and harvested. However, only provincial data for areas planted to fruits, coffee and cacao are available. Thus, the share of Surigao City area to Surigao del Norte was computed at 260.41 hectares/ 2,017,000 hectares or 0.000129. This serves as the proportionality factor. This factor is to be multiplied to the province's area planted to each crop to get the area planted for Surigao City. The derived values are shown in Table 4.14.

Table 4.14 Property Valuation for Surigao del Norte

Crop Types	Unit cost (Php/hectare)	Area Planted in Province (hectare)	Area Planted in Surigao City (hectare)		
Rice	30,486		3,930		
Corn	17,112		152		
Fruits	61,670	558	unknown	Derived Values	72.04
Coffee & Cacao	25,228	108	unknown		13.94
Vegetables	98,367	521	unknown		67.27
AVERAGE	31,597.27*				

Surigao City total area planted =3,930+152+72.04+13.94+67.27=4,235.24 hectares
* Weighted Average = {(30,486*3,930) + (17,122*152) + (61,670*72.04) +(25,228*13.94) + (98,367*67.27)} /(4,235.24) = 31,597.27
Note: Area of Surigao del Norte is 2,017,000 hectares
Area of Surigao City is 260.41 hectares

b. Compute the total property value by type of property in each municipality. (For regions and provinces, the subareas affected by hazards in the municipality is the unit of analysis for property valuation and damages are aggregated for assessment).

(i) Compute built-up property values for municipalities

- Gather private construction statistics from the NSO[1]. Determine total floor area constructed per municipality since year 2000. Census data of 2000 is cumulative data for floor areas since 1977. Municipal data can be obtained by request from the Industry Statistics Division, National Statistics Office.

[1]Private construction statistics from approved building permits relate to data on new constructions and additions, alterations and repairs of existing residential and nonresidential buildings and other structures undertaken in all regions/provinces of the country.

The built-up area is approximated by the floor areas comprising the total floor area (TFA) of construction for all type of buildings, generally categorized as residential floor area (RFA) and nonresidential floor area (NRFA).

The residential floor areas (RFA) reflect a composite floor area comprising different types of residential construction covering single detached, duplex type/quadruplex, apartment, accessoria, residential condominium and other buildings with related functions. The nonresidential building floor areas (NRFA) reflect a composite floor area comprising different types of residential construction commercial areas, industrial areas, institutional and agricultural buildings and others. Table 4.15 is the working table.

Table 4.15 Working Table for Estimating Property Value in Built-Up Areas Using Private Construction Statistics in Surigao del Norte

Municipality	Total (as of 2007)			2000			2001			2002 (up to 2007)		
	TFA	RFA	NRFA	TFA	RFA	NRFA	TFA	RFA	NRFA	TFA	RFA	NRFA
Alegria												
Bacuag												
Burgos												
Claver												
Dapa												
Del Carmen												
General Luna												
Gigaquit												
Mainit												
Malimono												
Pilar												
Placer												
San Benito												
San Francisco												
San Isidro												
Santa Monica												
Sison												
Socorro												
Surigao City												
Tagana-an												
Tubod												
Total												

- Overlay hazard map with the land use map. The intersections in the map overlay would represent the affected areas in each susceptible area (HSA, MSA, LSA), as illustrated in table below.

  In Table 4.16, the area values in column (2) represent the smaller built-up areas in Surigao City obtained in a land use cover map. When added up (3.85 sq km), it amounts to the total built-up area in Surigao City. It may be possible that not all built-up areas in a municipality are affected by a hazard. In the example below, only built-up areas 3 and 4 were affected. The overlay will show you if built-up areas 3 and 4 are under HSA, MSA, or LSA. The size of the built-up areas within the susceptible areas must be estimated. This would vary under a GIS platform but would need approximation in a manual alternative.

However, since not the whole of built-up areas 3 and 4 have existing structures or buildings, the share of the TFA in these areas must be obtained. For example,

Built-up area 3 = (0.29/3.85) x 1.04 = 0.08 sq km

Table 4.16 Working Table for Built –up areas

Areas (1)	Size of built-up (sq km) (2)	Susceptibility (3)	TFA 2007 (sq km) (4)	TRA 2007 (sq km) (5)
SURIGAO CITY	**3.85**		**1.04**	**0.98**
Built-up area1	2.33		0.63	0.59
Built-up area2	0.19		0.05	0.03
Built-up area3	0.29	HSA	0.08	0.00
Built-up area4	1.04	MSA	0.28	0.00
Built-up area5	0.00		0.00	0.00
Built-up area6	0.00		0.00	0.00

- Calculate the Potentially Affected Property (P_{APr}) for each hazard event by multiplying the unit property value to the affected built-up area in HSA, MSA, and LSA. A summary may be seen in column (Z) of Table 4.17.
- Repeat the procedure for all municipalities.

Table 4.17 Estimated Potentially Affected Property for Surigao City (Sample Table)

Municipality (A)	Land Use (B)	Land Area (sq km) (C)	Unit Property Value (PhP/sq km) (D)	Affected area (in sq km)			P_{Apr} (Built up Areas) (Z) = (E or F or G)×D
				HSA (E)	MSA (F)	LSA (G)	
Surigao City	Built-up area3	0.29	7,509,000,000	0.08			600,720,000
	Built-up area4	1.04	7,509,000,000		0.28		2,102,520,000

(ii) Compute property values for agricultural lands per municipality

- Using the same overlay (hazard map and land use map), determine the intersections between the hazard susceptible areas and the agricultural areas. The intersections would be the agricultural areas affected by a hazard that may fall within HSA, MSA, or LSA. Compute the size of the intersections (in sq km).

It may be seen that not all affected agricultural areas are in susceptible areas. For example, in Surigao City, only four subareas (e.g. agricultural lands 6, 7, 8, 9) were within the different susceptible zones as shown in Table 4.18.

Table 4.18 Working Table Agricultural Land Areas (Property Valuation Computation)

Surigao City	Area in Map (sq km)	Susceptibility	Unit Cost (PhP)/ Hectare	Cost of Agricultural Land (PhP)
Sub-Areas	43.15		31,597.27	136,342,220.05
Agricultural land 1	8.59	-	31,597.27	27,142,054.93
Agricultural land 2	0.60	-	31,597.27	1,895,836.20
Agricultural land 3	4.51	-	31,597.27	14,250,368.77
Agricultural land 4	7.44	-	31,597.27	23,508,368.88
Agricultural land 5	4.33	-	31,597.27	13,681,617.91
Agricultural land 6	8.11	HSA	31,597.27	25,625,385.97
Agricultural land 7	0.46	HSA	31,597.27	1,453,474.42
Agricultural land 8	7.14	MSA	31,597.27	22,560,450.78
Agricultural land 9	1.97	LSA	31,597.27	6,224,662.19
Agricultural land 10	0.00	-	31,597.27	0.00
Agricultural land 11	0.00	-	31,597.27	0.00
Agricultural land 12	0.00	-	31,597.27	0.00
Agricultural land 13	0.00	-	31,597.27	0.00
Agricultural land 14	0.00	-	31,597.27	0.00
Agricultural land 15	0.00	-	31,597.27	0.00

- Calculate the potentially affected property (P_{APr}) for each hazard event by multiplying the average cost of agricultural land per hectare of Surigao City (Table 4.19) with the land area of agricultural land that falls in the HSA, MSA, and LSA.

- Calculate the value of the affected areas in the different zones. For each land area in column C in Table 4.23 multiply the unit property value (D) by the area values in (C). A summary may be seen in column (Z) of Table 4.19.

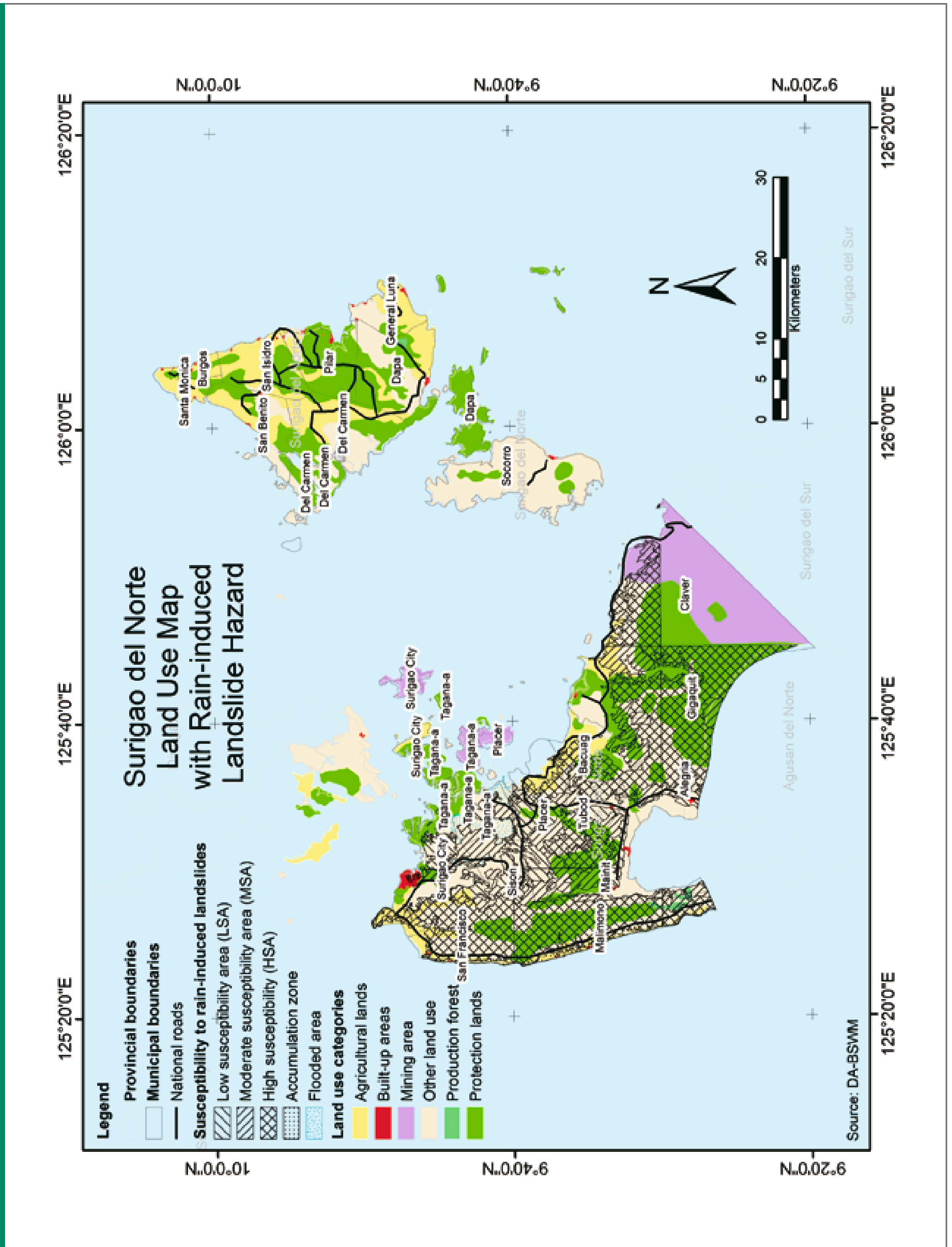
Table 4.19 Sample Working Table, Potentially Affected Property, Rain-induced Landslide, Surigao del Norte

Municipality (A)	Land Use (B)	Land Area (km^2) (C)	Unit Property Value (PhP/sq km) (D)	Affected area (in sq km)			Value of Affected Property (PhP)
				HSA (E)	MSA (F)	LSA (G)	(Z)= (E or F or G)×D
Surigao City	Agricultural land 6	8.11	3,159,727	8.11			25,625,385.97
	Agricultural land 7	0.46	3,159,727	0.46			1,453,474.42
	Agricultural land8	7.14	3,159,727		7.14		22,560,450.78
	Agricultural land9	1.97	3,159,727			1.97	6,224,662.19

NOTE:

Columns (E), (F) and (G) are the intersection areas of the overlay of the *hazard map* and the agriculture lands represented in the land use map.
Column (E) represents the agriculture land area (column B) of municipality (column A) covered by the HSA zone of the hazard map.
Column (F) represents the agriculture land area (column B) of municipality (column A) covered by the MSA zone of the hazard map.
Column (G) represents the agriculture land area (column B) of municipality (column A) covered by the LSA zone of the hazard map.
Column (Z) represents the property value of the affected area. This will be used to determine the factor for damage depending on the value and the location (e.g. HSA,MSA, LSA)

Map 5 Land Use Map with Rain-induced Hazard Map



2. COMPUTE FOR THE CONSEQUENCE IN TERMS OF *FATALITY* AND *COST OF PROPERTY DAMAGE*

No matter how strong a hazard is, it will not be strong enough to wipe out the entire population, or destroy all structures in the region or province. Even in High Susceptible Areas, only a portion of the structures will be damaged.

Having computed for the potentially affected population and potentially affected property in the region or province, the next step is to know what proportion of that population will die, or what percentage of all properties will actually be damaged from a hazard event. The operational question is: If flood happens in the province, how many will likely die? Or, in an earthquake of Magnitude 6, how much damage to property will be incurred?

2.1 Compute for Consequence of Fatality

The equation for estimating fatality is:

$$C_F = P_{AP} \times F_F$$

where C_F = consequence in terms of fatality per hazard event (fatality/hazard)

P_{AP} = potentially affected population

F_F = factor for fatality

a. Following the format in Table 4.20, multiply the potentially affected population obtained in step 1, with the *factor for fatality*. Note that the unit of analysis for consequence of fatality is the barangay.

The *factor for fatality* is a multiplier from 0 to 1 that indicates a proportion of the total affected population that has the probability of dying as a consequence of a hazard event of a specific magnitude.

The *factor for fatality* can be obtained using a series of matrices developed for these Guidelines (see Table 4.21 to Table 4.25). The factors were developed based on hazard event exposures of the country and serve to provide *indicative* estimates of the *"proportion"* of fatalities out of the total population affected by a hazard event. Annex 5 explains in detail how these factors were derived.

In GIS, the computation can be done by using the SELECT/QUERY and MULTIPLICATION functions. The QUERY is meant to identify areas in which the factor for fatality is applied. See Annex 6 for details.

b. Repeat the procedure for all hazards.

Table 4.20 Sample Calculation of Consequence of Fatality, Rain-induced Landslides Surigao del Norte

Municipality (A)	Barangay (B)	Pop. Density (E)	P_{AP} Potentially Affected Population			F_F Factor for fatality			C_F Consequence in terms of Fatality		
			Frequent (I)	Likely (J)	Rare (K)	Frequent (L)	Likely (M)	Rare (N)	Frequent (O) = (I×L)	Likely (P) = (J×M)	Rare (Q) = (K×N)
Surigao City	Cabong-bongan	170.82	158.86	210.11	278.44	3.30×10^{-5}	6.60×10^{-5}	1.00×10^{-4}	0.0052424	0.0138673	0.027844
	Mat-i	314.60	1,286.71	2,221.08	2,450.73	6.60×10^{-5}	1.33×10^{-4}	2.00×10^{-4}	0.0849229	0.2954036	0.490146
	Taft (Pob.)	16,935.90	2,032.31	6,435.64	6,435.64	1.00×10^{-4}	2.00×10^{-4}	3.00×10^{-4}	0.2032310	1.2871280	1.930692

Table 4.21 Factors for Fatality for Earthquake-related Hazards

Magnitude of earthquake (Ms)	Affected Area	Factors for fatality [1,2]		
		< 250 (persons/ sq km)	250 – 500 (persons/ sq km)	>500 (persons/ sq km)
4.9 – 6.1	HSA	3.30×10^{-4}	6.60×10^{-4}	1.00×10^{-3}
6.2 – 6.9	HSA MSA	6.60×10^{-4}	1.33×10^{-3}	2.00×10^{-3}
> 7.0	HSA MSA LSA	1.00×10^{-3}	2.00×10^{-3}	3.00×10^{-3}

1/ Factors for fatality and property damage can be applied to provinces with similar *g value* as Metro Manila or Surigao del Norte. However, using this default value will overestimate risks for province of Cebu and under estimate for parts of Davao (.56 *g value*).
2/ Factors for fatality are **not** used for liquefaction and ground rupture.

Table 4.22 Factors for Fatality for Volcanic Eruption

Hazard Event	Affected Area	Factors for fatality		
		< 250 (persons/ sq km)	250 – 500 (persons/ sq km)	>500 (persons/ sq km)
frequent	HSA	6.66×10^{-4}	1.33×10^{-3}	2.00×10^{-3}
likely	HSA MSA	1.33×10^{-3}	2.66×10^{-3}	4.00×10^{-3}
rare	HSA MSA LSA	2.00×10^{-3}	4.00×10^{-3}	6.00×10^{-3}

Table 4.23 Factors for Fatality for Rain-induced Landslide

Hazard Event	Affected Area	Factors for fatality		
		< 250 (persons/ sq km)	250 – 500 (persons/ sq km)	>500 (persons/ sq km)
Frequent	HSA	3.30×10^{-5}	6.60×10^{-5}	1.00×10^{-4}
Likely	HSA MSA	6.60×10^{-5}	1.33×10^{-4}	2.00×10^{-4}
Rare	HSA MSA LSA	1.00×10^{-4}	2.00×10^{-4}	3.00×10^{-4}

Table 4.24 Factors for Fatality for Flood

Hazard Event	Affected Area	Factors for fatality [1]		
		< 250 (persons/ sq km)	250 – 500 (persons/ sq km)	>500 (persons/ sq km)
Frequent	HSA	3.30×10^{-5}	6.60×10^{-5}	1.00×10^{-4}
Likely	HSA MSA	6.60×10^{-5}	1.33×10^{-4}	2.00×10^{-4}

1/ In flood maps used, susceptible and nonsusceptible areas are only identified. In this case, only the susceptible area will be assigned a return period. Bigger catchments (HSA, MSA) would be assigned larger return periods.

Table 4.25 Factors for Fatality for Storm Surges

Hazard Event	Affected Area	Factors for fatality		
		<250 (persons/ sq km)	250-500 (persons/ sq km)	>500 (persons/ sq km)
Frequent	HSA	1.67×10^{-4}	3.30×10^{-4}	5.0×10^{-4}
Likely	HSA MSA	3.30×10^{-4}	6.70×10^{-4}	1.0×10^{-4}
Rare	HSA MSA LSA	5.00×10^{-4}	1.00×10^{-3}	1.5×10^{-3}

The first column of Tables 4.21 to 4.25 presents the range of magnitudes of the hazard event. The second column (affected area) provides the geographical extent or impact areas of the hazard event. The last three columns present the factors for fatality.

The first row, magnitude 4.9 - 6.1 for earthquake-related hazards and frequent for the other hazard types, represents the frequent event; the second row, magnitude of 6.2 – 6.9 for earthquake-related hazards and likely for the other hazard types, represents the likely event; the third row, magnitude of > 7.0 for earthquake- related hazards and rare for the other hazard types, represents the rare event.

The factor for fatality is premised on the principle that highly dense areas will have higher fatality as compared to less dense areas. Therefore, the factors will be dependent on the population density of an area. If the population density of an area is less than 250 persons per sq km, the third column should be used. For areas with density of 250 to 500 persons per sq km, the fourth column will provide the factor. And the last column is used for areas with population density of more than 500 persons per sq km.

To the extent feasible, local data/value (especially local historical loss data) must be used to refine the factors. In the revisions of the *factors*, mandated agencies should be consulted, e.g., NDCC-OCD and their Regional and Local Disaster Coordinating Councils.

2.2 Consequence in terms of property damage

The working equation for estimating property damage is:

$$C_{PrD} = P_{APr} \times F_{PrD}$$

where C_{PrD} = consequence in terms of cost of property damage per hazard (PhP/hazard)

P_{APr} = potentially affected property (PhP of affected area)

F_{PrD} = factor for property damage

The *factor for property damage* can be obtained using the series of matrices developed for these Guidelines. Similar with the approach used for *factor for fatality*, the *factor for property damage* was developed to allow for the estimation of the probable *"proportion"* of properties damaged by a hazard event. Given that the factors are determined from event damages without disaggregation of each component areas, the numbers are basically *indicative.* Annex 5 explains in detail how the factors were derived.

a. Following the format in Table 4.26, multiply the potentially affected property with the factor for property damage. Note that the unit of analysis for consequence of property damage is the subarea affected in the municipality.

- If the property is in the HSA, write the factors for the frequent, likely and rare corresponding to the value of the property in the table of factors.
- If the property is in the MSA, write the factors for likely and rare corresponding to the value of the property in the table of factors.
- If the property is in the LSA, write only one factor.
- Property areas in HSA are affected by all events, areas in the MSA are damaged by likely and rare events and areas in LSA are affected by rare events.

Note that not all areas will be affected. For example, in Surigao City, only four subareas were found to be in the different susceptible zones.

- For *frequent* hazard event, the *consequence in terms of property damage* is the product of the property values in HSA area (column H) of Table 4.26 and the factor (column K of Table 4.26).The results are shown in Column (N).
- For *likely* hazard event, the *consequence in terms of property* damage is the product of individual property values in HSA and MSA areas (columns H and I) of Table 4.26 multiplied by the property factor (column L Table 4-34). as shown in column (O) of Table 4.26.
- For *rare* hazard event, the *consequence in terms of property damage* is the product of the individual property values in HSA, MSA and LSA areas (columns H, I and J) of Table 4.26 multiplied by the property factor (column M of Table 4. 26) as shown in column (P) of Table 4.26.
- The C_{PrD} of the individual subareas is obtained in each cell (N), (O), (P).
- The consequence of damage (C_{PrD}) of the aggregated properties to a municipality is obtained by adding vertically, the damages from frequent (C_{PrD} =sum column N), likely (C_{PrD}= sum column O) and (C_{PrD} =sum column P) rare events.

b. Repeat procedure for all other areas and hazards. In GIS, the computation can be done by using the series of SELECT/QUERY selection and MULTIPLICATION commands. The SELECT/QUERY is done to choose the particular event for which the factor of property damage is applicable. The MULTIPLICATION is used in computing for C_{PrD} . See Annex 6 for details.

Table 4.26 Consequence in terms of Property Damage, Rain-induced Landslides, Surigao City

Municipality (A)	Land Use (B)	Affected Areas (sq km) (C)	Unit Value (PhP/ sq km) (D)	P_{Apr} Potentially affected property			F_{PrD} Factor for property damage			C_{PrD} Consequence in terms of property damage		
				HSA (H)	MSA (I)	LSA (J)	Frequent (K)	Likely (L)	Rare (M)	Frequent (N)	Likely (O)	Rare (P)
Surigao City	Agricultural land 6	8.11	3,159,727.00	25,625,385.97			0.17	0.33	0.50	= (H)x(K) 4,292,252.15	= (H) x (L) 8,520,440.84	= (H) x (M) 12,812,692.99
	Agricultural land 7	0.46	3,159,727.00	1,453,474.42			0.08	0.17	0.25	= (H) x (K) 119,911.64	= (H x (L) 243,456.97	= H) x (M) 363,368.61
	Agricultural land 8	7.14	3,159,727.00		22,560,450.78			0.33	0.50		= (I) x (L) 7,501,349.88	= (I) x (M) 11,280,225.39
	Agricultural land 9	1.97	3,159,727.00			6,224,662.19			0.25			= (J) x (M) 1,556,165.55
Surigao City	Built-up area 3	0.08	7,509,000,000.00	600,720,000.00			0.01	0.02	0.03	=(H) x (K) 5,857,020.00	=(H)x (K) 11,714,040.00	=(H)x (K) 17,571,060.00
	Built-up area 4	0.28	7,509,000,000.00		2,102,520,000.00			0.02	0.03		= (I)x(L) 41,987,988.20	=(I) x(M) 62,981,982.30

Note: the factors in columns (K), (L) and (M) are taken from Table 4.29 for built-up areas and Table 4.30 for agricultural lands.

Estimating property damage in the Guidelines is based on direct damage cost by valuing the various categories of the land uses to represent replacement costs.

The use of the factor is premised on the principle that areas with *high property values* will have higher proportionate damages as compared to *less valued* areas. Therefore, the factors will be dependent on the *affected* property value of an area.

Tables 4.27 to 4.33 present the factors for property damage. If the property value of an affected area is less than PhP10 million, the column (<10M) should be used. For affected areas with properties in mid-range values (10 to 100 million), the fourth column provides the factor. The last column is used for *high value areas* (more than PhP100 million in property).

The factors for damage for earthquake-related events are only applied to built- up areas. No damage is assumed for agricultural areas. There are two sets of factors for property damage under hydrometeorologic conditions, one for built-up areas and another for agricultural areas.

Damages are generally higher for agricultural areas arising from a wider coverage of floods. Given that in likely events, such as 25 -100 year floods, it may be assumed, as a first estimate, that the crop areas suffer 100 percent loss. The rest of the factors are proportioned linearly.

Similarly, landslide affects agricultural areas such as localized damage to fields of crops and production forests. As a first estimate, loss is taken as 75 percent of the areas affected under rare occurrences.

Table 4.27 Factors for Property Damage for Earthquake-related Hazards: Built-Up Areas

Magnitude of earthquake (Ms)	Affected Area	Factors for property damage[1/]		
		< 10M PhP	10M PhP– 100M PhP	>100M PhP
4.9 – 6.1	HSA	1.40×10^{-2}	2.80×10^{-2}	4.20×10^{-2}
6.2 – 6.9	HSA MSA	2.80×10^{-2}	5.60×10^{-2}	8.50×10^{-2}
> 7.0	HSA MSA LSA	4.20×10^{-2}	8.50×10^{-2}	1.27×10^{-1}

1/ These factors can be applied to provinces with similar *g value* as Metro Manila. Refer to Map 2. However, using this default value will overestimate for the provinces of Cebu, Bohol, Negros Oriental and Siquijor in Region7 and provinces of Cagayan, Isabela, and Quirino in Region 2. Further the same default value will underestimate for the provinces of Davao, Compostela Valley, and Davao Oriental in Region 11 (.56 *g value*).

Ideally, estimating the damage must be based on damage and loss functions developed or used by other agencies (e.g., DPWH for critical infrastructures, DA/PCIC, for crop damages). The direct damages and losses that one obtains for a certain bounded area (say a Barangay, Municipality, Province or Region) are then aggregated to obtain the total value. To the extent feasible, local data/value (especially local historical loss data) must be used to refine the factors. In the revisions of the *factors*, mandated agencies should be consulted e.g., NDCC-OCD and Regional and Local Disaster Coordinating Councils.

Table 4.28 Factors for Property Damage for Volcanic Eruption: Built-Up Areas

Return Period	Affected Area	Factors for damage		
		< 10M PhP	10M PhP – 100M PhP	>100M PhP
Frequent	HSA	1.30×10^{-2}	2.50×10^{-2}	3.80×10^{-2}
Likely	HSA MSA	2.50×10^{-2}	5.00×10^{-2}	7.60×10^{-2}
Rare	HSA MSA LSA	3.80×10^{-2}	7.60×10^{-2}	1.14×10^{-1}

Table 4.29 Factors for Property Damage for Rain-induced Landslides

Return Period	Affected Area	Factors for damage		
		< 10M PhP	10M PhP – 100M PhP	>100M PhP
Frequent	HSA	3.30×10^{-3}	6.70×10^{-3}	1.00×10^{-2}
Likely	HSA MSA	6.70×10^{-3}	1.33×10^{-2}	2.00×10^{-2}
Rare	HSA MSA LSA	1.00×10^{-2}	2.00×10^{-2}	3.0×10^{-2}

Box 4.1 Estimating Damage from Ground Shaking

Damages to individual buildings or structures that arise from ground shaking come from the interaction of the hazard magnitude (or intensity), exposure and a combination of factors related to building characteristics and site conditions (e.g. material composition, ground condition, among others) which determine their vulnerability. For aggregating damage effects to an area, the damages of similar structures may be generalized to establish damage functions relating magnitudes and probabilities with percentage damages with reference to certain characteristics (e.g., building material and their behavior).

For example, studies and experts' experience may reveal that masonry construction for earthquake intensity X with a specified return period would experience 100 percent collapse, and that for intensity IX, 20 percent collapse and 80 percent badly damaged; with reinforced concrete (RC), new structures may survive collapse but old RC structures may not under intensity X.

In terms of monetary loss, a function relating percent damage with repair costs or replacement costs need to be determined. In case of loss of life, a loss function related to the damage may need to be obtained or devised from simple rules defined by hazard and disaster risk experts. For example, a collapse of a structure may be taken as resulting to loss of lives, while varying degrees of damage may result to injuries. Other considerations in the assessment of damages and risks include temporal factors such as daytime or night time population being exposed, preparedness aspects, building and structural codes used, quality of construction (among others). It is important that these factors be considered in assessing risk reduction from ground shaking impacts.

Compositing of different variables (e.g., structural types, materials used, configuration, method of construction) to establish relationships of vulnerability, damage and loss with different degrees of seismic hazard may need to be performed. This level of analysis may be pursued through further studies.

Table 4.30 Factor for Property Damage for Rain-induced Landslides: Agricultural Crops

Return Period	Affected Area	Factors for Damage		
		< 10M PhP	10M PhP – 100M PhP	>100M PhP
Frequent	HSA	8.25×10^{-2}	16.75×10^{-2}	2.50×10^{-1}
Likely	HSA MSA	16.75×10^{-2}	33.25×10^{-2}	5.00×10^{-1}
Rare	HSA MSA LSA	2.50×10^{-1}	5.00×10^{-1}	7.50×10^{-1}

Table 4.31 Factors for Property Damage for Floods: Built-Up Areas

Return Period	Affected Area	Factors for damage		
		< 10M PhP	10M PhP – 100M PhP	>100M PhP
Frequent	HSA	6.67×10^{-2}	1.30×10^{-2}	2.00×10^{-2}
Likely	HSA MSA	1.33×10^{-2}	2.67×10^{-2}	4.00×10^{-2}

Table 4.32 Factors for Property Damage for Floods: Agricultural Crops

Return Period	Affected Area	Factor for property damage based on property value		
		< 10M PhP	10M PhP – 100M PhP	>100M PhP
Frequent	HSA	1.67×10^{-1}	3.33×10^{-1}	5.00×10^{-1}
Likely	HSA MSA	3.33×10^{-1}	6.66×10^{-1}	1.00

Table 4.33 Factors for Property Damage for Storm Surges

Return Period	Affected Area	Factors for damage		
		< 10M PhP	10M PhP – 100M PhP	>100M PhP
Frequent	HSA	1.67×10^{-3}	3.30×10^{-3}	5.00×10^{-3}
Likely	HSA MSA	3.30×10^{-3}	6.70×10^{-3}	1.00×10^{-2}
Rare	HSA MSA LSA	5.00×10^{-3}	1.00×10^{-2}	1.50×10^{-2}

C. RISK ESTIMATION

Objective: To estimate the risk of the hazard in terms of *fatality* and *property damage*.
Output/s: Estimated risks of fatality and damage to property (in tabular and map forms) per hazard.
Process: The working equations for *Risk Estimation* are:

For risk of fatality: $R_F = P \times C_F$

where R_F = risk of fatality (fatality/year)
P = probability of occurrence of hazard event (the difference between reciprocal of return periods of two incremental hazard events)
C_F = consequence in terms of fatality per hazard event

For risk of property damage: $R_{PrD} = P \times C_{PrD}$

where R_{PrD} = risk of property damage (PhP/year)
P = probability of occurrence of hazard event (the difference between reciprocal of return periods of two incremental hazard events)
C_{PrD} = consequence in terms of cost of property damage per hazard event

The procedure is:

1. Get data on return period from *frequency analysis* in the *hazard characterization* step.
2. Get data on estimated fatality and property damage per hazard event from *consequence analysis*.
3. Compute for risk in terms of fatality and property damage.
4. Repeat process for other hazards.

With the results of the frequency and consequence analysis available, risk estimation can now be performed. In principle, the risk is obtained by multiplying the probability of occurrence and the consequence.

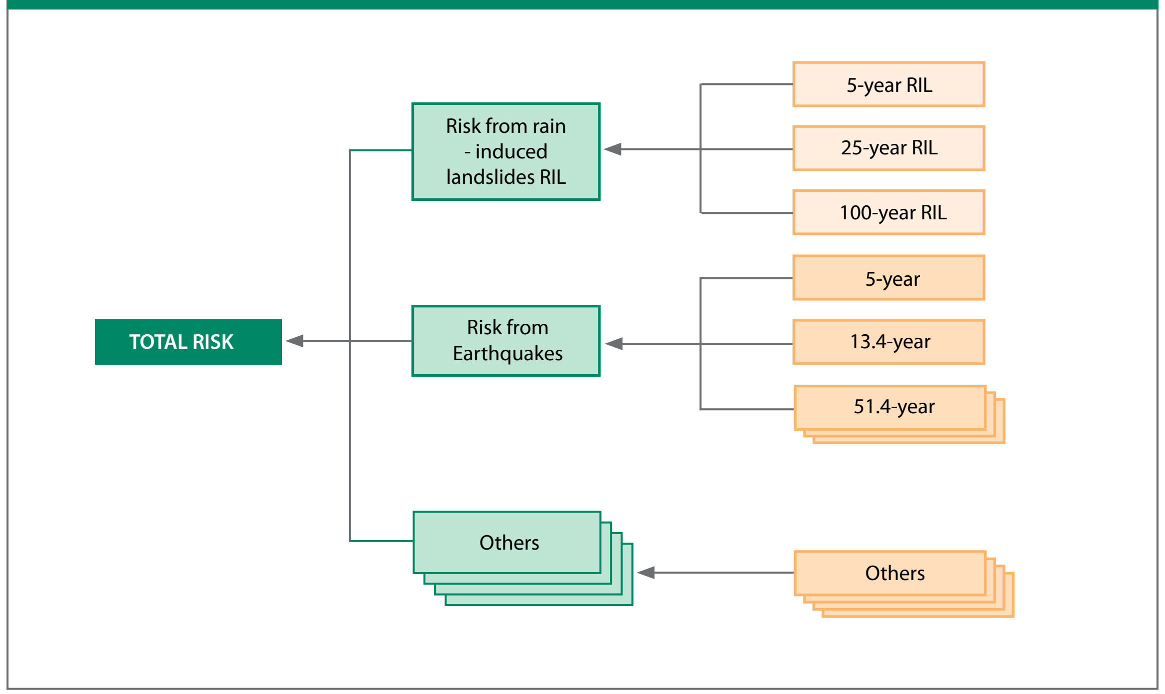
In terms of fatality or loss of life, the Guidelines use the barangay as the area of analysis at the provincial level since the barangay is the smallest administrative unit with population data. This will enable the planner to pinpoint in greater detail (vis-à-vis municipal or provincial level data) the population exposed to risk. As regards the property damage, these have been computed at the municipal level.

The last stage of the DRA process is risk prioritization across municipalities. The weighted average risk of fatality for a municipality will be computed using barangay risk estimates weighted against the ratio of the barangay area to the municipality area.

The calculation of risk at a geographic level assumes that the contributions of all events (or hazards) are additive.

Note that risk estimates are calculated for all the levels of hazard events (e.g., 5-year flood, 25-year flood, etc.). The total risk for a hazard (e.g., flood) is the sum of the risks from all of the hazard events considered (frequent, likely, rare). Finally, the total risk is the sum of risks from all hazards. This principle is illustrated below.

Figure 4.1 Schematic Illustration for Estimating Total Risk



1. GET DATA ON RETURN PERIOD FROM *FREQUENCY ANALYSIS* IN THE *HAZARD CHARACTERIZATION* STEP

In estimating risks, the return period obtained in the hazard characterization and frequency analysis step will be used (Table 4.10) presented here anew.

Table 4.10 Summary Frequency Table

Origin	Hazards	Hazard Occurrence	Return Period[1/]
Geologic	Earthquake-related Earthquake-induced landslides Ground shaking Ground rupture Liquefaction	4.9 – 6.1 (Frequent)	5
		6.2 – 6.9 (Likely)	13.4
		> 7.0 (Rare)	51.4
	Volcanic eruptions	Frequent	300 and Below
		Likely	Above 300 -600
		Rare	Above 600
Hydrometeorologic	Rain-induced landslide Storm Surge	Frequent	5
		Likely	25
		Rare	100
	Floods [2/]	Frequent	≤10
		Likely	>10

1/ The figures for geologic hazards except volcanic eruptions are for Surigao del Norte. Each province should compute for their return periods based on their *g value* and zone, as described in these Guidelines.

2/ These are only applicable to areas prone to flooding as reflected in flood susceptibility maps or flood hazard maps. It will be up to the planner to assess flooding in the area based on past occurrences to determine whether they are frequent or likely events with the corresponding return period of ≤10 or >10, respectively. In the computations for Surigao del Norte, where floods are likely events, a return period of 100 years was used.

2. GET DATA ON ESTIMATED FATALITY AND PROPERTY DAMAGE PER HAZARD EVENT FROM *CONSEQUENCE ANALYSIS*.

For fatality (loss of life), as an example, use truncated version of Table 4.20 retaining only Columns A, B, O, P and Q, as follows:

Table 4.34 Reference Table for Risk Estimation in Terms of Fatality: Rain-induced Landslide

Municipality (A)	Barangay (B)	C_F Consequence in terms of fatality		
		Frequent (O)	Likely (P)	Rare (Q)
Surigao City	Cabongbongan	0.0052424	0.0138673	0.027844
	Mat-i	0.0849229	0.2954036	0.490146
	Taft (Pob.)	0.2032310	1.2871280	1.930692

For property damage, as an example, use truncated version of Table 4.26 retaining only Columns A, B, C, N, O and P, as follows:

Table 4.35 Reference Table for Risk Estimation in Terms of Damage to Property: Rain-induced Landslide

Municipality (A)	Land Use (B)	Affected Areas (sq km) (C)	C_{PrD} Consequence in terms of property damage		
			Frequent (N)	Likely (O)	Rare (P)
Surigao City	Agricultural land 6	8.11	4,292,252.15	8,520,440.84	12,812,692.99
	Agricultural land 7	0.46	119,911.64	243,456.97	363,368.61
	Agricultural land 8	7.14		7,501,349.88	11,280,225.39
	Agricultural land 9	1.97			1,556,165.55
Surigao City	Built-up area 3	0.08	5,857,020.00	11,714,040.00	17,571,060.00
	Built-up area 4	0.28		41,987,988.20	62,981,982.30

3. COMPUTE FOR RISK IN TERMS OF FATALITY AND PROPERTY DAMAGE.

3.1 Risk of Fatality

The working equation for estimating risk of fatality is:

$$R_F = P \times C_F$$

where R_F = risk of fatality (fatality/year)

P = probability of occurrence of hazard event (the difference between reciprocal of return periods of two incremental hazard events)

C_F = consequence in terms of fatality per hazard event

The first step is to transpose columns O, P and Q of Table 4.34 from row data to column data and add a column on return period and another column for probability of occurrence (or the inverse of the return period). The risk of fatality is then computed (product of the consequence and probability of occurrence) and the results are placed in the last column. Table 4.36 reflects the process.

Table 4.36 Working Table for Risk Estimation in Terms of Fatality: Rain-induced Landslide, Surigao del Norte

Barangay	Hazard Occurrence	C_F Consequence in terms of fatality	Return Period	P Probability of occurrence (Inverse of Return Period)	R_F Risk of fatality (Persons/ Year)
Taft	Frequent	0.2032310	5	0.20	
	Likely	1.2871280	25	0.04	0.20590
	Rare	1.9306920	100	0.01	0.05792
Mat-i	Frequent	0.0849229	5	0.20	
	Likely	0.2954036	25	0.04	0.04726
	Rare	0.4901460	100	0.01	0.01470

The risk of fatality, R_F is the product of consequence (C_F) of the higher event and the difference between reciprocal of return periods of two incremental hazard events (i.e., difference in the probabilities of occurrence of *frequent* and *likely* hazard events and that of *likely* and *rare* hazard events). This difference in probabilities is further explained in Annex 2.

The *risk of fatality* for each barangay would be the sum of the risk for frequent, likely and rare events. Thus, for Barangay Taft, its total risk for fatality/year is 0.20590+.05792 = 0.26382.

Table 4.37 Working Table for Risk Estimation in Terms of Fatality Aggregated to the Municipal Level: Rain-induced Landslide, Surigao del Norte

Barangays	Barangay Risk	Area (sq km)	Product
Capayahan	3.900×10^{-3}	6.07	2.367×10^{-2}
Cawilan	5.522×10^{-3}	6.28	3.468×10^{-2}
Del Rosario	3.600×10^{-3}	2.49	8.963×10^{-3}
Marga	4.551×10^{-3}	5.71	2.599×10^{-2}
Motorpool	4.230×10^{-3}	6.62	2.800×10^{-2}
Poblacion (Tubod)	0.000×10^{0}	0.72	0.000×10^{0}
San Isidro	5.994×10^{-3}	4.09	2.451×10^{-2}
San Pablo	4.197×10^{-5}	1.16	4.868×10^{-5}
Timamana	1.579×10^{-2}	6.17	9.742×10^{-2}
Municipality of Tubod		**39.31**	**2.433×10^{-1}**

The risk of fatality for a municipality is the weighted average of risks of all barangay using the area (of the barangay) as the "*weights*". As seen in Table 4.37, the barangay risk is multiplied with its individual area. The sum of the products is divided by the municipality area to obtain a municipal risk, i.e., $2.433 \times 10^{-1} / 39.31 = 6.189 \times 10^{-3}$ fatality/year for the municipality of Tubod.

3.2 Risk of Property Damage

The working equation for estimating risk of property damage under these Guidelines is:

$$R_{PrD} = P \times C_{PrD}$$

where R_{PrD} = risk of property damage (PhP/year)
P = probability of occurrence of hazard event (the difference between reciprocal of return periods of two incremental hazard events)
C_{PrD} = consequence in terms of cost of property damage per hazard event

The first step is to transpose columns N, O and P of Table 4.26 from row data to column data and add a column on return period and another column for probability of occurrence (or the inverse of the return period). The risk of property damage is then computed (product of the consequence and probability of occurrence) and the results are placed in the last column. Table 4.38 reflects the process.

The *risk of the property damage* for each subarea would be the sum of the risk values obtained in last column.The risks to other subareas are similarly computed. The risk of property damage to a municipality is aggregated from the risks from these individual areas.

For example, for the affected built-up areas of Surigao City, the total risk would be from two areas: R_{PrD} =2,401,378.2 + 1,889,459.5 = PhP4,290,837.70/yr.

4. REPEAT PROCESS FOR OTHER HAZARDS

The entire process shall be repeated for all other hazards and for both risk of fatality and risk of property damage. The final results should tally with the number of hazards characterized, e.g., if three hazards were characterized, three sets of risk estimates should be obtained (or, three risk estimates for fatality and three risk estimates for property damage).

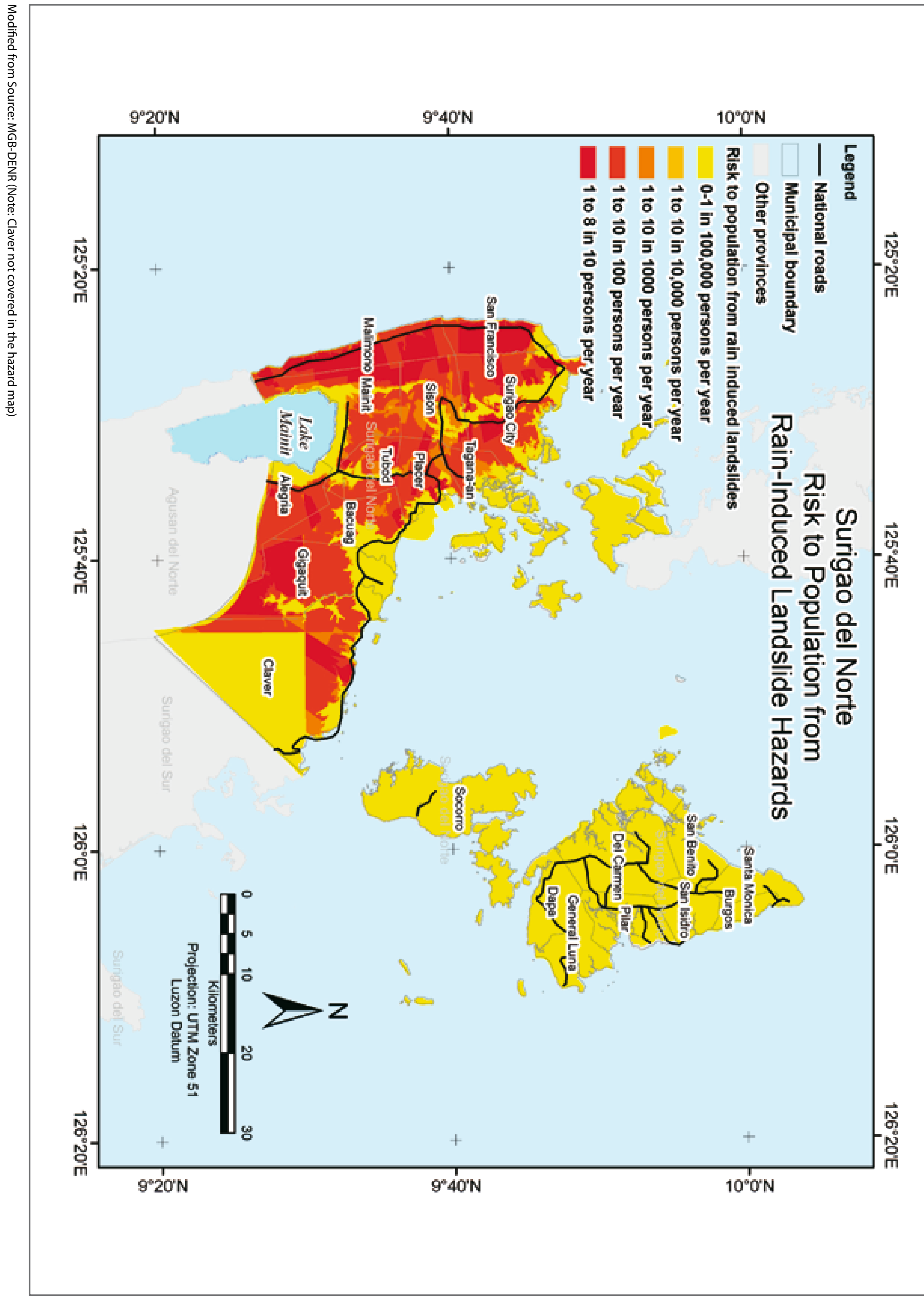
Table 4.38 Working Table for Risk Estimation in Terms of Property Damage:Rain-induced Landslide, Surigao City

Municipality Subareas	Hazard Occurrence	C_{PrD} Consequence in terms of property damage	Return Period	P Probability of occurrence (Inverse of Return Period)	R_{PrD} Risk of property damage (PhP/Year)
Surigao City Agriculture Land 6	Frequent	4,292,252.15	5	0.20	
	Likely	8,520,440.84	25	0.04	1,363,270.53
	Rare	12,812,692.99	100	0.01	384,380.79
				Total	**1,747,651.32**
Surigao City Agriculture Land 7	Frequent	119,911.64	5	0.20	
	Likely	243,456.97	25	0.04	38,953.11
	Rare	363,368.61	100	0.01	10,901.06
				Total	**49,854.17**
Surigao City Agriculture Land 8	Frequent		5	0.20	
	Likely	7,501,349.88	25	0.04	
	Rare	11,280,225.39	100	0.01	338.406.76
				Total	**338.406.76**
Surigao City Agriculture Land 9	Frequent		5	0.20	
	Likely		25	0.04	
	Rare	1,556,165.55	100	0.01	15,561.66
				Total	**15,561.66**
Surigao City Built-Up3	Frequent	5,857,020.00	5	0.20	
	Likely	11,714,040.00	25	0.04	1,874,246.40
	Rare	17,571,060.00	100	0.01	527,131.80
				Total	**2,401,378.20**
Surigao City Built-Up4	Frequent		5	0.20	
	Likely	41,987,988.20	25	0.04	
	Rare	62,981,982.30	100	0.01	1,889,459.50
				Total	**1,889,459.50**

In addition, in computing for the *total* risk, due care must be undertaken to avoid "*double counting*" of fatality or property damage. In order to avoid this error, a correction should be applied to the total risk (i.e., the sum of the several risks).

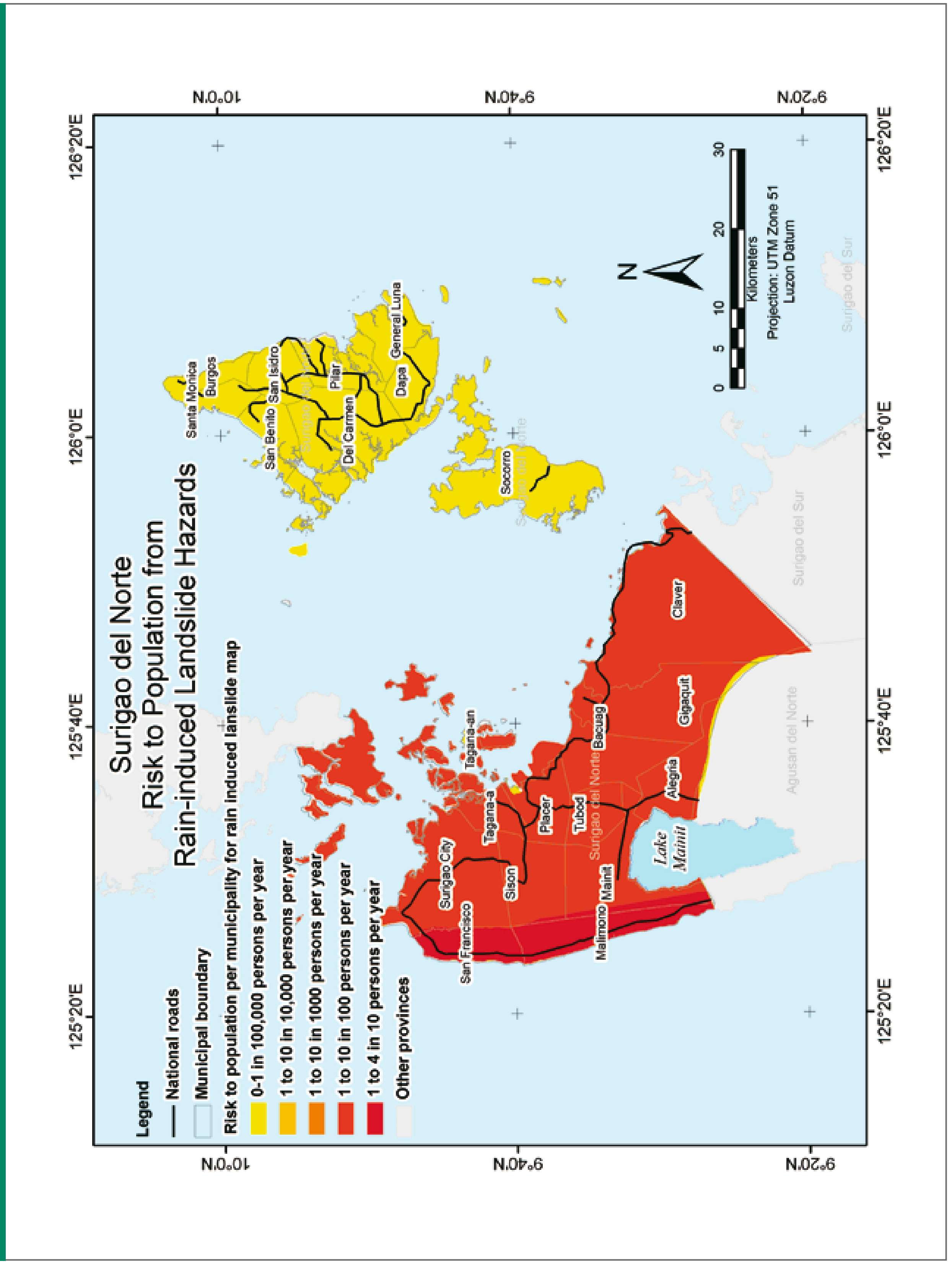
In areas of the barangay where the two or more hazard maps overlap (i.e., intersection of the hazard maps), the lesser of the figure(s) should be *deducted* from the total risk. The summary table for the risk estimates shall be as indicated in Table 4.39 and Table 4.40. Risk maps are shown in the succeeding pages.

Modified from Source: MGB-DENR (Note: Claver not covered in the hazard map)



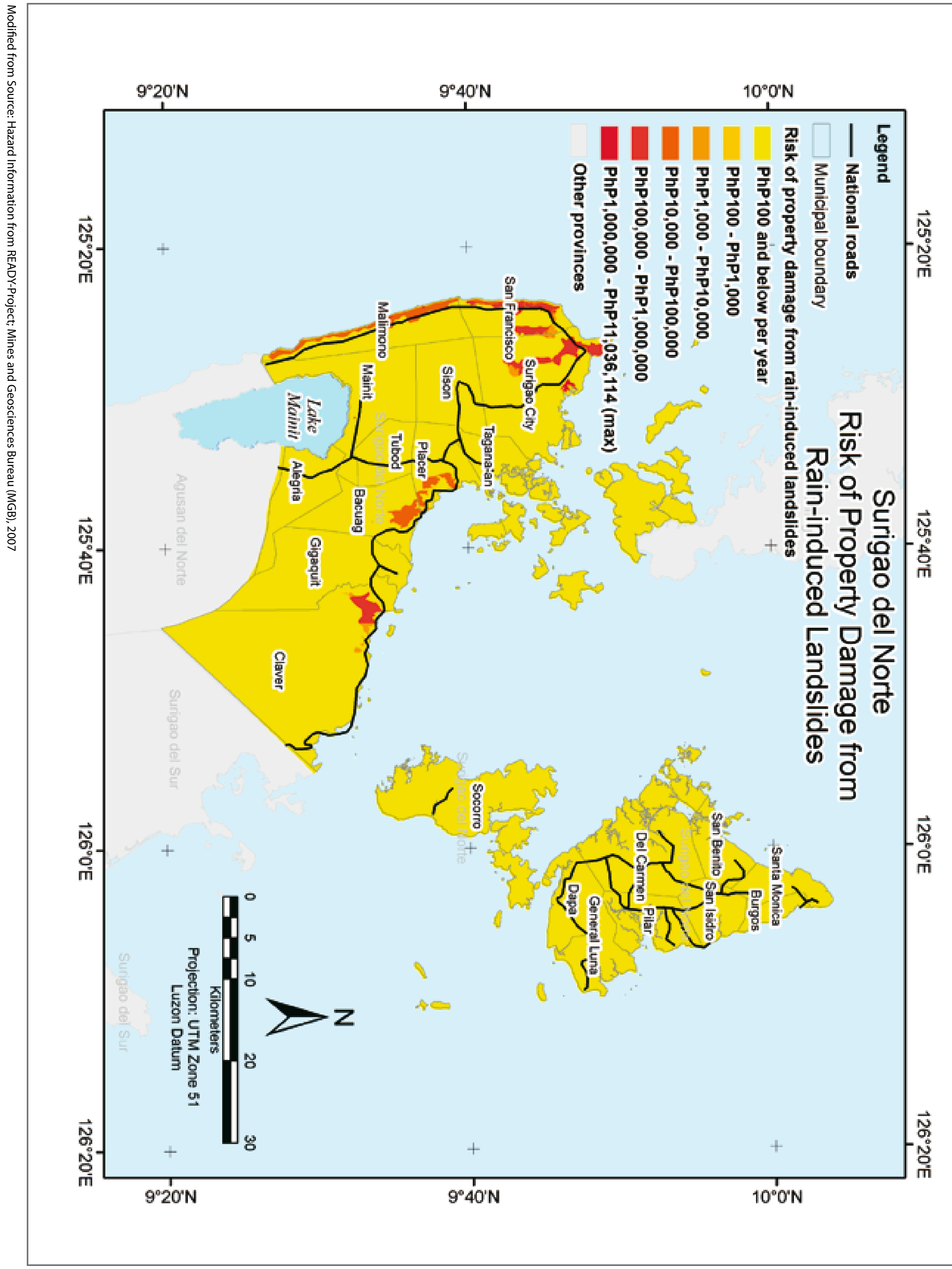
Map 6 Risk of Fatality from Rain-induced Landslides in Individual Areas

Map 7 Risk of fatality from Rain-induced Landslides aggregated to municipal level



Modified from Source: Hazard Information from READY-Project; Mines and Geosciences Bureau (MGB), 2007

Map 8 Risk of Property Damage from Rain-induced Landslides for individual areas



Modified from Source: Hazard Information from READY-Project; Mines and Geosciences Bureau (MGB), 2007

Table 4.39 Summary Table for Risk of Fatality (person/yr), R_F

Municipality	Risk of Fatality						
	Earthquake-induced Landslide Deposition	Earthquake-induced landslide	Flooding	Lique-faction	Rain-induced Landslide	Ground Rupture	Storm Surge
Alegria	2.220×10^{-4}	2.370×10^{-4}	1.080×10^{-4}	- NA -	5.310×10^{-3}	- NA -	0.000×10^{0}
Bacuag	7.071×10^{-6}	4.905×10^{-5}	6.739×10^{-5}	- NA -	2.698×10^{-3}	- NA -	1.655×10^{-5}
Burgos	0.000×10^{0}	0.000×10^{-2}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	4.665×10^{-6}
Claver	1.334×10^{-4}	3.200×10^{-5}	6.264×10^{-5}	- NA -	1.772×10^{-3}	- NA -	1.494×10^{-5}
Dapa	0.000×10^{0}	9.184×10^{-7}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	1.212×10^{-5}
Del Carmen	0.000×10^{0}	5.570×10^{-7}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	9.922×10^{-7}
General Luna	0.000×10^{0}	0.000×10^{0}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	5.314×10^{-4}
Gigaquit	1.661×10^{-5}	9.330×10^{-6}	2.662×10^{-4}	- NA -	8.332×10^{-3}	- NA -	3.734×10^{-5}
Mainit	7.578×10^{-4}	1.073×10^{-2}	2.468×10^{-4}	- NA -	3.263×10^{-3}	- NA -	0.000×10^{0}
Malimono	2.230×10^{-3}	1.981×10^{-2}	1.216×10^{-5}	- NA -	1.293×10^{-2}	- NA -	1.367×10^{-7}
Pilar	0.000×10^{0}	0.000×10^{0}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	9.238×10^{-7}
Placer	3.238×10^{-5}	1.128×10^{-4}	5.089×10^{-5}	- NA -	3.290×10^{-3}	- NA -	7.209×10^{-6}
San Benito	0.000×10^{0}	4.425×10^{-6}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	8.620×10^{-6}
San Francisco	8.663×10^{-3}	1.289×10^{-2}	1.449×10^{-4}	- NA -	1.282×10^{-2}	- NA -	7.152×10^{-6}
San Isidro	0.000×10^{0}	0.000×10^{0}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	5.681×10^{-6}
Santa Monica	0.000×10^{0}	0.000×10^{0}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	4.325×10^{-5}
Sison	1.382×10^{-4}	5.318×10^{-4}	3.055×10^{-5}	- NA -	6.731×10^{-3}	- NA -	0.000×10^{0}
Socorro	0.000×10^{0}	4.006×10^{-6}	0.000×10^{0}	- NA -	0.000×10^{0}	- NA -	0.000×10^{0}
Surigao City	2.544×10^{-3}	2.484×10^{-3}	7.829×10^{0}	- NA -	4.145×10^{-3}	- NA -	7.924×10^{-5}
Taganaan	2.513×10^{-5}	1.976×10^{-5}	6.404×10^{-5}	- NA -	1.626×10^{-3}	- NA -	3.135×10^{-6}
Tubod	5.776×10^{-4}	2.442×10^{-3}	1.264×10^{-4}	- NA -	6.189×10^{-3}	- NA -	0.000×10^{0}

Table 4.40 Summary Table for Risk of Property Damage R_{PrD}

Municipality	Earthquake-induced Landslide Deposition	Earthquake-induced Landslide Built-up Areas	Flooding Agriculture Areas	Flooding Built-up Areas	Liquefaction	Rain-induced Landslide Agriculture Area	Rain-induced Landslide Built-up Areas	Ground Rupture	Storm Surge	Total
Alegria	0.00	0.00	0.00	0.00	1,182,160.48	0.00	75,107.80	0.00	0.00	1,257,268.28
Bacuag	0.00	0.00	1,048,327.04	0.00	0.00	1,064,874.43	0.00	0.00	0.00	2,113,201.47
Burgos	0.00	0.00	0.00	0.00	590,882.85	0.00	0.00	0.00	0.00	590,882.85
Claver	0.00	0.00	637,159.93	0.00	0.00	614,922.65	0.00	0.00	121,783.48	1,373,866.06
Dapa	0.00	0.00	0.00	0.00	938,493.84	0.00	0.00	0.00	0.00	938,493.84
Del Carmen	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3,612,247.10	3,612,247.10
General Luna	0.00	0.00	0.00	0.00	938,612.16	0.00	0.00	0.00	4,793,976.08	5,732,588.24
Gigaquit	0.00	0.00	2,158.95	78,008.11	903,742.35	0.00	0.00	0.00	4,829,677.29	5,813,586.70
Mainit	0.00	0.00	0.00	95,327.48	1,807,959.72	0.00	59,579.67	29,230.00		1,992,096.87
Malimono	0.00	75,118.22	683,459.21	59,021.46	869,069.59	4,333,270.77	3,781,062.34	0.00	1,171,207.12	10,972,208.71
Pilar	0.00	0.00	0.00	0.00	695,333.71	0.00	0.00	0.00	6,869,675.71	7,565,009.42
Placer	0.00	0.00	565,713.07	0.00	0.00	1,404,972.80	0.00	0.00	0.00	1,970,685.87
San Benito	0.00	0.00	0.00	0.00	278,017.45	0.00	0.00	0.00	199,257.44	477,274.89
San Francisco	0.00	0.00	340,327.14	0.00	486,664.26	3,116,973.59	2,189,856.66	0.00	1,095,750.11	7,229,571.76
San Isidro	0.00	0.00	0.00	0.00	451,942.14	0.00	0.00	0.00	470,689.58	922,631.72
Santa Monica	0.00	0.00	0.00	0.00	451,976.70	0.00	0.00	0.00	4,319,188.67	4,771,165.37
Sison	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24,602.00	0.00	24,602.00
Socorro	0.00	0.00	0.00	0.00	173,797.61	0.00	0.00	0.00	0.00	173,797.61
Surigao City	0.00	212,072,612.36	625,204.25	292,086.05	77,605.97	2,151,473.91	4,290,837.70	31,960.00	96,943,328.22	316,488,717.8
Taganaan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tubod	0.00	0.00	0.00	0.00	0.00	0.00	183,849.61	0.00	0.00	183,849.61

D. RISK PRIORITIZATION

Objective: Based on risk estimates, determine priority areas and assess vulnerability of these priority areas (micro vulnerability analysis).

Output/s: Maps and summary tables of priority areas based on a composite score.

Process:

1. Determine "*priority score*" for each municipality.
    - Determine risk prioritization score for fatality.
    - Compute for the proportion of damaged property and determine risk prioritization score for property damage.
    - Combine prioritization scores for fatality and property damage to obtain the composite prioritization score.

2. Assess vulnerability of sectors
    - On population
    - On social infrastructures
    - On service infrastructures
    - On transport and access
    - On economy
    - On environment

The main objective of risk prioritization is to determine which areas should be given attention considering the extent of risks in the area as quantified through risk estimates.

To enrich the risk prioritization process, further vulnerability assessments (based on the various planning sectors) are taken in conjunction with the risk ranking exercise. In particular, further vulnerability (i.e., social, economic, infrastructure and environment related aspects) analysis is undertaken for *high risk* areas.

Vulnerability and exposure aspects of infrastructure include utilities (e.g., solid waste, power, water, and sewerage), road network and transport system of significance to the province or region.

Here, focus is on strategic utilities, economic activities (e.g., main industries, mining), services that are critical to regional and provincial development (e.g., roads, power

plants, airport). This may be done also for areas where critical buildings and activities are located, (e.g., government center, ecozones) or where critical resources are located (e.g., watersheds and its subareas).

1. DETERMINE "PRIORITY SCORE" FOR EACH MUNICIPALITY

1.1 Determine risk prioritization score for fatality

Having completed the *risk estimation* step, risks in terms of fatality are computed per barangay and municipality and risks in terms of property damage at the municipal level are obtained. The following steps will provide the method of combining the various risk estimates to obtain a prioritization using composite scores. The computations of risk of fatality reflected in Table 4.39, for rain-induced landslide for Surigao del Norte will be used to illustrate the process. Table 4.41 will be used as prioritization criteria for risk of fatality.

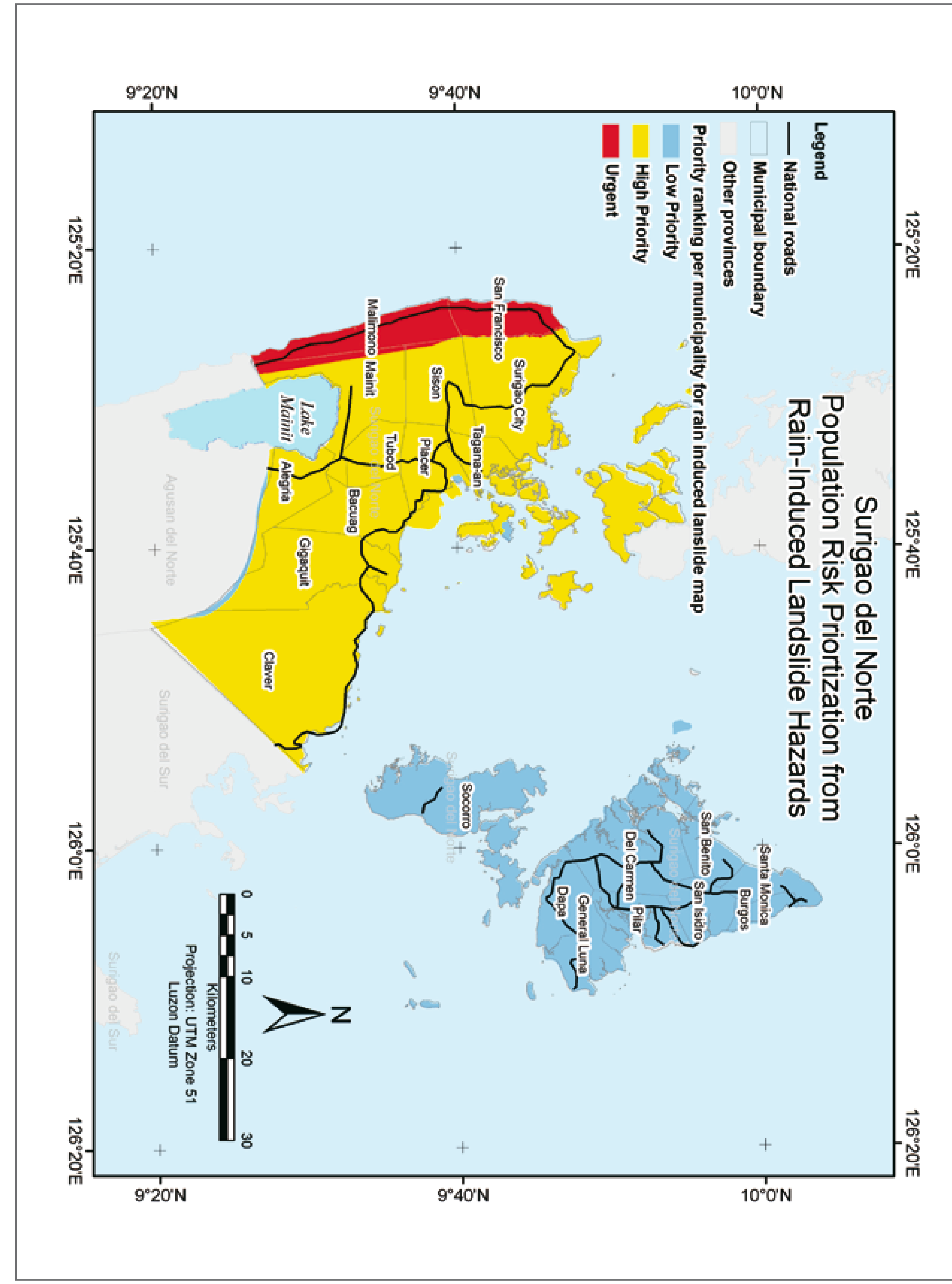
Table 4.41 Prioritization Criteria for Risk of Fatality, R_F

Risk Levels		Risk Score	Acceptability/Action needed
Description	R_F		
High risk to Very High risk	$>10^{-2}$	Urgent (3)	Highly intolerable. Extensive detailed investigation needed and implementation of options essential to reduce risk to acceptable levels; may be too expensive and not practicable.
			Moderately intolerable. Detailed investigation, planning and implementation of options required to reduce risk to tolerable levels.
Moderate risk	10^{-5} to 10^{-2}	High Priority (2)	Intolerable. Further investigation, planning and implementation of options required to reduce risk to acceptable levels.
Very Low risk to Low risk	$<10^{-5}$	Low Priority (1)	Tolerable, provided plan is implemented to maintain or reduce risks. May require investigation and planning of options.
			Usually accepted. Treatment requirements and responsibility to be defined to maintain or reduce risk.

Note that the internationally acceptable individual risk criterion is set at 10^{-6} fatalities per year.

Table 4.42 Prioritization Based on Risk of Fatality: Surigao del Norte

Municipality	R_F	Risk Score	
Alegria	5.310×10^{-3}	2	High
Bacuag	2.698×10^{-3}	2	High
Burgos	0.000×10^{0}	1	Low
Claver	1.772×10^{-3}	2	High
Dapa	0.000×10^{0}	1	Low
Del Carmen	0.000×10^{0}	1	Low
General Luna	0.000×10^{0}	1	Low
Gigaquit	8.332×10^{-3}	2	High
Mainit	3.263×10^{-3}	2	High
Malimono	1.293×10^{-2}	3	Urgent
Pilar	0.000×10^{0}	1	Low
Placer	3.290×10^{-3}	2	High
San Benito	0.000×10^{0}	1	Low
San Francisco	1.282×10^{-2}	3	Urgent
San Isidro	0.000×10^{0}	1	Low
Santa Monica	0.000×10^{0}	1	Low
Sison	6.731×10^{-3}	2	High
Socorro	0.000×10^{0}	1	Low
Surigao City	4.145×10^{-3}	2	High
Tagana-an	1.626×10^{-3}	2	High
Tubod	6.189×10^{-3}	2	High



Map 9 Priority Municipalities based on Risk of Fatality, R_F from Rain-induced Landslides

1.2 Determine risk prioritization score based on property damage

A threshold refers to a value above which priorities should already indicate nontolerance, specifically, for risks to property damage. In these Guidelines the threshold value shall be adopted from the NDCC concept of declaring disaster / calamity in the Philippines.

> "A state of calamity may be declared, through a resolution, by the Sangguniang Panlalawigan (provincial legislative council) or the Sangguniang Panglungsod/Bayan (city/ municipal legislative council) of an Local Government Unit (LGU) when there is an epidemic or at least two or more of the following conditions apply for at least four days:
>
> - 20 percent of the population are affected and in need of assistance, or 20 percent of the dwelling units have been destroyed;
> - A great number or at least 40 percent of the means of livelihood such as bancas (small wooden boats used for fishing and transport), vehicles and the like are destroyed; and
> - Major roads and bridges are destroyed and impassable for at least a week, thus disrupting the flow of transport and commerce."

Source: NDCC Memorandum Order 2, 1999

For purposes of risk prioritization under these Guidelines, the following thresholds are adopted:

- 20 percent of the dwelling units have been destroyed will be taken as 20 percent of the residential floor area value.
- Widespread destruction of fishponds, crops, poultry and livestock, and other agricultural products will be interpreted as damage amounting to 40 percent of agricultural crop values.

a. Prioritize Affected Built-Up Areas

Table 4.43 presents all built-up areas in Surigao del Norte affected by rain-induced landslides. In column (B) the risk computed earlier (Table 4.40) is reflected. In column (D), reflect the product of column (C) x 5,534 PhP/sq m (unit value of residential structures presented in Table 4.13) and 20 percent. Source of Column (C) is Table A4.7 in Annex 4. Reflect the percentage in column (E) by dividing *value*s of column (B) by column (D).

The yearly estimate of the damage is compared with 20 percent values.

Table 4.43 Risk Scores of Areas Affected by Rain-induced Landslides Based on Built-Up Areas, Surigao del Norte

Municipality (A)	R_{PrD} (PhP/year) (B)	Total Residential Area (sq m) (C)	20% of Residential Value (PhP) (D)	Percentage (E)	Risk Score (F)
Alegria	75,107.80	130,948.10	144,933,357.08	0.05%	2
Mainit	59,579.67	212,907.30	235,645,799.64	0.03%	2
Malimono	3,781,062.34	116,312.20	128,734,342.96	2.94%	2
San Francisco	2,189,856.66	72,545.40	80,293,248.72	2.73%	2
Surigao City	4,290,837.70	980,567.50	1,085,292,109.00	0.40%	2
Tubod	183,849.61	77,291.90	85,546,674.92	0.22%	2

For Column (F), if risk exceeds the 20 percent threshold value, a score of 3 is provided and taken as urgent; otherwise, a score of 2 is given and is taken as priority.

Damage on built-up areas exceeding millions of pesos may be found in Malimono, San Francisco, Tubod, Alegria, Surigao City but none of them meet the 20 percent of residential property value threshold. These areas are taken as priority. Note however, that there could still be further screening of areas after field validation of actual conditions in the area.

b. Prioritize Affected Agricultural Areas

Table 4.44 presents all agricultural land areas in Surigao del Norte affected by rainfall-induced landslides. Column (B) reflects the risk to agricultural areas from Table 4.40 while column (C), reflects the value of affected agricultural areas.

In column (D), reflect the product of column (C) and the threshold value of 40 percent. Similarly, reflect the percentage in column (E) by dividing *value*s of column (B) by column (D). Give risk scores based on these values.

For Column (F), if risk exceeds the 40 percent threshold value, a score of 3 is provided and taken as urgent; otherwise, a score of 2 is given and is taken as priority.

Table 4.44 reveal that the municipalities of San Francisco, Placer, Malimono, Bacuag, Claver and Surigao City are priority areas although they did not exceed the suggested 40 percent threshold value for agricultural areas. Even

Table 4.44 Risk Scores of Areas Affected by Rain-induced Landslides Based on Agricultural Land Areas, Surigao del Norte

Municipality (A)	R_{PrD} (PhP/year) (B)	Value of Affected Agricultural Land Area1[1/] (PhP) (C)	40% of Agricultural Values (PhP) (D)	Percentage (E)	Risk Score (F)
Bacuag	1,064,874.43	21,123,007.56	8,449,203.02	12.6%	2
Claver	614,922.65	36,350,831.92	14,540,332.77	4.2%	2
Malimono	4,333,270.77	73,087,367.48	29,234,946.99	14.8%	2
Placer	1,404,972.80	22,772,160.75	9,108,864.30	15.4%	2
San Francisco	3,116,973.59	51,160,864.35	20,464,345.74	15.2%	2
Surigao City	2,151,473.91	55,863,973.36	22,345,589.34	9.6%	2

[1/] The values are computed by multiplying the area of affected agricultural lands by the value derived from Tables 4.13 and 4.14 (sample for Surigao City) and the area of affected agricultural lands in Table 4.19 applying the necessary conversions.

so, the risks presented in column (B) may be significant to the province considering that these run in millions per year. A 5-year aggregate of potential losses for Malimono will be about PhP22 million pesos.

The numbers are simply estimates and past records on natural disaster losses may help confirm the values shown.

1.3 Combine prioritization scores for fatality and property damage to obtain the composite prioritization score

This is the last step to rank and prioritize areas based on the previous scores on fatality and damages. Here a composite score will be obtained to help identify municipalities where further vulnerability assessments will be made.

a. Copy the scores for risk of fatality in Table 4.42 and risk of property damage from the last columns of Tables 4.43 and 4.44 on built-up areas and agricultural areas, respectively, under the headings in Table 4.45.
b. To prioritize municipalities based on property and crop loss and risk to life, obtain a composite score by adding the scores in columns (B), (C), and (D) and reflect in column (E) of Table 4.45. In column (F), indicate priorities following the rules:

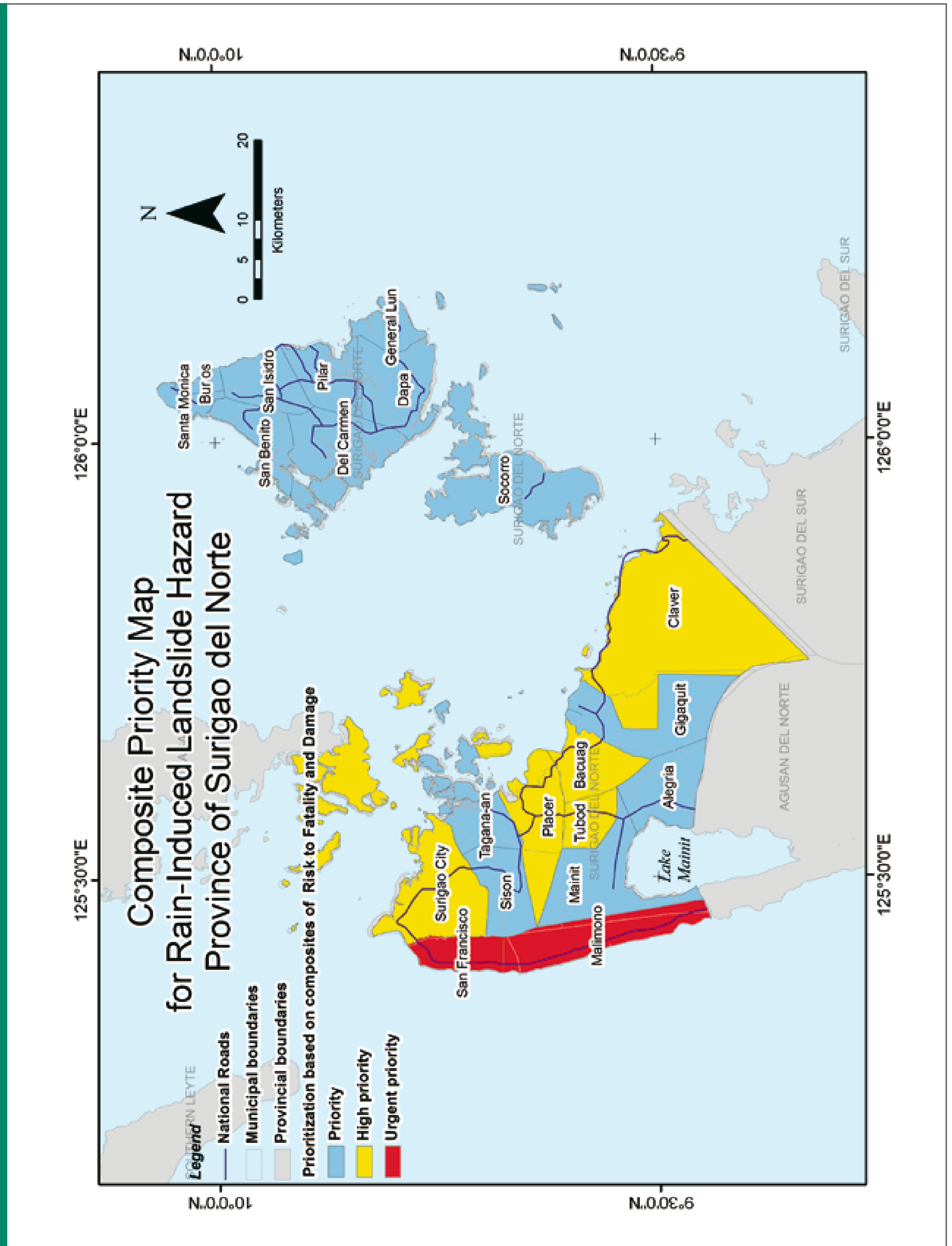
Composite Scores for Prioritization
Scores of 7 and above: urgent
Scores of 4 to 6: high priority
Scores 3 and below: priority

Table 4.45 Prioritization Based on Composites of Risks of Fatality and Property Damage for Rain-induced Landslide, Surigao del Norte

Municipality (A)	Risk Scores			Municipality Scores (E)= (B)+(C)+(D)	Priority (F)
	Fatality (B)	Built-up Areas (C)	Agricultural Areas (D)		
Alegria	2			2	Priority
Bacuag	2		2	4	High Priority
Burgos	1			1	Priority
Claver	2		2	4	High Priority
Dapa	1			1	Priority
Del Carmen	1			1	Priority
General Luna	1			1	Priority
Gigaquit	2			2	Priority
Mainit	2			2	Priority
Malimono	3	2	2	7	Urgent
Pilar	1			1	Priority
Placer	3		2	5	High Priority
San Benito	1			1	Priority
San Francisco	3	2	2	7	Urgent
San Isidro	1			1	Priority
Santa Monica	1			1	Priority
Sison	2			2	Priority
Socorro	1			1	Priority
Surigao City	2	2	2	6	High Priority
Tagana-an	2			2	Priority
Tubod	2	2		4	High Priority

Based on the composite risk score, the Municipalities of Malimono and San Francisco should be given urgent attention given their vulnerability to rain-induced landslides. The high priority areas are the municipalities of Bacuag, Claver, Placer and Tubod and the city of Surigao. Further vulnerability assessment should now be directed in these urgent and high priority areas.

Map 10 Priority Municipalities based from Rain-induced Landslides



2. ASSESS VULNERABILITY OF SECTORS

Having prioritized the areas, further identify, describe, and assess vulnerability of sectors in high risk municipalities or contiguous/cluster of municipalities identified as urgent or high priority.

At this stage, the "how and why" some sectors (or its components) are more at risk than others with respect to a hazard should be understood and factors that contribute to the vulnerability need to be revealed so that appropriate DRR measures and PPAs are proposed.

Table 4.46 provides a list of these factors and their indicators. A map of these elements at risks overlain in hazard maps or risk maps will help visualize the exposures of these specific sectors. See Maps 12 and 13.

Table 4.46 Vulnerability Factors

Sectors	Elements at Risk	Description of Factors
Population	Schools	Population of school children (elementary, high school)
	Special population groups (elderly, physically challenged, children, indigenous peoples)	Number of exposed population
	Poor	Poverty incidence-percentage of exposed population below poverty line
Social Infrastructures	Schools, hospitals, fire protection, houses/dwelling units	Location Number of schools and hospitals and describe structural conditions of buildings using information which will indicate safe or unsafe conditions Number of housing units by type of structure, materials used, tenure status
	Structures (e.g., dams, irrigation, flood control, etc.) and early warning systems	Conditions of structures that describe their remaining useful life and structural condition which will indicate safe or unsafe conditions
Service Infrastructures	Waterlines and wastewater, drainage facilities, treatment plants, power plants, communication lines and towers	Location and numbers Useful life and structural condition which will indicate safe or unsafe conditions

Sectors	Elements at Risk	Description of Factors
Transport and Access	Roads and bridges	Important networks or linkages of provincial /regional importance as necessary to provide services during and after a disaster • Proportion of roads, bridges in high risk areas • Classification of road networks (national, provincial, municipal, barangay) • Road densities • Bridges by type Useful life and structural conditions which will indicate safe or unsafe conditions
Economy	Agricultural areas	Area Area and number of livestock and poultry
	Industries	Number of registered business establishments, products sold/ services provided, number and profile of workers, equipment and machinery stock
Environment	Watersheds, coastal areas, forestlands, protected areas	Coastal and forest resources, flora and fauna exposed to natural hazards Site conditions (e.g., number, being in a catchment area, poor drainage, distance from a hazard source or path -i.e., fault line, 4 km eruption zone) which create the unsafe conditions of these areas

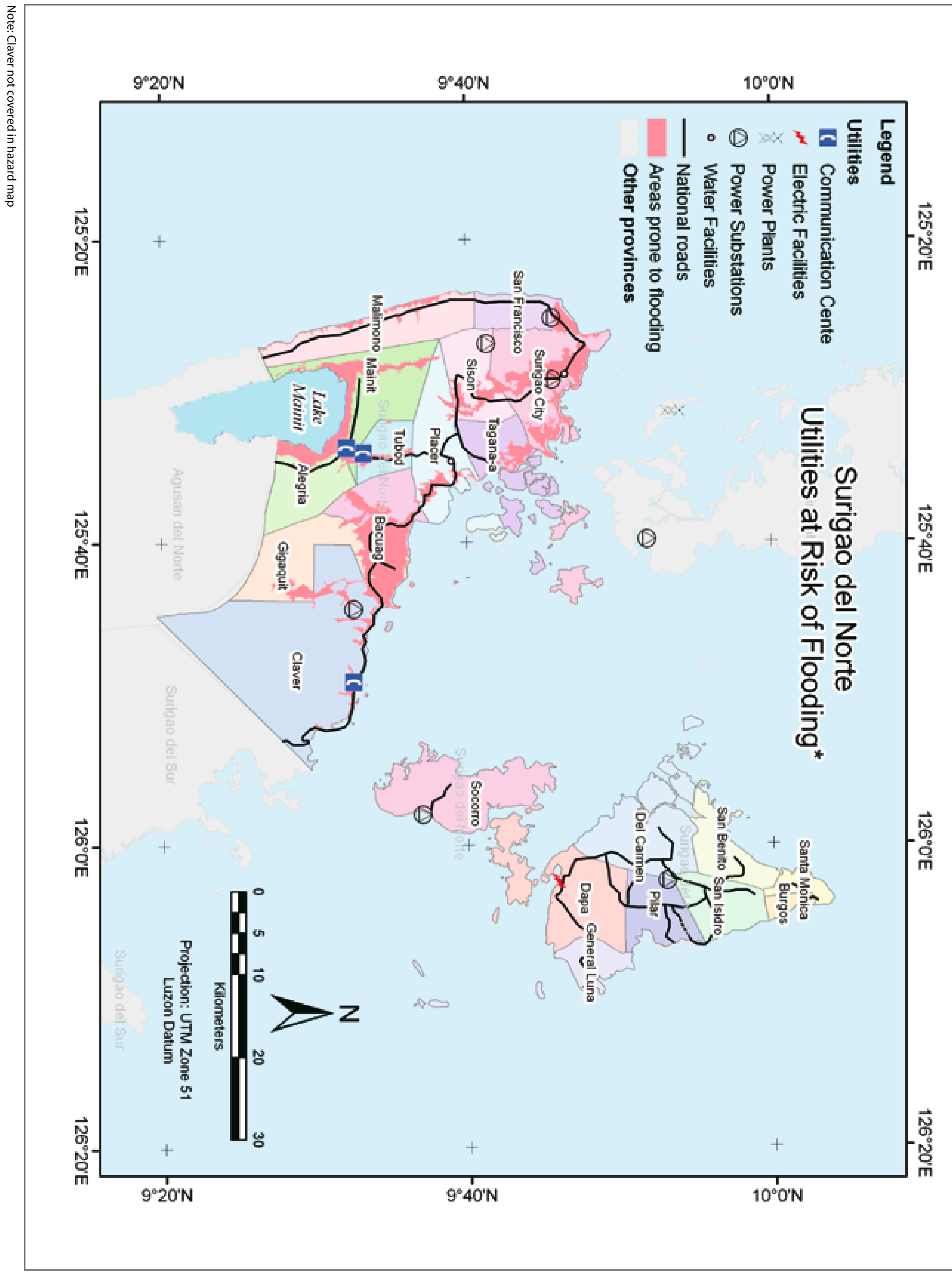
The assessment should not end with a mere inventory of existing mitigation measures and organizations with hazard mitigation responsibility. It should also help in understanding why certain policies may or may not be effective at mitigating hazards.

For example, extending public facilities into hazard-prone areas may attract more people to settle or promote activities in these areas. These increase the exposure of populations and hence weaken mitigation efforts.

The placement of levees as a flood mitigating structure provides a false sense of security to those immediately behind the structure. The levees in fact serve only to protect up to a certain depth (or design return period) of water and runs the risk of meeting higher return periods or stronger events for which the levee may fail. Development behind the levees may pose greater risk without regulation of land use/ development.

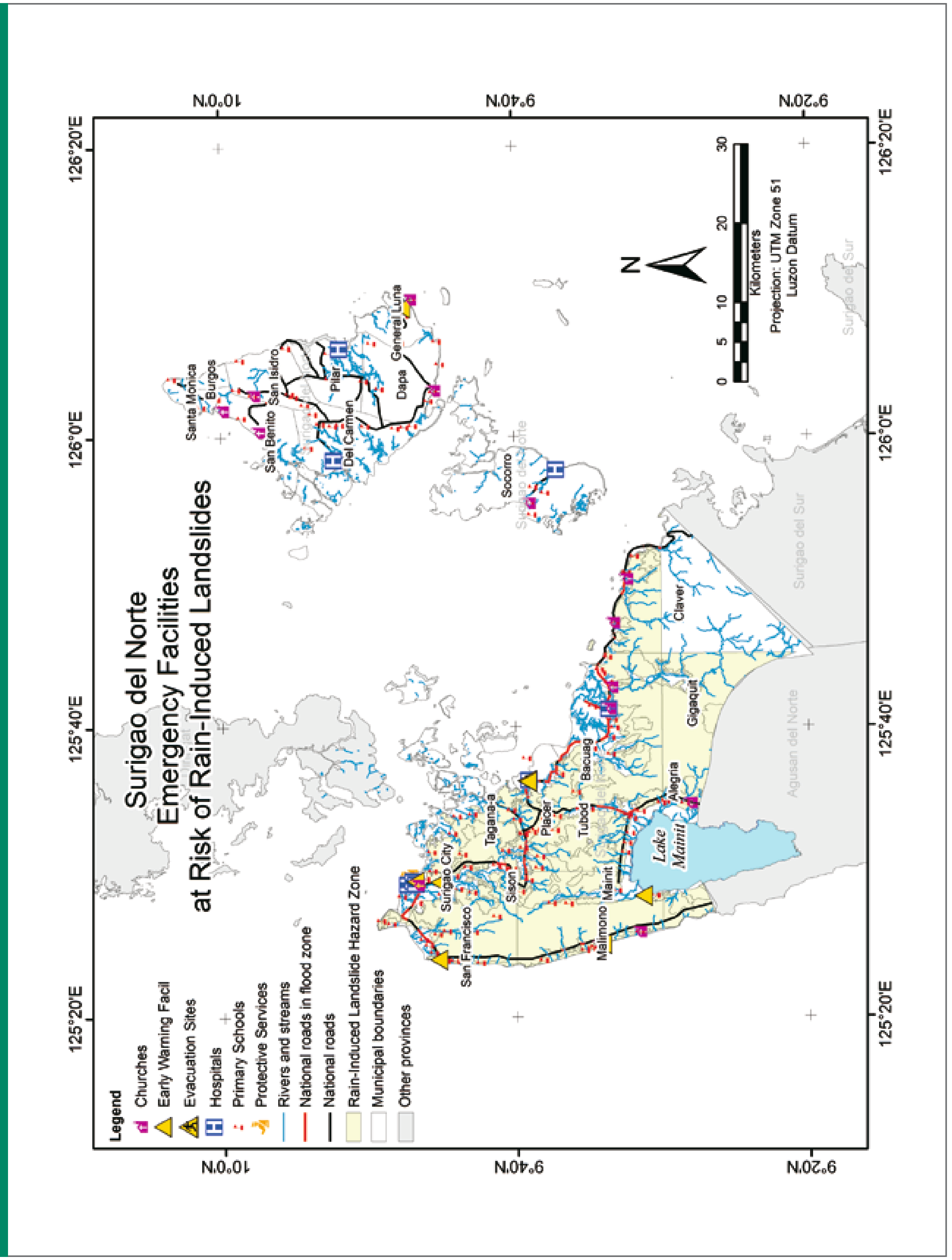
The assessment should also help identify areas where no policy exists and therefore new policies are needed to reduce current and future risks of hazards.

Note: Claver not covered in hazard map



Map 11 Utilities at Risk from Flooding

Map 12 Emergency Facilities at Risk from Rain-induced Landslides



Note: Claver not covered in hazard map

A summary of these risk issues and vulnerabilities may be listed following the format of Table 4.47.

Table 4.47 Summary of Risk Issues and Vulnerabilities

Map Overlays	Risk Issues (What risks? What are the estimates?)	Explanation-description (What vulnerabilities?)
Single or Multihazard	Numbers in terms of fatalities and damages to property Ranking and prioritization of areas at risk	Vulnerability of high risk or priority areas (describe vulnerability of elements and/or population at risk)

In the table, the risk issues are listed based on the quantification of risks (i.e., estimated number of fatalities per year and potential damage costs) of affected areas or clusters. A summary of the risk scores for each hazard helps determine the priority areas. Further assessment of the conditions and factors contributing to the vulnerability of high risk areas help explain the impact of hazards to an area's development and physical arrangements. The table provides the basis for DRR interventions to reduce risk and vulnerabilities.

E. SUMMARY

The outputs of the DRA are the following:

- Inventory of hazards that affect the planning area;
- Estimates of risks for each hazard type;
- Risk maps derived from the hazard maps;
- Overlays of important facilities on risk maps;
- Identified vulnerability factors that contribute to risk; and
- List of priority areas/Prioritization map for risk reduction focusing on areas with high estimates of fatalities/year and cost of damages/year using the procedures described in these Guidelines.

These outputs from risk assessment become inputs towards the analysis of the planning environment and form part of the basis in developing PPAs and their locations. The next chapter looks further into the implications of the natural hazard risks on the planned areas.

5

Mainstreaming Risk Assessment Results in the Plan

Mainstreaming Risk Assessment Results in the Plan

This chapter shows how the results of disaster risk assessment are utilized to enhance the outputs of the various phases of the plan formulation process. The main purpose for mainstreaming disaster risk assessment is to determine high risk areas and the conditions that contribute to the risks or to their vulnerabilities. From there, disaster risk reduction principles and measures are incorporated into development goals, objectives, strategies and programs, projects and activities (PPAs).

These Guidelines supplement the Guidelines on Provincial/Local Planning and Expenditure Management (PLPEM), particularly Volume 2 on the formulation of the Provincial Development and Physical Framework Plan (PDPFP). The context, coverage, outline and planning logic of the PDPFP are thus adopted.

The procedure for mainstreaming results of the disaster risk assessment into the plan include the following steps: (a) analysis of the risk impact to the land use and physical framework; (b) identifying development issues and their translation into goals, objectives and targets; (c) specifying disaster risk reduction (DRR) measures in the form of strategies and programs, projects and activities (PPAs).

A. ANALYSIS OF THE RISK IMPACT TO THE LAND USE AND PHYSICAL FRAMEWORK

Objective: To ascertain the relevance and significance of the identified risk issues and concerns to the planned development of the region/province.

Output: An enhanced/revised land use and physical planning framework

Process: From the high risk areas and vulnerabilities derived from risk evaluation, analyze how these might affect the land use and physical framework

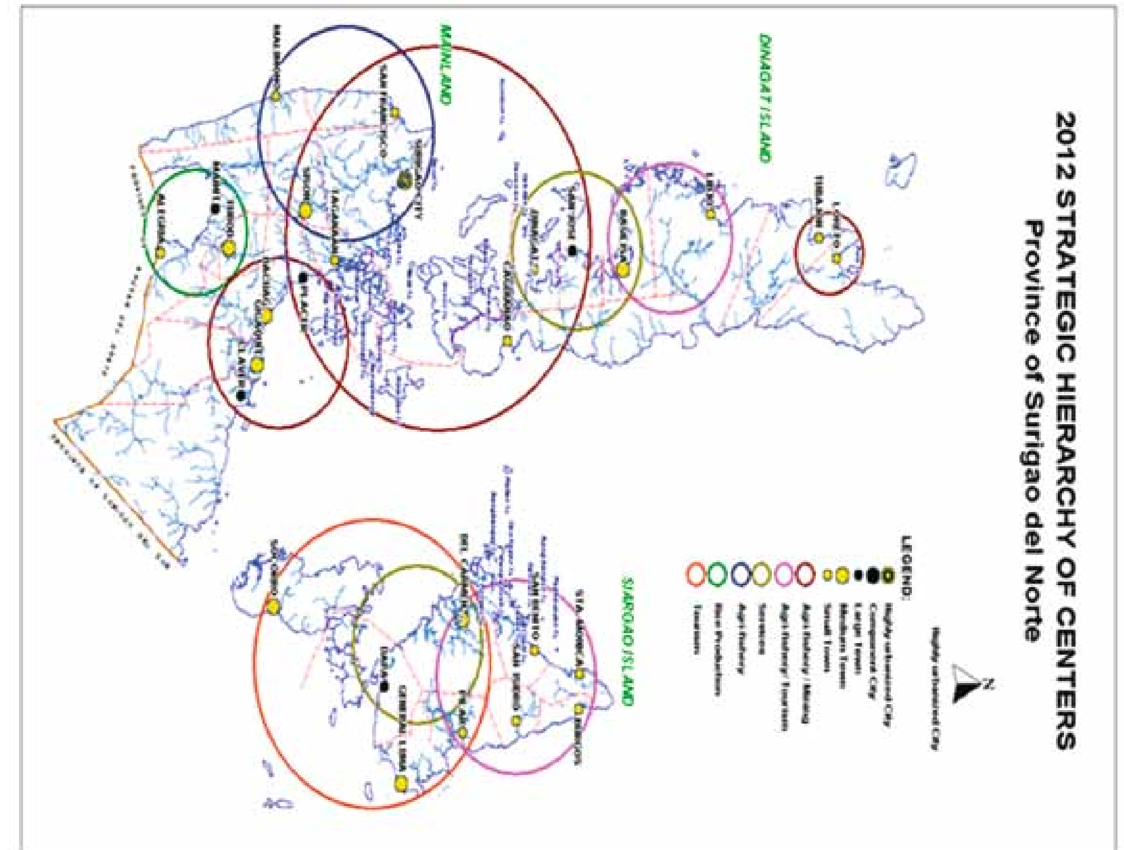
The worksheet below may be used:

Hazard	Risk Evaluation		Implications
	Risk Estimates and High Risk Areas	Vulnerabilities	
Single or Multihazard	Numbers in terms of fatalities and damages to property Ranking and prioritization of areas at risk	Example: urban center is located in a high risk area poor condition of roads and bridges (see Chapter 4 on the identification of risk and vulnerability factors, and Annex 7 on characteristics of resilience)	What are the implications to the Land Use and Physical Framework? (e.g., identification of alternate urban center, and the corresponding economic activities) Identification of alternate transport routes or maintain present routes but rehabilitate or improve them

The boxed illustration above shows how the risk estimates are used to enhance planning analyses. In general, the risk analysis becomes more meaningful if it is evaluated vis-à-vis its implications to the development framework of the province or region.

In the case of Surigao del Norte, development strategies are based on the province's comparative advantages and the potentials of clusters of municipalities (see Figure 5.1).

Figure 5.1 Surigao del Norte Development Strategies, Given Planning Challenges and Identified Disaster Risks



Source: Draft DRR-Enhanced PDPFP of Surigao del Norte, 2008

Planning Considerations

Given the risks, what changes may be made in the physical framework plan?

- Rethinking roles/functions of settlement clusters
- Alteration of service and facility requirements
- Ensuring functionalities and linkages within and among settlement clusters as well as with key development areas outside the province (i.e., neighboring provinces, regional hierarchy, Mindanao-wide, national system)
- Responding to socioeconomic fragilities and improving resilience (specific vulnerable sectors, population groups)

The following queries can thus be made: *Given the results of the risk analysis, should an existing development strategy still be pursued? What changes can be made so as to still pursue this development strategy*?

These questions may be answered by:

a. Considering options to avoid high risk areas and transferring settlements and service functions to safer or relatively lower risk areas. This may also necessitate redefining the roles and functions of the settlement or development clusters and the resulting land uses. The alteration of roles and functions imply corresponding changes in service and facility requirements which aim to ensure that attendant risks are reduced;
b. Allowing the improvement of the physical and economic interactions within and among key development areas and clusters, even the linkages of areas outside the province (i.e., neighboring provinces, regional hierarchy, and national system); and
c. Determining the impact of disaster risks on the socioeconomic conditions of the area, particularly on the fragilities of key elements at risk.

Cases from the DRR-enhanced plans prepared under the National Economic and Development Authority – United Nations Development Programme – European Commission (NEDA-UNDP-EU) Technical Assistance on Mainstreaming Disaster Risk Management in Subnational Development and Land Use/Physical Planning illustrate these points.

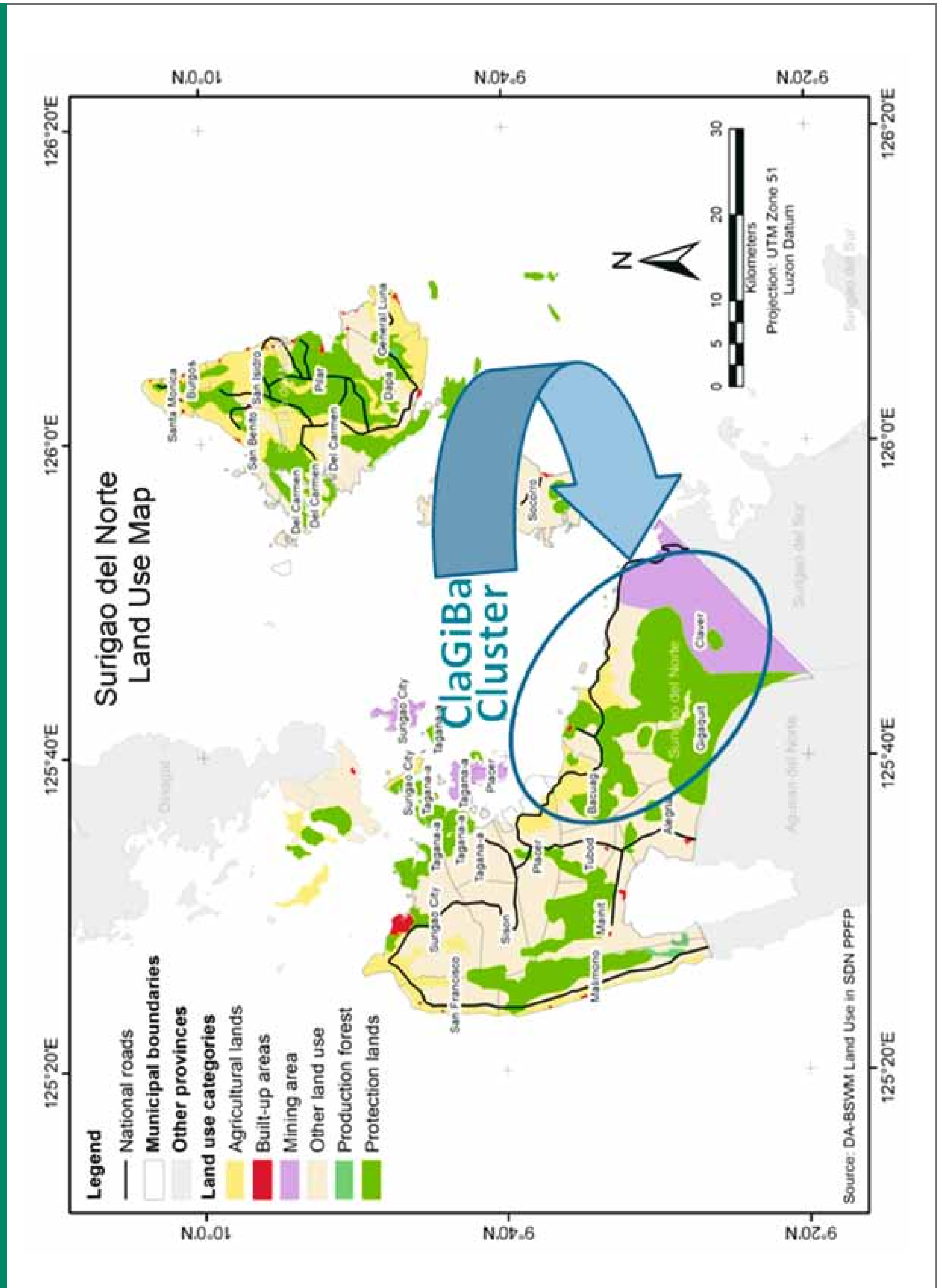
CASE 1: CLAVER-GIGAQUIT-BACUAG DEVELOPMENT CLUSTER IN SURIGAO DEL NORTE

Table 5.1 Risk Impact to the Land Use and Physical Framework: The Case of the Claver-Gigaquit-Bacuag (ClaGiBa) Cluster in Surigao del Norte

Hazard	Risk Evaluation		Implications
	Risk Estimates and High Risk Areas	Vulnerabilities	
Flooding Earthquake and rain-induced landslides Storm surge	Barangay Poblacion of Bacuag is most susceptible to all the four hazards having an estimated fatality ranging from 1 or more in 10 persons to 1 to 10 fatalities in 1000 persons a year. The other 7 urban barangays and 25 rural barangays are also exposed to the hazards. The estimated property damage due to flooding: Claver - PhP6.6 million Bacuag - PhP6.1 million Gigaquit - PhP2.8 million About 80.22 sq km of prime agricultural areas are prone to flooding. Another 198.94 sq km of land are estimated to be with high susceptibility to rain-induced landslide. Coastal communities prone to flooding are also exposed to storm surge.	Prime agricultural areas are susceptible to flooding. These are low-lying areas which require adequate drainage to minimize overflow of run-offs to the urban center. Almost all areas in Gigaquit are planted to rice; about 40 percent in Bacuag and a small portion of Claver are susceptible to flooding. Portions of settlement areas in this cluster that are susceptible to flooding are also exposed to storm surge. Areas suitable to mixed farming and agroforestry are susceptible to rain-induced landslide, portions of which are in Claver where there are mining activities.	The risks (as revealed by estimates on fatalities and property damage) could considerably disrupt the cluster's economic activities when a disaster occurs since it plays a significant role in rice, coconut and aquaculture production and mining. The goal of Claver to become a large town may be imperiled by its susceptibility to flooding as this may discourage investments. The risks could mean loss of income to majority of families as the primary source of income is farming. Secondary sources of income are mining and mining-related services.

Source of Basic Data: Draft DRR-Enhanced PDPFP of Surigao del Norte, 2008

Figure 5.2 The ClaGiBa Development Cluster in Surigao del Norte



Source of Basic Data: Draft DRR-Enhanced RPFP of Caraga Region, 2008

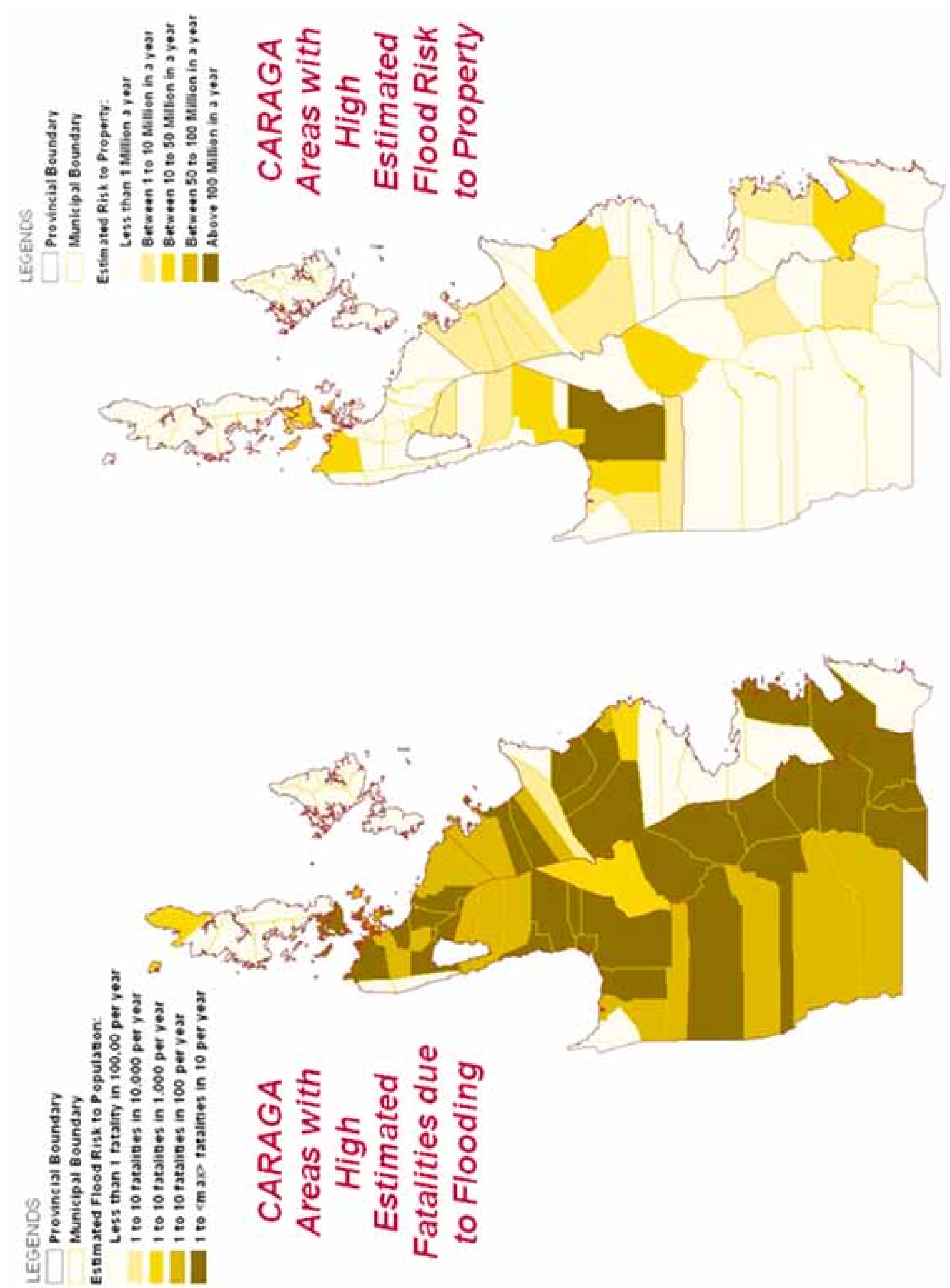
CASE 2: CARAGA REGION

Table 5.2 Risk Impact to the Land Use and Physical Framework: CARAGA Region

Hazard	Risk Evaluation		Implications
	Risk Estimates and High Risk Areas	Vulnerabilities	
Flooding, rain-induced landslide, storm surge, liquefaction, and ground rupture	Butuan City ranks 1 in terms of risks to fatalities and damages to properties in 4 out of the 5 hazards (except storm surge); Surigao City ranks 1 in terms of fatality risks from storm surges, second in terms of risks to flooding, and ranks 3 in ground rapture risks; and Bislig City ranks 1 in terms of risks to property damages from storm surges, second in terms of liquefaction and ground rapture risks, and 8 in terms of flooding risks.	The three cities are the most populated areas in the region; socioeconomic conditions are characterized by high poverty incidence, poor health and nutrition status, and other aggravating conditions that contribute to the already high exposure to risks and may result to greater negative impact when disasters happen.	The high risks and vulnerabilities of the three cities adversely affect their roles: Butuan City as regional center and major trading, processing, commercial and service center of CARAGA, also the show window of history and culture in Mindanao; Surigao City as commercial and trading center in the Pacific rim of the region, special zone for mineral-based industries; and Bislig City as the agri-forestry and aquamarine processing center and agri-industrial center.

Source of Basic Data: Draft DRR-Enhanced RPFP of CARAGA Region, 2008

Figure 5.3 Risks from Flooding in CARAGA



Source of Basic Data: Draft DRR-Enhanced RPFP of Caraga Region, 2008

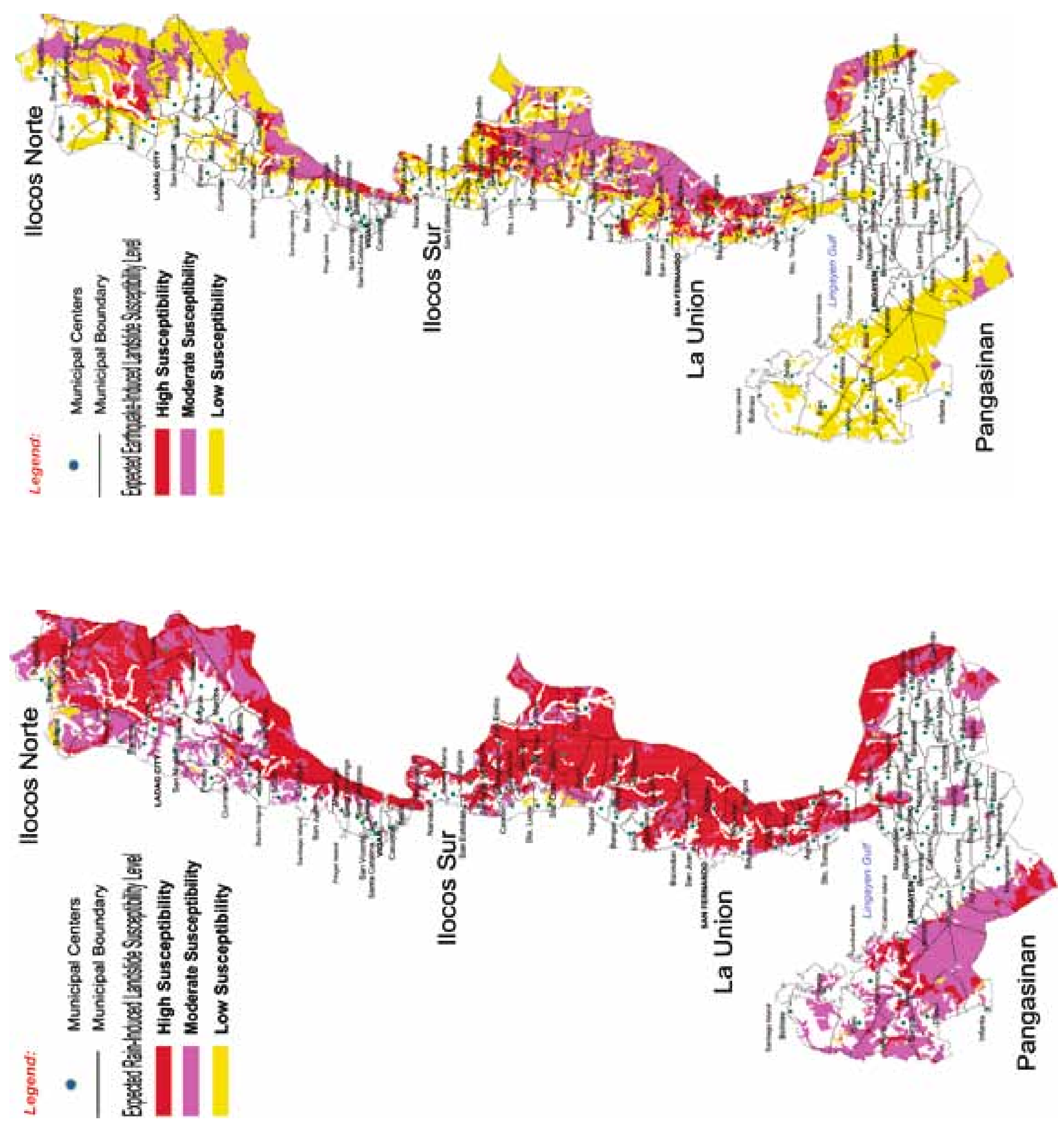
CASE 3: ILOCOS REGION

Table 5.3 Risk Impact to the Land Use and Physical Framework: Region 1

Hazard	Risk Evaluation		Implications
	Risk Estimates and High Risk Areas	Vulnerabilities	
Rain-induced landslides, earthquake-induced landslides, liquefaction	More than half of the region's total lands are at risk to rain-induced landslides (58%) and earthquake-induced landslides (52%) which may result to some PhP23 million and PhP181 million of property damage, respectively. While only one-fifth of the area is prone to liquefaction, this hazard accounts for 74 percent of the risks attributed to the three hazards. The urban areas are at greater risks with property damage amounting to some PhP667 million or 85 percent of the total damages that may occur.	Areas susceptible to rain- or earthquake-induced landslides are those with steep slopes particularly in mountainous municipalities abutting the Cordillera and the Zambales mountain ranges. Most of the at-risk uplands communities are poor, and where socioeconomic conditions are relatively worse than their lowland counterparts. The susceptibility of the areas are worsened where the forest and vegetative covers are degraded and where kaingin is commonly practiced. Areas prone to liquefaction, on the other hand, are mostly those areas located in the flood plains of major rivers and where soil conditions make them more vulnerable to this type of hazard (see Figure 5.4).	The more problematic susceptible areas are those having strategic roles in the regional hierarchy of settlements or those considered as key growth centers (KGC) and identified as having relatively larger highly susceptible areas to the hazards (area figures shown are in sq km): **KGC** **Area** Alaminos 6.09 Narvacan 2.77 Agoo 1.59 Candon 0.93 San Fernando 0.45 Vulnerability assessment for the KGCs and their satellite municipalities and influence areas should be undertaken to specifically identify their socioeconomic fragilities and pinpoint vulnerable situations which will be the basis of specifying corresponding responses and interventions.

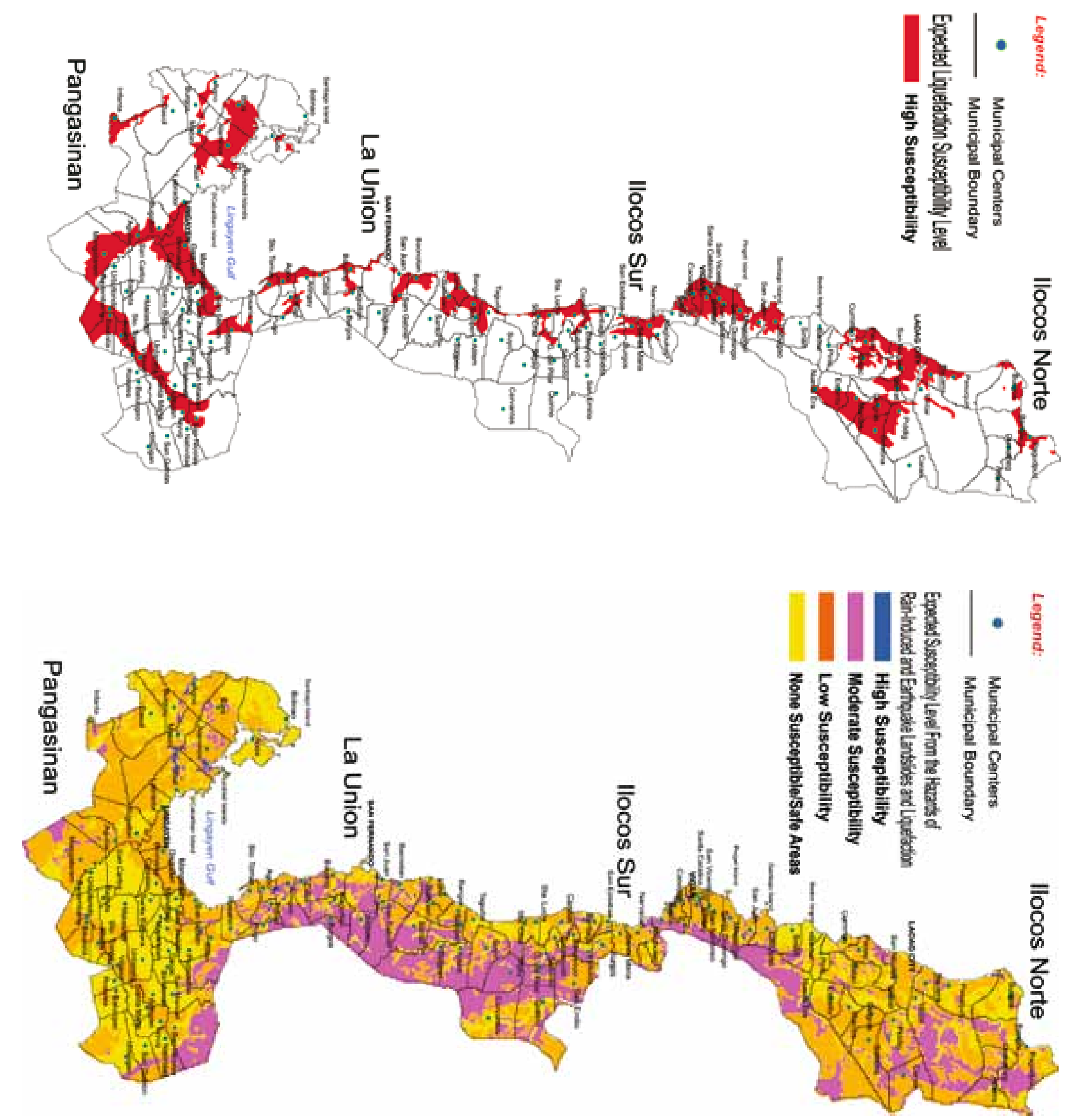
Source of Basic Data: Draft DRR-Enhanced RPFP of Region 1, 2008

Figure 5.4 Areas Susceptible to Hazards in Region 1



Source of Basic Data: Draft DRR-Enhanced RPFP of Region I, 2008

Figure 5.4 Areas Susceptible to Hazards in Region 1



Source of Basic Data: Draft DRR-Enhanced RPFP of Region I, 2008

Consider another case based on the evaluation of a proposed flood control project in Pampanga, Region 3.

CASE NO. 4: FLOODING IN PAMPANGA

Table 5.4 Risk Impact to the Land Use and Physical Framework: Flooding in Pampanga

Hazard	Risk Evaluation		Implications
	Risk Estimates and High Risk Areas	Vulnerabilities	
Flooding, lahar deposition	For the Porac-Gumain River in the Pasac Delta, the following consequences were estimated for at least three flooding events : • A 2-year flood will have an inundation depth of 0.3 to 0.4 meters affecting some 47,100 hectares for about 9 days; • A 5-year flood will have a depth of 0.3 to 0.6 meters and covers some 49,600 hectares for as long as 18 days; and • A worst scenario case (20-year flood) will result to an inundation depth of 1.5 to 1.8 meters affecting some 51,900 hectares in 45 days. Annual direct losses include: PhP198.96 million damage to properties; agricultural production losses of PhP411.82 million; business disruption resulting in foregone income in PhP1,127.07 million. For the San Fernando flooding, the worst case would result to an inundation depth of 0.3-0.6 meters lasting for 18 days. Damage to properties is estimated to be PhP590 million.	As an aftermath of Typhoon Gloria in July 2002, actual flooding was recorded, with worst cases as follows: inundation depth of 1.2 meters maximum at the town center of Guagua; 1.0 meter maximum at the Poblacion of Sasmuan; and average of 0.6 meter in the urban areas of Lubao. Greatly affected were residential and commercial areas. Agricultural areas most affected were ricelands and aquamarine areas. The urban core of San Fernando City was affected by flooding: inundated area of 124.19 sq km and affecting 16 barangays mostly residential, commercial, industrial and institutional areas; and inundation depths greater than 0.6 meters, and lasting for more than a month. Perennial flooding may be attributed, not only to excessive rainfall, insufficient channel capacities, and high run-off coefficients in areas affected; but also to human activities, particularly the indiscriminate dumping of garbage along rivers and creeks, increasing informal settlers and illegal structures along waterways and improper construction of drainage systems.	Serious and long-duration flooding will be experienced in the affected areas if the drainage problems are not solved. This would greatly affect San Fernando City as the regional center of Central Luzon. Guagua and Lubao are big towns with populations of more than 100 thousand. Flooding will also affect economic interactions between Metro Manila and the North Luzon since the North Luzon Expressway and the Manila North Road passes through San Fernando City. Economic linkages between Manila and the industrial areas of Subic and Bataan will also be affected every time the Guagua and Lubao sections of the Gapan-San Fernando-Olongapo (GSO) National Road are flooded.

Source of Basic Data: NEDA Region 3 Project Evaluation Reports, 2007

The importance of the risk estimates is best appreciated in the analysis of the planning area, particularly in determining relatively risk-free or safe areas where developments can be encouraged or directed to. In the case of Region 1, the following planning challenges and opportunities are revealed by the disaster risk assessment (see also Figure 5.5):

a. Settlements development –identification of safety zones (nonsusceptible areas) for human settlements and community building;
b. Protection land use – identification of safety corridors or enhancement of the environmental integrity of key zones;
c. Production land use – provide venues for secured systems for product service delivery and sustainable production; and
d. Infrastructure development – provide safety channels or road network linkages for interzonal development and specifying the required infrastructure support for the desired physical development.

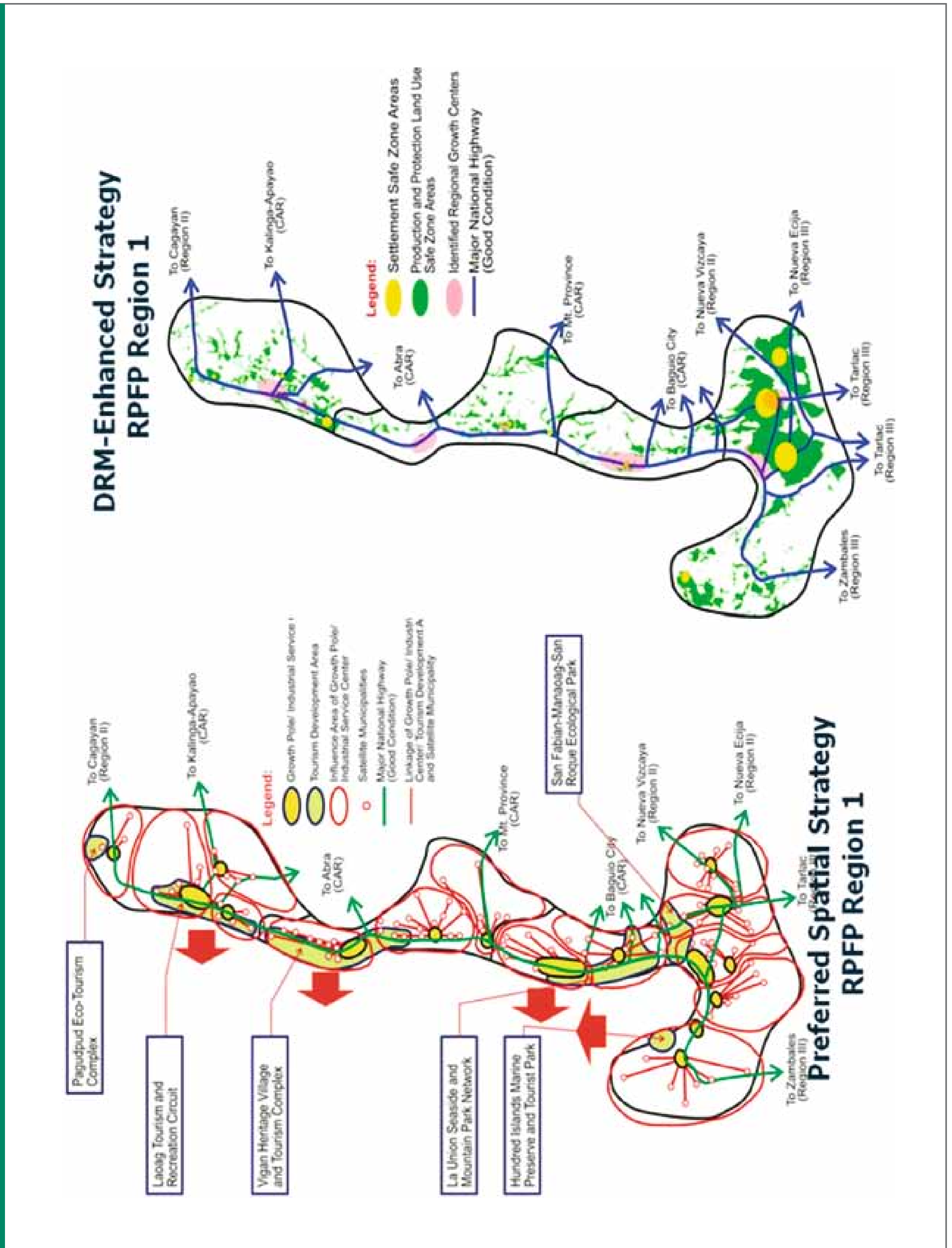


Figure 5.5 Identifying Safe Areas in Region 1

Source of Basic Data: Draft DRR-Enhanced RPFP of Region I, 2008

B. IDENTIFYING DEVELOPMENT ISSUES, GOALS, OBJECTIVES AND TARGETS BASED ON THE RISKS

Objective: To identify development issues, goals, objectives and targets based on the risks

Output: Enhanced set of development issues, goals, objectives and targets

Process: From the matrix on risk impact to the land use and physical framework, identify development issues and the corresponding goals and objectives/targets that need to be attained

1. IDENTIFYING DEVELOPMENT ISSUES AND CONCERNS

Based on an analysis of the risk impact to the land use and physical framework, development issues and concerns are identified. These are either existing or potential land use conflicts attributed to the risks (e.g., settlements in high risk areas, production systems most likely to be affected by disaster since they are in a high risk area, or critical infrastructures threatened) or possible adverse impact of the disaster risks to the overall development scenario of the province or region which will require intervention measures.

2. SPECIFYING DISASTER RISK REDUCTION GOALS, OBJECTIVES AND TARGETS

Having known the risk-related issues and concerns, the goals and objectives/ targets in the plan are redefined, guided by the vision of the region or province. The possible changes may be in relation to timeframes, target areas or population groups, downscaling or refocusing of goals, objectives and targets, among others. It is also possible that new goals, objectives and targets are formulated to directly address risks. What is important is that these are reformulated taking into account the constraints posed by the hazards and that these are realistic and attainable.

At the regional or provincial development level where plans are indicative frameworks, it may be difficult to be very specific hence detailed objective or target setting may not be possible unless the data available allow for such analysis.

C. IDENTIFYING INTERVENTION MEASURES TO RESPOND TO THE DISASTER RISKS

Once the significance and priority of the risks are ascertained and the goals, objectives and targets are set, the next thing to do is to identify the corresponding intervention approaches or options to address the impact of the disaster risks. The measures may be classified into four major categories, as follows: (a) risk avoidance or elimination; (b) risk reduction or mitigation; (c) risk sharing or transfer; and (d) risk acceptance or retention.

a. Risk avoidance or elimination – removing a risk trigger by not locating in the area of potential hazard impact, not purchasing or making use of vulnerable land or building; or denying a risk by not creating an activity or simply refusing to engage in functions that could potentially be affected by risks;

b. Risk reduction or mitigation – reducing the frequency of occurrence or the severity of the consequence by changing physical characteristics or operations of a system or the element at risk. It can take on the following subcategories:

   - risk prevention – instituting measures so that the hazard does not turn into a disaster, or at the very least reduce the impact of the hazard;
   - risk or loss reduction through mitigation – reducing the severity of a hazard impact through appropriate actions prior to a hazardous event such as by preparing the people, protecting property and ensuring that all facilities or systems are functional. Strategies and PPAs under this option include structural and nonstructural measures, those that reduce the socioeconomic vulnerabilities or improve coping mechanisms of communities at risk, and those that impede triggers to disasters;
   - risk or loss reduction through preparedness – reducing the severity of hazard impact by improving capability to rescue, salvage, and recover through actions completed after hazard impact. Strategies and PPAs may include the installation of early warning systems; information, education, and communication (IEC) programs; and evacuation plans and programs;
   - segregation of exposure through duplication or redundancy – increasing system sustainability by providing back-up support for systems or facilities that may become nonfunctional after the hazard impact (concept of spare tire or stand-by generator); and
   - segregation of exposure through separation – increasing system capacity and robustness through geographic, physical and operational separation of facilities and functions (decentralizing services or functions).

c. Risk sharing or risk transfer – shifting the risk-bearing responsibility to another party, often times involving the use of financial and economic measures particularly insurance systems to cover and pay for future damages. In some literature, the segregation of exposure by separation is considered as a risk spreading or risk transfer option; and

d. Risk retention or acceptance – this is the "do-nothing" scenario where risks are fully accepted and arrangements are made to pay for financial losses related to the hazard impact or to fund potential losses with own resources.

DRR can be applied to almost every aspect of development. Depending on the types of risks, one can provide for a range of options to respond to such risks. The choice as to which final DRR measure or approach to adopt will depend on the decision-making process of the province/region. Ideally, this should be the result of a participative process involving all stakeholders particularly the communities affected by the risks.

One can also refer to Annex 7 for an enumeration of the characteristics of resilience, whether they pertain to a disaster-resilient community or to an enabling environment. As depicted, resilience is classified into seven major components, namely: environment and natural resources; health and well being; sustainable livelihoods; social protection; financial instruments; physical protection; and planning regimes. The Annex also serves as a checklist of desirable conditions along the seven resilience components. The lack of these conditions or any deviation from the desired state may point to the need for the appropriate interventions to improve resilience and reduce disaster risks. For example, on environment and natural resource management, the risk concern covers not only those pertaining to natural resource capital but also climate change adaptation. A notable characteristic of a disaster-resilient community is one that adopts sustainable environmental management practices that reduce hazard risk. Such practices include soil and water conservation, sustainable forestry, watershed management to reduce flood risk, the conservation of mangroves as buffer against storm surges, maintenance of water supply and drainage system, among others.

Table 5.5 provides examples of risk reduction options and strategies by type of risk. A list of DRR-related PPAs in terms of structural and nonstructural categories is given in Table 5.6.

Table 5.5 Examples of Disaster Risk Reduction Strategies

Risks/ Strategies	Avoid or Eliminate Risks	Reduce and Mitigate Risks	Share and Transfer Risks	Risk Retention
Infrastructure risks	• Prohibit development in high risk areas • Buyout and relocate structures in highly prone areas • Destroy and remove structures in hazard-prone areas	• Strengthen structure's ability to resist hazard • Change use or occupancy pattern of structure • Enforce stricter zoning and building standards • Develop response plans and improve hazards warning systems • Build redundant infrastructure systems • Secure items from damage and loss	• Develop alternate locations for key functions • Institute a geologic hazard abatement district for home owners to share in future repair costs • Real estate disclosures	• Take no action • Self-insure the stocks • Treat physical losses as expenses
Social and cultural risks	• Deny occupancy of hazardous buildings • Protect cultural assets through zoning standards	• Integrate sociocultural indicators into risk assessment • Fund hospitals and social services mitigation • Identify needs of various population groups (e.g., elderly, handicapped, women, children)	• Promote incentives for homeowners, renters and businesses to purchase insurance • Create mutual aid agreements	• Take no action • Prepare shelter plans for displaced residents
Economic risks	• Avoid or eliminate capital stock risks by mandating "smart" growth or avoiding high risk areas • Develop business retention and job placement programs	• Provide incentives to mitigate or reduce risk • Diversify income sources • Attract wide range of business types • Mitigate risks to key income generators (base industries, large employment sectors) • Incentives for "smart" growth • Build economic alliances and partnerships	• Shared responsibilities between government and private / business sector	• Take no action • Special funds or lines of credits for lost revenues
Natural resource/ environmental risks	• Eliminate sources of pollution • Mandate use of technologies (e.g., emissions-free vehicles) • Enforce strict zoning	• Eliminate point sources of pollution • Launch clean-up efforts • Regulate use and storage of potential pollutants • Reduce densities in sensitive areas • Habitat conservation plans • Incentives for use of specific technologies • Incentives for good development decisions	• Develop transfer of development rights programs, or environmental land swaps • Greater shared responsibilities of Indigenous Peoples in the management and protection of forests	• Take no action • Brownfield clean-up and reuse costs

Table 5.6 Example of DRR-related PPAs

Hazard	DRR-related PPAs		
	Structural Mitigation Measures		Nonstructural Measures
	Control Works (Temporary)	Restraint Works (Permanent)	Mitigation (including Preparedness) and Risk Transfer
Earthquake and rain-induced landslide	• Cutting unstable soil and rock mass • Shaping of slope (stepping) • Vegetation • Drainage and excavation of trenches	• Cast-in-place concrete crib • Pre-cast block • Ground anchor • Gravity retaining wall • Concrete spraying works • Crib retaining wall • Soil nailing	• Hazard-resistant design of the slope • Good design for construction of building at the toe of the slope • Risk transfer (insurance, reinsurance, catastrophic bonds (cat bonds)
Storm/ Flood	• Sand bag dikes beside river • Diversion trenches • Artificial channels	• Mechanical land treatment of slope, such as terracing to reduce the runoff coefficient • Construction of dams/ dikes • Construction of levees beside river • Construction of bridges • Other flood control structures (i.e., spillways, concrete channels, drainage)	• Hazard-resistant design and construction • Flood and storm forecasting • Flood evacuation training programs • Coastal zone management plan • Financial alternatives • Risk transfer (insurance, reinsurance, cat bonds)
Volcanic Eruption	• Excavation of trench • Shaping of slope (stepping) • Vegetation • Drainage and excavation of trenches	• Construction of dikes	• Volcanic-resistant design (i.e., roof) • Evacuation planning • Public awareness • Training program • Delineation of buffer zones • Risk transfer (insurance, reinsurance, cat bonds)
Earthquake	• None	For concrete structures : • Reinforce building with steel moment frame • Increase lateral support by infilling opening • Protect wall by stiffening floor For wood and other building structures: • Follow the existing building code for retrofitting of the building under threat of the earthquake impact	• Hazard-resistant design and construction codes • Early warning system and training • Earthquake evacuation planning and training programs • Earthquake macro and micro zoning • Monitoring and evaluation of old buildings for retrofitting • Financial alternatives • Risk transfer (insurance, reinsurance, cat bonds)

Risk treatment and control through land use planning and management is among the best DRR approaches and all provinces and regions are encouraged to devise their own development schemes for the proper use and management of land. It may involve the specification of a land use code of practice similar to the case of Switzerland. Here, hazard-prone areas are designated as red zones where buildings are strictly prohibited; less hazard-prone areas are blue zones where buildings and facilities are allowed to be constructed but with restrictions and safety requirements; and safe areas or yellow zones areas where developments are encouraged to take place without any restriction.

In the case of the national land use plan of Lebanon, land development restrictions are specified and strictly followed (see Figure below).

Codes of Practice in Land Use Planning*
(The Case of Switzerland)

Red zones – buildings are strictly prohibited

Blue zones – buildings are possible but with restrictions, provided certain safety requirements are met

Buildings exposed to hazards have to be designed corresponding to the hazard's possible impacts

To minimize fatalities, the establishment of warning systems and evacuation plans by the communities are required

Events involving large numbers of people have to be avoided as much as possible

Yellow zones – buildings are without restriction

*For areas prone to natural hazards (mass movements, flooding and snow avalanches)
Source: World Meteorological Organization, 2006

Risk Management via Land Use Planning
(The Case of National Land Use Plan of Lebanon)

In zones susceptible to flooding, the rules of land development must necessarily be restrictive:

- reduce construction
- banning housing projects for the purpose of real estate development
- no installations intended for public use
- no obstruction of river watercourses
- prohibition of closed fencing and the obligation to reserve at least 80 percent the land for use of gardens, lawns, orchards or vegetable gardens

In many cases, once the extremely high-risk areas are identified and the logical policy recourse is to prohibit or restrict occupancy or any developments in those areas, then resettlement becomes an inevitable option for the affected population.

For a resettlement to be considered effective, a study made on the Mt. Pinatubo Rehabilitation Options by MB Anderson (1993) suggests the consideration of at least four basic factors, namely:

a. Livelihood – the people to be resettled must, within a specified period of time, be able to earn a stable and secure livelihood through their own production efforts and/or employment;
b. Social and political involvement – the people who will be resettled must be in full charge of their own social and political activities within a short and specified time, which means that in addition to the economic viability of the resettlement, there must also be a viable community in which people participate in the management of their social and political life;
c. Integration into surrounding economy/community – an effective settlement is one that is integrated into the economies of the surrounding (host) communities so that there would be no intergroup or intercommunity tensions; and
d. Low vulnerability to disasters – an effective settlement is one in which there is minimal vulnerability to a new disaster; the site should be as safe as possible from the type of disaster that caused the initial dislocation and from any other natural disasters and that the settlement should not, by its own existence, increase the area's vulnerability to environmental or ecological disasters.

The Anderson document also mentioned that many resettlement schemes that were designed and constructed at great costs now stand abandoned by their inhabitants because the groups they intended to house never developed into viable and organic communities. The reasons for this are covered in the ten lessons outlined below:

a. People who need assistance to resettle are those who have limited capacities; those who do not self-resettle (and in many cases oppose being resettled) are those who lack material resources and social mechanisms of psychological strength for taking initiatives;
b. Resettlement is very stressful. A move to a new resettlement represents a loss of power and because they have just experienced extreme powerlessness in relation to a cataclysmic event, any additional loss of control over their own

lives like planning and livelihood is particularly hard to face. The second issue that is derived from the difficulties that disaster victims face when they have to move involves a tendency to adopt "conservative" rather than open-ended or adventuresome strategies immediately after the move;

c. Resettlement programs have built-in characteristics which tend to increase dependency on outside assistance on the part of people being resettled rather than supporting their independence and self-sufficiency;
d. The single most important factor for recovery from a disaster is the reestablishment of a secure source of livelihood;
e. The physical arrangement of a settlement is the second most important factor that determines the likelihood of its success. The poor choice of site, unsatisfactory layout or design, and housing design and construction that do not meet the settlers' needs and expectations are three of the most often cited causes of failures of resettlement schemes;
f. The roles and responsibilities of men and women very often change under the circumstances of resettlement. When communities are displaced, the economic activities that people were engaged in also change and this very often causes a shift in the gender-based division of labor and social roles;
g. When governments focus resources on the creation of new settlements, groups who have significant material, social and psychological capacities may elect to join because they see it as a promising option for getting ahead;
h. Integration of the physical infrastructure and the population of a new settlement into the economic and social systems of the neighboring communities or the bigger community or municipality where the resettlement is located affects the success of any settlement;
i. Settlements always have an important impact on the environment and ecology of areas in which they are placed; and
j. Settlements require a combination of community-based, cooperative actions and private, individualized actions.

Also, a study undertaken by NEDA Region III (1996) shows that there are as many as ten resettlement arrangements which can be considered, each having its own merits:

a. Standard new resettlement sites. As provided under the Mt. Pinatubo Commission (MPC) program (standard lots and housing units with community facilities including road system, water and electric services, public markets and productivity centers; and with social, recreational, religious facilities); the national government agencies and local government units (LGUs) are the developers. These are typical MPC lowland resettlement areas - new town centers with 500 to 1000 housing units, all with urban facilities and services;
b. Basic new resettlement sites. With basic facilities and services only (with water and electricity, barangay hall, health station and elementary school); nongovernment organizations (NGOs) are the developers in cooperation with LGUs and beneficiaries;
c. Conversion of evacuation sites to resettlement sites. By joint efforts of beneficiaries/ occupants, LGUs and NGOs;
d. Private developer moderate-standard residential subdivisions. With various lot sizes, improved to basic standards. Open to all Mt. Pinatubo victims. With some contractor mass-built houses, including houses built by various builders. Government mortgage loan programs (nonsubsidized/subsidized, individual/ community). Building material loans and guidance/supervision of construction for self-built or mutual-built houses. Key inputs are LGU assistance in site acquisition, access road and offsite utility line extensions, and national government cooperation with required regulatory approvals and housing loan programs;
e. Barangay/municipal assimilation. Existing sale or rental housing, houses built on individual lots, small-medium subdivisions, with self-built and contractor-built houses. As incentive to host barangay or community, some public facility extensions and upgrading may be required. Use would be made for existing schools, health clinics and other public buildings and services of the barangay/ municipality;
f. Community resettlement on self-selected, may be government or nongovernment aided but developed on a self-help basis. Development standards would be determined by the resettlement group together and/or individually according to their needs and resources;
g. Rehabilitation of lahar-devastated community. Either incrementally by the affected families who choose to stay or return; or as a government or NGO-sponsored project with "right of first refusal" to displaced owners and other prior occupants (after lahar is depleted or lahar flows ceased to occur, dike projects already make the area safe, or for other reasons future lahar risk had become minimal). Development requirements would vary widely depending on degree of devastation and decisions of participants;
h. Frontier resettlements. Remotely located land for farming, agriforestry, ranching, agri-industry, including a small town center with shops and services and some houses, constructed to moderate standards with a minimum of basic services;

i. Recycling of resettlement sites. Sites are permanent; beneficiaries are accommodated for a maximum period (say up to three years with rare extensions for specific causes). Emphasis on preparation for and assistance with livelihood. Assistance is provided in obtaining a house, homestead or farmstead. These sites could also serve as evacuation centers if houses were vacant at the time new families displaced were seeking accommodations; and
j. Cash vouchers (one-time cash payments) to be used only for permanent resettlement of families with self-selected locations, house/lot, farm, etc. Thus the family or families meet their resettlement needs in the real estate market place wherever and however they choose. This scheme had also been adopted in the "balik-probinsya" program to encourage slum dwellers in cities to go back to their province of origin.

The key elements of the enhanced plan may be summarized in a development framework matrix, the examples of which are shown in the following cases:

Table 5.7 Development Planning Framework: Case of ClaGiBa Cluster in Surigao del Norte

Development Issues and Challenges	Goal	Objective/ Target	Strategy/Policy	Program/ Projects/ Activities
Low agricultural productivity of the area due to flooding Possible decrease of economic opportunities due to the adverse effect of hazards in mining areas Exposure of critical infra support to the natural hazards	To ensure sustainable use of land resources and achieve environmental balance To provide adequate infrastructure support to catalyze economic growth	Reduce flooding in the cluster to increase agrifishery productivity Minimize damage to properties and crops Create an environment conducive to investments, especially in agrifishery, tourism and mineral processing	Provision of adequate drainage systems in prime agricultural areas that are prone to flooding Promotion of tolerant or resistant palay variety to be planted in flood prone areas Provision of appropriate drainage structures along major roads to properly convey run-offs to water bodies Provision of stable structures in side slopes along major road network Restriction of mining and quarrying activities within 10-km radius from urban centers, ecotourism sites and other protected areas Discourage establishment of settlements in high risk areas	Flood mitigation program Watershed rehabilitation and reforestation program Agricultural productivity enhancement program Infrastructure programs for the protection of major roads from flooding and landslides Enforcement of zoning ordinances and environmental laws

Source: Draft DRR-enhanced PDPFP of Surigao del Norte, 2008

Table 5.8 Development Planning Framework: The CARAGA Case

Development Issues & Challenges	Goals and Objectives	Strategy/Policy	Program/Projects/ Activities
High risks in the cities of Butuan, Surigao and Bislig threaten their roles as key centers of CARAGA (refer to Table 5.2 for details).	Ensure the viability of the three regional centers to assume their designated roles by reducing disaster risks attributed to the five identified hazards Improving the resilience of threatened communities, facilities and other elements at risk	Conduct more detailed risk and vulnerability assessment in highly prone areas Strictly implement land use plans and building codes (placing restrictions to buildings/structures in highly susceptible areas) Encourage residential and key urban functions and services to locate and/or relocate in risk-free areas. Implement risk reduction and mitigation measures in high risk areas/priority KGCs Introduce structural and nonstructural slope stabilization measures in degraded areas Implement IEC on the hazards and conduct disaster preparedness trainings, drills and simulation exercises Encourage public-private sector partnership in the implementation of PPAS (spreading responsibilities)	Risk and vulnerability assessment and studies of high risk areas Updating of land use plans to institute risk zonation, siting criteria and other DRR measures Urban sites and services improvement and development program Disaster risk reduction package for high risk areas and priority KGCs Slope stabilization programs and projects for critical and degraded areas IEC and community awareness programs, disaster preparedness training programs Public-private sector link-up to implement DRR measures

Source: Draft Caraga DRR-Enhanced RPFP, 2008

Table 5.9 Development Planning Framework: The Case of Region 1

Development Issues and Challenges	Goals and Objectives	Policies and Strategies
High risks particularly in urban areas brought about by three hazards in Region 1: rain-induced landslides, earthquake-induced landslides and liquefaction (refer to Table 5.3 for details).	Ensure the attainment of the vision to have a well planned and managed settlement system that encourages and facilitates economic and social interface between urban and rural areas as well as between cities and emerging urbanizing areas considering the identified risks.	Provide major infra/support facilities to areas identified in the municipal land use plans as future safe settlement zones. The future development of the region shall be in harmony with development plans; e.g., land use plan, to prevent misuse of physical resources; i.e., indiscriminate land conversion for inappropriate use. Develop identified safe zones as secondary settlements area to decongest existing major settlement areas that are vulnerable to natural hazards. Specifically, the concept of town clustering shall be adopted, where a complex of amenities and services are initially provided in a proposed settlements area to trigger the movement of the population to these safe zones. The viability of the RDC-adopted network of settlements shall be continuously reviewed and revised accordingly, taking into account the concept of "safe and unsafe zones" for the identified roles and functions of the subregional centers, major and minor urban areas. Its refinement shall be based on the risks to property damages as may be associated with the probable occurrence of landslides and liquefaction. Mitigating measures shall be put in place to cushion the adverse effects and impacts of natural hazards occurrences on properties. These measures must be coupled with corresponding operating and implementing mechanisms.

Source: Draft Region 1 DRR-Enhanced RPFP, 2008

Table 5.10 Development Planning Framework: The Case of Flooding in Pampanga

Development Issues and Challenge	Goal	Objective/ Target	Strategy/Policy	Program/Projects/Activities
Flooding aggravated by the effects of the Mt. Pinatubo eruption along the influence areas of Porac-Gumain and San Fernando Rivers in Pampanga (refer to Table 5.4 for details).	Rehabilitate Pinatubo eruption affected areas; restore conditions to at least the preeruption levels; and institute measures to protect settlements, industrial and other socioeconomic development against lahar deposition and flooding	Reduce flood risks by implementing measures to reduce extent and minimize duration of flooding as follows: **Porac-Gumain:** Reduce inundation depth from 1.5-1.8 meters to 0.60-0.90 meters during 20-year flood event; and shorten inundation time from 45 days to 10 days, and 10 days to 2-3 days during 20-year and 2-year flood event, respectively	Implement flood/ mudflow control measures in order to: (a) mitigate flood damages by channel improvement works in the Porac-Gumain River; and (b) improve drainage efficiencies of river channel networks in the Pasac Delta, including the Fernando river and its efficient link up with the Third River	**Pinatubo Hazard Urgent Mitigation Project (PHUMP) - Phase III** Part I: Flood/Mudflow Control Works • Dredging/excavation of major (Pasac, Guagua and Dalan Bapor) rivers, 19.2 km in length • River diversion of the lower Porac-Gumain River to Pampanga Bay, 18.7km in length (7.2km with dike and 11.5km without dike) • Improvement of 6 local drainage channels (14.7 km) and partial relocation of 2 channels (4.5 km) • Construction of new bridges and raising of key roads and bridges. • Dredging, excavation, improvement and embankment protection of San Fernando River and tributaries (with upgrading of Panlumacan Bridge and approaches)
		San Fernando: Reduce inundation depth from 0.3-0.6 meters down to 0.1-0.2 meters; shorten inundation time from 18 days down to 4 days Secure the reliability of the region's major arterial roads and other key infrastructure facilities	Plan out and implement nonstructural measures and institutional capability building in order to complement and ensure effectiveness of the instituted structural measures. Retrofit key roads and infrastructures corresponding to the worst case scenario	**Part II: Monitoring and Planning of Nonstructural Measures and Institutional Capability Building (ICB)** • Formulation of comprehensive land use plan/s covering the entire watershed (with right of way) acquisition and resettlement plan); • Optimum rehabilitation options in the upstream stretch of Porac and Gumain river basins; • Instituting flood forecasting and warning system (FFWS); • Formulation of flood management plans of downstream LGUs; • Formulation of development framework plan (ID institutional set-up and requirements); and • Ensuring sustainable operation and maintenance of PHUMP II and III **Widening/Improvement of Gapan-San Fernando-Olongapo (GSO)Road & Emergency Dredging Project** • Widening/improvement of critical GSO Road sections; • Raising of Sta. Cruz Bridge; and • Dredging of critical waterways affecting GSO Road

Note: Derived from NEDA Region 3 Project Evaluation Reports on the PHUMP. 2008

One need not disregard previous analyses but simply enhance them by seeing to it that DRR concepts and principles are integrated. The next two matrices show how this is done by making use of the same examples in the Volume 2 of the NEDA-ADB PLPEM Guidelines, on the PDPFP (Tables 22 and 23 in pages 111 and 112, respectively).

In the first example (see Table 5.11), all the entries are retained but enhancements are made such that the same strategies and PPAs will contribute in increasing resilience of the target poor population and in ensuring that the proposed interventions will not inadvertently increase their vulnerabilities. In the second and third cases, the strategies and PPAs that address the high dropout rate in the elementary level and the lack of affordable housing are enhanced by implementing interventions in hazard-free areas.

Table 5.11 Enhancing Strategies & PPAs Derived from Income/Access to Services

Issues/ Problems	Goals	Objectives	Strategies	Programs	Projects
Low incomes, lack of livelihood opportunities	Increase incomes/ livelihood opportunities	Provide employment to xx families in yy areas.	Encourage export competitive industries	Export infrastructure program	Port repair project (to reduce handling costs)
					Regional highway project (to support export market)
				Skills training for export productivity program	Training for productivity project in yy areas
			Provide microfinance	Microfinance program	Pilot micro-finance project
High dropout rate for elementary school	Decrease elementary dropout rate	Improve school retention in yy areas.	Improve physical access to schools	Road to school improvement program	Build/repair school access road project
				Classroom building program in yy areas	Classroom construction in yy areas
			Provide subsidy for poor students	Subsidized school lunch program	Subsidized school lunch project in yy areas
Lack of affordable housing	Provide affordable housing	Provide affordable housing for xx households	Provide access to new housing sites	New housing road access program	Access road construction project
			Improve sites/ services in yy areas	CMP program in yy areas	CMP project in yy areas
			Private sector-led development of affordable housing	Land titling and administration program	Land titling project in yy areas

Ensure that strategies and PPAs are implemented in hazard-free areas

Ensure that strategies and PPAs will increase resilience and do not increase the risks or vulnerabilities of areas

Source: Volume 2 (PDPFP) of the PLPEM Guidelines, 2007

In the same manner, the issues shown in Table 5.12 on urban encroachment into prime agricultural lands and environmental degradation are responded to by the same sets of goals, objectives, strategies and PPAs, but with enhancements in the interventions, particularly the inclusion of sustainable environmental practices to reduce hazard risks.

Relative to the flooding problem in Table 5.12, the objective of relocating or discouraging settlements in flood-prone areas actually aims to reduce flood vulnerability by avoidance while the objective of protecting households in flood prone areas seeks to mitigate its adverse effects. The corresponding structural and nonstructural measures are specified to address the flooding problem.

Table 5.12 Enhancing Strategies, Programs, Projects Derived from Land Use

Issues/ Problems	Goals	Objectives	Strategies	Programs	Projects
Urban encroach-ment into prime agricultural lands	Mitigate indiscriminate land conversion; protect selected agricultural land	Prevent unnecessary land conversion in yy areas	Encourage urban expansion to environment-tally compatible areas	Urban expansion road program	Access road construction project
				Review and update land use plans and zoning	Updated land use plans and zoning for yy areas
Adoption of sustainable environmental management practices & interventions that reduce hazard risks			Improve agri incomes to discourage conversion	Agricultural productivity program	Agricultural productivity research project
Flooding	Protect communities in flood prone areas	Protect xx households in yy areas	Protect and rehabilitate watershed	Watershed rehabilitation program	Tree planting project in yy areas
			Nonstructural measure		Production forest project in yy areas
Reducing Flood Vulnerability By Mitigation			Provide protective infrastructure	Flood control program	Retention pond and dike project
			Structural measure		
Reducing Flood Vulnerability By Avoidance		Relocate or discourage settlement in flood-prone areas	Provide alternative livelihood for residents of flood-prone areas	Alternative livelihood program for flood prone communities	Port expansion project (accommo-date families in flood prone areas)
Environmental degradation	Curb environ-mental degradation	Significantly reduce industrial discharge into yy areas	Implement existing anti-pollution regulations	Bantay kalikasan program	Environment police project in yy areas
					Legislation higher pollution penalties
Adoption of sustainable environmental management practices & interventions that reduce hazard risks			Encourage use of environment friendly technology	Green technology program	Reduced tariffs on green technology equipment

Source: Volume 2 (PDPFP) of the PLPEM Guidelines, 2007

D. SUMMARY

This is the first attempt to introduce disaster risk assessment methodologies in the development planning process. Planners are encouraged to keep on enhancing the methodologies and document experiences in applying them, with the aim of sharpening planning analyses as basis for sound decision making.

In general, the risk assessment should lead to:

1. More defined disaster mitigation goals and objectives/targets to reduce and avoid long-term vulnerabilities to identified hazards; and
2. Improved identification and analysis of hazards towards an appropriate disaster mitigation strategies and PPAs.

Risk reduction programs are more likely to be implemented as part of bigger development projects rather than as stand-alone projects. Incorporating DRR concepts and measures into project designs or proposals at an early stage will reduce the project costs in contrast to its introduction when the project is in an advanced stage of preparation.

Furthermore, by integrating DRR concepts into developmental activities, huge losses from disasters could be avoided. Resources invested in risk reduction can easily be justified when one considers the probable costs of emergency, recovery, repair, and reconstruction works.

In conclusion, planners should strive to prepare DRR-enhanced plans that significantly contribute to disaster risk reduction which aims to make communities and societies become resilient to hazards and ensure that development efforts do not increase vulnerability to these hazards.

6

Mainstreaming DRR in Investment Programming, Budgeting, Project Evaluation and Development and Monitoring and Evaluation

Mainstreaming DRR in Investment Programming, Budgeting, Project Evaluation and Development and Monitoring and Evaluation

The plan formulation stage ends with the list of programs, projects, and activities (PPAs) that address the development challenges of the province as well as meet the development goals, objectives and strategies. With mainstreaming, it is expected that the final PPAs include those measures that reduce risks from disasters and vulnerabilities on the population, economy, and environment.

This chapter discusses the secondary entry points for mainstreaming after the plan formulation stage of the development planning cycle.

A. POST-PLAN FORMULATION MAINSTREAMING

The results of the risk assessment enrich the analysis of the planning environment, the formulation of the land use and physical framework and the identification of development issues, goals and objectives. As an end result, if the risk assessment reveals that the Local Government Unit (LGU) or province is susceptible to natural hazards, disaster risk reduction (DRR) measures will be identified along with other development programs, projects and activities.

After plan formulation, the next stages of the development planning cycle are investment programming, budgeting/financing, implementation and monitoring and evaluation, with project evaluation and development as added tool to improve project design and financing. These are represented in the orange boxes of the mainstreaming framework described in Chapter 3.

a. *Investment Programming.* These PPAs from the Provincial Development and Physical Framework Plan (PDPFP) are then programmed to come up with the Provincial Development Investment Program (PDIP). By definition, the PDIP is a prioritized list of PPAs, the year or years in which each project will be implemented and the annual expenditure for each project. The annual slices of the PDIP, referred to as the annual investment program (AIP), are determined based on an iterative process of prioritization and matching of financial resources.

b. *Project Evaluation and Development.* Ideally, all projects in the PDIP and the AIP should undergo project evaluation and development to enhance: (i) knowledge and nature of the PPAs; (ii) identification and understanding of project outcome and outputs; and (iii) financial and economic viability.
c. *Budgeting/Financing.* Evaluated PPAs in the AIP are the main inputs into the budgeting process.
d. *Project Implementation, Monitoring and Evaluation.* PPAs provided with budgetary and other financial resources are then implemented, monitored and evaluated to determine the project outcomes and impacts that will serve as inputs to the next risk assessment and planning cycle.

B. INVESTMENT PROGRAMMING

The list of proposed PPAs derived in the PDPFP goes through the process of prioritization and matching with financing sources. The end product is the six-year PDIP. It is important that all DRR PPAs are part of the PDIP since this will be the tool that provinces use for budget preparation and fund sourcing. The main reference for investment programming is Volume 3, Investment Programming and Revenue Generation, of the NEDA-ADB Guidelines on Provincial/Local Planning Expenditure Management (PLPEM).

There will be DRR projects that will require financing sources which might be relatively large compared to the annual budget and would therefore compete for resources from other local priorities especially those that address basic needs. The following are proposed initial project screening approach:

a. From the list of DRR PPAs, determine projects that national government agencies are mandated to implement, such as large flood control projects of the Department of Public Works and Highways (DPWH) and watershed and river basin management projects of the Department of Environment and Natural Resources (DENR).
b. DRR PPAs that cannot be funded from the provincial budget may be packaged for external financing. It is important that the LGUs exhaust first local resources and utilize their revenue raising powers to meet shortfalls as an indicator of good governance.

Risk-sensitive development challenges, goals and objectives also influence the prioritization process, particularly in defining criteria and assigning weights that will

be adopted by the PDIP Committee of the province. This will enable DRR measures to compete for resources against other development projects.

C. BUDGETING

Financing will come from the budget of the province, city or municipality where the DRR measures will be implemented as well as other financing schemes offered by the national government, private sector and the Official Development Assistance (ODA) community.

1. 20 PERCENT LOCAL DEVELOPMENT FUND

Section 287 of the 1991 Local Government Code (LGC) requires each LGU to appropriate in its annual budget no less than 20 percent of its annual internal revenue allotment for development projects. Eligible projects under this fund are those directed towards meeting the social and economic development objectives of the locality as well as for environmental management. Thus, DRR projects which address social, economic and environmental fragilities would qualify.

2. LOCAL TAXES

Annex G of Volume 3 of the PLPEM presents a local revenue toolkit which identifies taxes, fees and charges that LGUs may use to raise additional revenues to finance its investment programs, as defined in the 1991 LGC.

Land-based taxes such as land development permit fee and taxes on sand, gravel and other quarry taxes may be set at a level that an LGU may be able to recoup investments in ensuring safe use of these resources.

Infrastructure-based taxes such as special levy on lands specially benefited by public works funded by LGUs may be seen as a cost-recovery mechanism especially if these public works are designed to withstand onslaught of disasters.

3. LOCAL AND NATIONAL CALAMITY FUNDS

LGUs are mandated under the 1991 LGC to set five percent of their estimated revenue from regular sources as calamity fund. To specify conditions for use of these funds, the Department of Budget and Management and the Department of Interior and Local Government issued Joint Memorandum Circulars dated 20 March 2003 and 24 July 2003 allowing the use of the fund for undertaking disaster preparedness activities and measures such as preparation of relocation sites/facilities, disaster preparedness training and other pre-disaster activities. These also allow for spending on rehabilitation and reconstruction of infrastructures after a disaster. This is a significant entry point for DRR by ensuring that risk factors are also imputed in rebuilding infrastructures.

Apart from the LGU's own calamity fund, augmentation can also come from the calamity fund of the national government and other LGUs through the NDCC and the Disaster Coordinating Councils of the other LGUs.

The National Calamity Fund refers to the appropriation in the annual General Appropriations Act which is available for aid, relief and rehabilitation services to communities and areas affected by calamities including training of personnel and other predisaster activities as well as repair and reconstruction of permanent structures including capital expenditures for predisaster operations.

The fund availment process for the National Calamity Fund can be accessed at the NDCC website, http://www.ndcc.gov.ph.

4. INTER-LGU AND LGU-NGA COOPERATION

LGUs sharing the same hazards can go into cofinancing or cost-sharing for the implementation of DRR measures, even if hazard treatment facility is located within a specific LGU.

While there may be no documented cases yet of inter-LGU cooperation in the financing and implementation of DRR measures, there are cases of successful cooperation between LGUs and national government agencies, foremost of which are the cooperation among the Office of Civil Defense (OCD); Philippine Institute of Volcanology and Seismology (PHILVOCS); Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA); Mines and Geosciences Bureau (MGB); National Mapping and Resource Information Authority (NAMRIA); and Department of Agriculture (DA), DPWH, DENR, among others, for disaster preparedness advocacy, training, hazard mapping, and projects such as installation of early warning systems.

5. RISK SHARING/TRANSFER FINANCING

Insurance is the most widespread existing risk transfer mechanism offered by private and government sector companies.

5.1 Government Insurance Facilities

a. *Government Service Insurance System (GSIS)*

The Government Service Insurance System (GSIS) is the state insurance company of the Philippines. One of the funds that it administers is the General Insurance Fund (GIF) established on 1 September 1951 under Republic Act No. 656, as amended by Presidential Decree No. 245. The GIF is mandated under the said laws to indemnify or compensate the Government for any damage to, or loss of, its properties due to fire, earthquake, storm, or other casualty. "Government" refers to the national, provincial, city, or municipal government, agency, commission, board or enterprises owned or controlled by the Government.

b. *Philippine Crop Insurance Corporation (PCIC)*

Agricultural insurance is implemented and managed by the Philippine Crop Insurance Corporation (PCIC), a government-owned and controlled corporation created by virtue of Presidential Decree 1467 issued in 1978. Its charter was later revised to give it some legal impetus to expand and to adapt to current circumstances and is now operating under RA 8175, known as the "Revised Charter of the Philippine Crop Insurance Corporation Act of 1995".

Calamity funds earmarked by the government shall include a certain percentage for crop insurance and shall be released to and administered by the PCIC. Ten percent of the net earnings of the Philippine Charity Sweepstakes Office (PCSO) from its lotto operation shall also be earmarked for the Crop Insurance Program. Regular insurance programs are as follows:

i. Rice and Corn Crop Insurance - insurance protection available to farmers against loss in rice and corn crops due to natural calamities as well as plant pests and diseases; eligible borrowing farmers - for those availing of production loan under the government supervised credit program; self-financed farmers - optional, provided they agree to place themselves under the supervision of a PCIC- accredited agricultural production technician;

ii. High-Value / Commercial Crop Insurance - an insurance protection extended to farmers against loss in high value/commercial crops, due to natural calamities and other perils such as pests and diseases. The list of high value/commercial crops includes asparagus, banana, cassava, sugarcane, tomato, peanut, potato, garlic, onion, and industrial trees;

iii. Noncrop Agricultural Assets Insurance – an insurance protection extended to farmers against loss of their non-crop agricultural assets like warehouses, rice mills, irrigation facilities and other farm equipment due to perils such as fire and lightning, theft, and earthquake;

iv. Aquaculture / Fisheries Insurance - an insurance program designed to protect fish farmers/growers against loss of their crops/stocks in fishponds, fish cages, fish pens and other aquaculture projects prioritized by the Bureau of Fisheries and Aquatic Resources due to natural disasters and other perils that may be covered on case to case basis; and

v. Tobacco Industry Insurance - with the National Tobacco Administration, the PCIC can extend insurance protection to tobacco farmers/ stakeholders against losses of tobacco crop due to natural calamities as well as other perils.

5.2 Private or Commercial Disaster Insurance

Private insurance companies cover property such as buildings against flood, storm, or other specified environmental peril. The Philippine market is served by total of 119 domestic and foreign-controlled direct insurance companies in 2007. The directory of private domestic and foreign insurance companies for nonlife and life insurance is available at the official website of insurance commission, i.e., http://www.insurance.gov.ph/htm/_nonlife.asp.

6. INTERNATIONAL SOURCES

Recent developments have encouraged humanitarian assistance to become embedded in development projects, particularly as risk assessments and DRR are taken into account. DRR is becoming a critical issue due to the increasing need to put investment in preparedness at the national and subnational levels. Countries seek international assistance when their own institutions are not able to cope with increasing cost of disasters. Nongovernment humanitarian organizations and as well as governments through their official development assistance are able to respond.

Annex 8 presents the table of official development assistance (ODA) available for DRR financing.

D. PROJECT EVALUATION AND DEVELOPMENT

Project Evaluation and Development (PED) links planning and investment programming with financing. Recall that PPAs identified in the PDPFP undergo preliminary screening and ranking to arrive at a six-year PDIP, which in turn, is broken down into six single-year investment programs or AIP. All PPAs identified in the PDIP/AIP will be subjected to basic PED. The main reference for PED is Volume 5, Project Evaluation and Development of the NEDA-ADB PLPEM Guidelines.

DRR should be factored into the overall project development cycle, which includes project identification, preparation, appraisal and financing, detailed engineering and design, implementation, operation, and evaluation. DRR is especially important in the detailed engineering and/or design phase that is usually required for projects involving the construction of hard infrastructure. The subject of PED however is the thorough project preparation and appraisal that will look into all relevant issues affecting a project such as natural hazards.

DRR may be mainstreamed into PED following its four stages: (1) knowing the project; (2) understanding the project; (3) analyzing it thoroughly; and (4) judging it fairly (Table 6.1). Projects that will go through comprehensive PED are those: (a) requiring external funding; and (b) projects costing greater than the provincial internal revenue allotment divided by number of municipalities in the province.

Table 6.1 Procedures for Project Evaluation and Development

BASIC PED	COMPREHENSIVE PED	**KNOW** the project	• Identifies and characterizes the project's output – (public, private or mixed good? Tradeable, non-tradeable or partly tradeable? If tradeable, exportable or importable?) • The purpose of this stage is to anticipate the pricing problem, which will be relevant during the computation of the project's costs and benefits.
BASIC PED	COMPREHENSIVE PED	**UNDERSTAND** the project	• Entails logical framework analysis to ascertain if the project's output will result in outcomes that are consistent with the province's development goals as spelled out in the PDPFP. • Includes forecasting of "without project" scenario as a way of determining whether the project is worthy of government undertaking • Includes analysis of alternative provision schemes to enhance the project design and ensure that the desired outcomes are achieved.
	COMPREHENSIVE PED	**ANALYZE** it thoroughly	• Involves forecasting the demand for the project's output and determining the project's technical feasibility and cost-effectiveness. • Includes estimating the project's potential revenues and determining the cost of project investment, maintenance, and operations, which will give the province an indication of how much subsidy it may have to provide to sustain the project's operations and maintenance.
	COMPREHENSIVE PED	**JUDGE** it fairly	• Involves determining how much benefit society can really derive from the project's output. This is done by estimating the project's economic costs and benefits and undergoing benefit-cost, risk, and sensitivity analyses.

Source: NEDA-ADB, 2007

These PED procedures cover many tools that can be used to mainstream DRR with little or no modification. Examples of these tools are analyses of market situation, technical feasibility, financial and economic viability, risk and sensitivity, and externalities. The project identification undertaken at the planning stage, the stages of PED procedures, and the development of the logical framework and project proposal are the key entry points at which disaster risk issues can be factored into PED. These are shown in detail in Table 6.2.

Table 6.2 Entry Points of Disaster Risk Reduction (DRR) in Project Evaluation and Development

Entry Points	Actions/Considerations
PED Stage 1: Knowing the Project	• Identify the project's outputs and characterize how disaster risks affect the tradeability, nontradeability of a good. • Given presence of natural hazards, is it appropriate to charge a users fee and other pricing considerations?
PED Stage 2: Understanding the Project	• What is the rationale for the project and how relevant is it under situations where natural hazards are prevalent? • How vulnerable to disasters is the sector to which the project belongs? • What will be the effect of disasters to the outcome of the project? How will it affect the contribution of the project's outcome to meeting the project goals? • Will the project's outputs still result in the expected outcome if disasters occur? • How does disaster affect the mobilization of inputs that are needed to produce the output? • Is disaster risk included as an important assumption? • Are there verifiable indicators that point out effects of disaster risks? • Does the project consider setting "acceptable levels" of risk? • How will one measure accomplishment in terms of managing risks? • What is the likely trend of the outcome if the project is always affected by disasters? • Describe how disaster risks affect the current situation. • Forecast what the project outcome will be in the future if a disaster will happen. • Does the project have an alternative strategy of instituting the proper policy and regulatory framework in order to produce the same outcomes to mitigate disaster risks?
PED Stage 3: Analyzing it thoroughly	*Market Analysis* • What is the market situation of the project's output? How will hazards/disasters affect this market situation? • How will demand for the project's output be affected by hazards? • How do hazards affect the current supply of good similar to the project's output? How does disaster affect the price of the good being sold? • How do hazards/disasters widen the supply gap? • What is the effect of disasters to the responsiveness of the level of demand to the price of the good? • What is the effect of disasters to the responsiveness of the level of current supply to the price of the good? *Technical Analysis* • Does the project design incorporate formulations of disaster risk scenarios and models? • Have the components and activities of your project been designed to resist the hazard impacts? Do they contribute to reduction of risks and vulnerability? • Is the project still technically feasible given risk of natural hazards? • Is it still the best alternative to meet project objectives?

Entry Points	Actions/Considerations
	Financial Analysis • How will natural hazards or disasters affect the project cost? How will natural hazards or disasters affect the sustainability of project operations? • How much is needed to operate and maintain the project in usable form? How much more is needed if disasters occur? • Can the project still pay for itself if disaster occurs? • Is there allocation for periodic maintenance to ensure changing risks are addressed? • Will the local government be willing to subsidize its operations and maintenance given disaster risks? By how much? • Does the project incorporate any instruments for its financial protection (e.g., insurance)?
PED Stage 4: Judging it fairly	*Economic Analysis* • In the case of DRR projects, establish economic demand or need for the project and grounds for public sector involvement. • Undertake 'with-without' analysis for DRR projects and explore project alternatives. Consider DRR in exploring project alternatives for all other development projects in hazard-prone areas. • Include expected costs and benefits of any DRR measure. • Explore what size of error in the estimation of disaster risk would make the project economically unviable/non-sustainable or require further action to strengthen resilience. • Explore potential shifts in hazard vulnerability between groups (e.g., towards lower-income groups) as a consequence of the project. • Take into account both cost-efficiency findings and other non-economic factors in selecting the preferred project alternative. The following questions may also be considered in the analysis: • How will disaster risk be factored in the true cost of the project to society? • How will disaster risk affect the cost of the good at the project site? • How much is the benefit of the project truly worth to society prone to natural hazards? • Will the economic benefits of the project outweigh its economic cost, which includes disaster risks? *Analysis of Externalities* • Will any of the project's activities and outputs pose a hazard to the environment? • What are the potential risks to other people's health, lives, and property? • What are the potential risks to various population groups (e.g., women, physically challenged, children)? • How can these hazards be mitigated and if possible, prevented? • How much is the cost of mitigation and/or prevention? • Will any of the project's activity and output generate benefits even to the unintended beneficiaries of the project? *Environmental Impact Assessment (EIA)* • Include information on natural hazards in the project area. • Identify significant hazards, scenarios and related vulnerability. • Consider potential impact of project on hazard vulnerability and disaster risk in determining level of environmental screening required. • If hazard-related issues are significant, include them as key issues to be addressed in the environmental assessment. • Assess impact of project on vulnerability and potential impact of hazard events on the project, evaluate mitigation options, select preferred option and determine feasibility. • Is the management of disaster risk options acceptable to proponent and public? *Social Impact Assessment (SIA)* • Involve the public by identifying and working with all groups that may be exposed to greater (or lesser) hazard risk as a result of the project. • Identify potentially key types of social impact, including those related to disasters, and identify data requirements for an SIA. • Collect and review relevant data on the geographical and human environments related to the project • Identify potential hazards and associated risks that might affect the project and communities at any stage of the project. • Develop scenarios of the social consequences of exposure to hazards identified. • Assess the response of all affected groups in terms of attitude and actions. • Is the management of disaster risk options acceptable to proponent and public?

Entry Points	Actions/Considerations
	Risk and Sensitivity Analysis • Is the project worth pursuing even if it will be often affected by disasters? • How sensitive is the project given the changes in hazard conditions or disaster events? • What are the risk-mitigating components that should be included to reinforce the project? • Are the needs of female household heads taken into account when developing risk management activities? Have women-specific issues been taken into account?
Other aspects of PED: Logical Framework Analysis (as input to Stage 2)	• Consider natural hazards and related vulnerability in examining the project's broader context. • Cover disaster-related issues in determining stakeholder interests and concerns, ensuring in particular that hazard-vulnerable groups in the project area are included in these consultations. • Consider disaster-related issues in exploring causes and effects of the central problem addressed by the project. • Take disaster-related factors into account, as appropriate, in determining the project goal, purpose, and outcomes. • Consider both potential disaster risk reduction activities and potential impacts of other possible project components on vulnerability to natural hazards. • Include relevant indicators to monitor and evaluate any DRR components. • Consider disaster-related factors in identifying critical risks and assumptions, developing a risk management plan and establishing risk indicators.
Other aspects of PED: Project Proposal Preparation	Ensure that issues relating to the management and reduction of risk are covered in the draft project proposal, in the following important sections: • Problem identification • Activities • Assumptions • Risks • Sustainability factors
	Consider management of risk reduction in the analysis of the project proposal. Analyze in particular: • All relevant problems linked to risk management • Verify if there are "killer assumptions" connected to risk management (i.e., vital conditions that have not been verified that could put a project or some of its activities at risk from the start. (e.g., assuming flood design heights and flood sources without supporting studies) • If risk management has been fully taken into account regarding the sustainability of the intervention
Other aspects of PED: Terms of Reference (TOR) for Pre-feasibility Studies	In terms of reference (TOR) for developing preparatory and pre-feasibility studies, include questions such as the following: • Are natural hazards capable of creating disasters relevant factors in this project? Which ones, and why? • Could the project increase risk? • What risks could have a direct impact on the project? • What could be the potential impact of the project in preventing disasters? • Ensure consultation with relevant organizations • Include risk management and reduction as a specific point in donors' key issues and guidelines • Make reference to studies, reports and relevant data, and consult with relevant organizations

Source: Provention, 2006

E. PROJECT IMPLEMENTATION, MONITORING AND EVALUATION

The PPAs and their DRR project components need to be monitored during implementation using the selected performance and risk indicators and make any adjustments in inputs, activities, targets and objectives as may be necessary. The logical framework or logframe should be used as basis for monitoring and evaluation. Some key questions are:

- Were disaster risks and related assumptions accurately assessed during the implementation?
- Were disaster risks appropriately and cost-effectively addressed by the project?
- What are the benefits and achievements of any DRR components?
- Were the selected disaster risk-related performance and risk indicators sufficiently relevant and informative?
- How did the impacts of any disasters occurring over the course of the project affected its outcome and achievements?
- Is the sustainability of the project's achievements potentially threatened by future hazard events?

Project outcomes and impact will provide information if risks have been reduced in terms of increased resilience (or decreased vulnerability) of population and property. This information should feed into the next cycle of the risk assessment and development planning process.

Annexes

ANNEX 1

NATURAL HAZARDS: AN OVERVIEW[1]

Planners are not expected to become experts on hazards, but they should have sufficient understanding on how, why, and when hazards occur. This annex shall familiarize the users of the Guidelines on the science and behavior of natural hazards, and enable them to analyze and interpret hazard maps.

The natural hazards considered in the Guidelines pertain to events arising from geologic and hydrometeorologic processes that have the potential of causing deaths, injuries and damage to property. Hazards from these two main groups may occur independently of each other or may result as the consequence of one event or a chain or series of events. For example, rainfall and a volcanic explosion are separate events and the occurrence of one may not be triggered by the other. However, strong rainfall occurring over areas covered by sediments and ash from a recent volcanic eruption may cause lahars (mud flows) raging down slopes of areas and through natural courses of water, which may subsequently cause flooding and deposition of materials in low-lying areas.

While the Guidelines estimate risks based only from a single hazard event, it should not prevent the planner from determining which events in the hazard chain are likely to cause more damage or loss. With the help of hazard experts, planners should be able to identify, describe and assess the hazard events in the chain that will most likely result in greater risks to life and property.

In a chain of hazard events, it is difficult to assign probabilities of occurrence and the fatality and property damage risks, since it is likely that sufficient information may not be available to pinpoint which event in the chain had caused the damage.

A. GEOLOGIC HAZARDS

Geologic hazards result from geologic processes acting on or beneath the earth's surface. These include movement of plates in the earth's crust or from local concentrations of heat and are a source of hazards to people and their natural and built-up environment on the earth's surface (Kramer, 1996).

[1]This annex incorporates the main points of the lectures on Overview of Natural Hazards and Hazard Mapping of Dr. Renato U. Solidum, Jr., Director of the Philippine Institute of Volcanology and Seismology (PHIVOLCS), Department of Science and Technology in the five batches of Training on Mainstreaming Disaster Risk Reduction in Subnational Development and Physical Planning conducted in 2008 as part of the process for the preparation and review of the Guidelines.

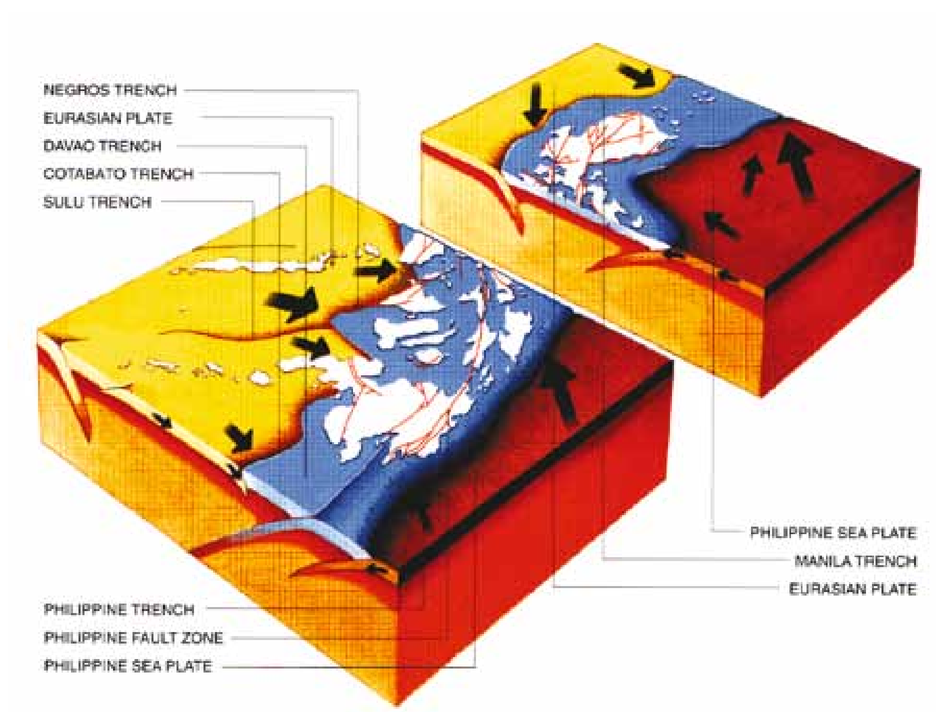
Geologic hazards covered in the Guidelines are limited to two classifications: those caused by earthquakes (ground shaking, ground rupture, earthquake-induced landslide, liquefaction) and those caused by volcanic eruptions.

1. EARTHQUAKE AND EARTHQUAKE-INDUCED HAZARDS

An earthquake is a weak to violent shaking of the ground produced by the sudden movement of rock materials below the earth's surface (L. Bautista, 2008). Earthquakes are caused either by the sudden movement along faults and trenches (tectonic), or by the movement of magma beneath volcanoes (volcanic). Faults are fractures in the earth's surface where rock movement has taken place and earthquakes produced.

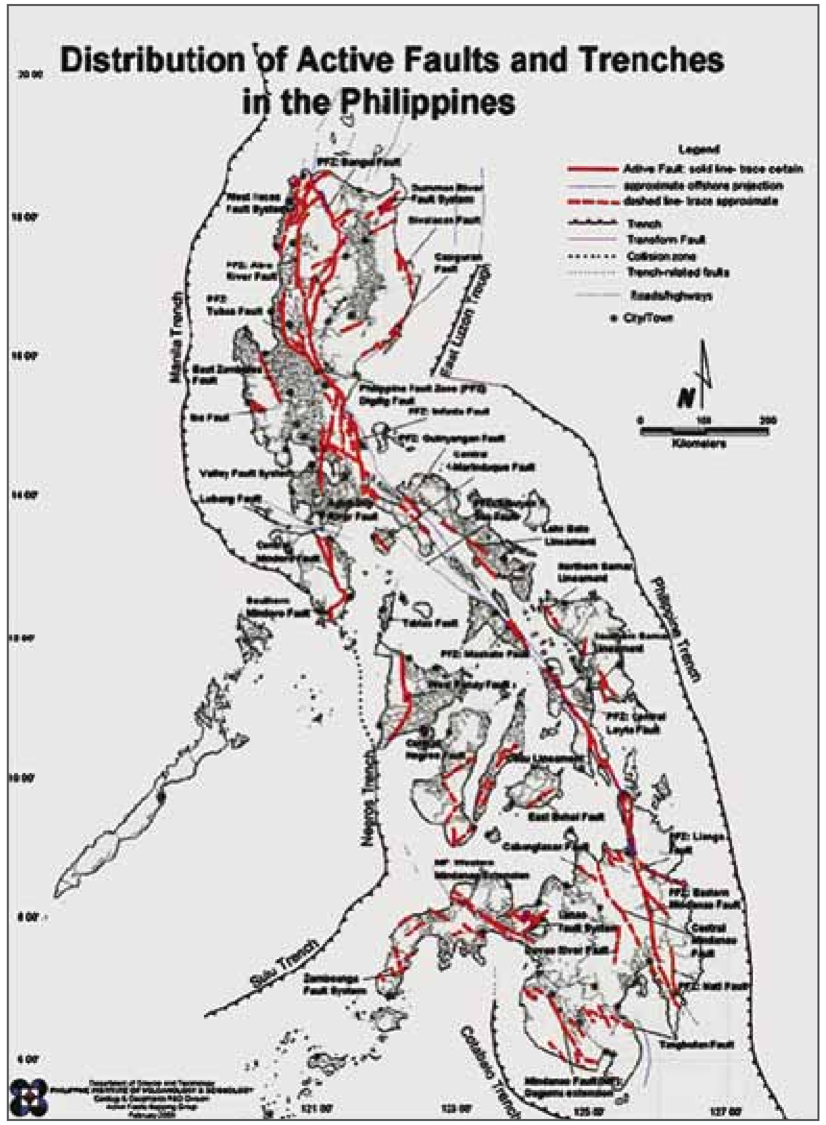
Two tectonic plates sandwich the country – the Philippine Sea Plate to the east and the Eurasian Plate to the west (Figure A1.1). Between these two plates is found the Philippine Fault Zone, where the country's most active faults are located, namely, Abra River Fault, Tubao Fault, Digdig Fault, Central Leyte Fault, Mindanao Fault, Mati Fault, and the West Valley Fault. Figure A1.2 shows the location of active faults and trenches in the Philippines.

Figure A1.1 Tectonic Plates Affecting the Philippines



Source: Philippine Institute of Volcanology and Seismology (PHIVOLCS), 2006

Figure A1.2 Distribution of Active Faults and Trenches in the Philippines

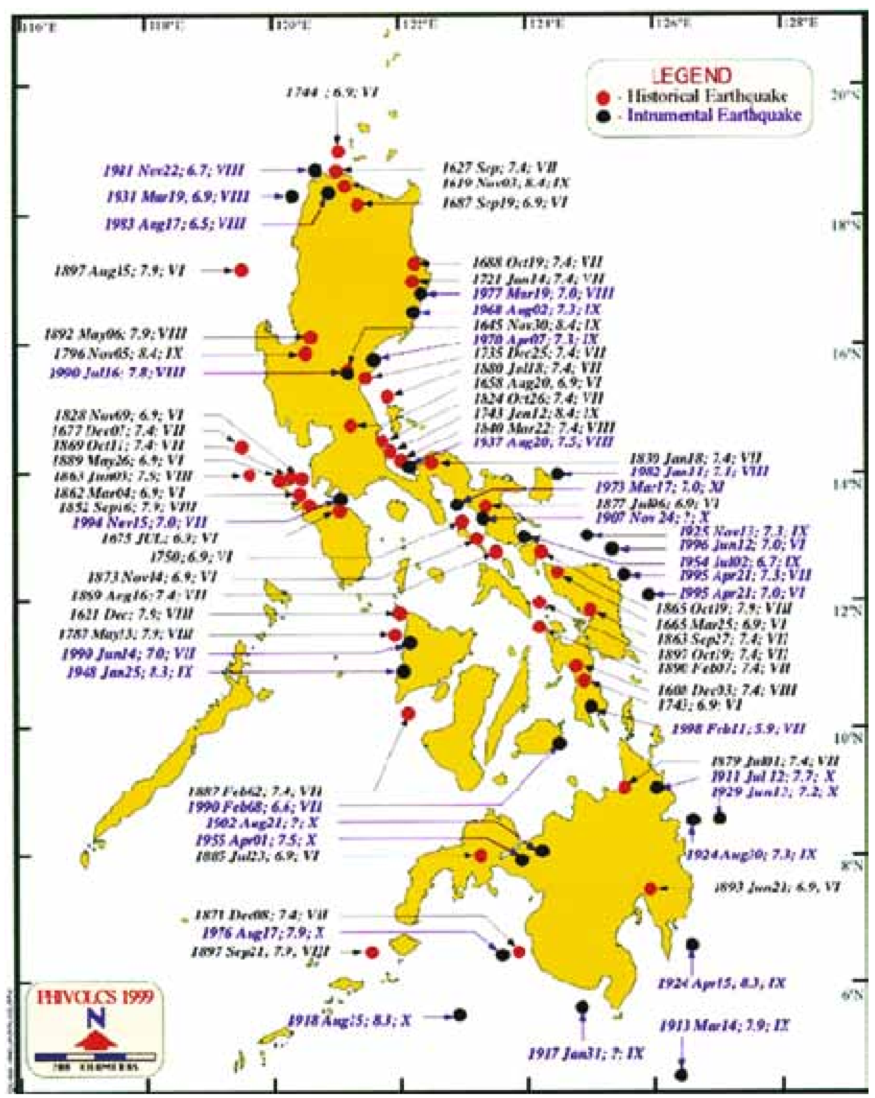


Source: PHIVOLCS

Movements along the active faults are responsible for the present-day high seismicity of the Philippine Archipelago. Earthquakes generated by movements along faults are all shallow-seated (from 0 to 70 km deep). Very destructive earthquakes may originate from fault movements occurring at less than 30 km. If strong shallow earthquakes occur under the sea and displace parts of the seabed, tsunamis are oftentimes generated.

Figure A1.3 provides a location map of historical and instrumental earthquakes that had hit the country. It reveals stronger earthquake sources which are near and aligned with the different active faults and trenches (Magnitude 6.9 and higher or Intensity VI and higher). It gives information on the range of magnitudes and intensities that had occurred near active fault lines and trenches of their area. Descriptions of the consequences may be referred to the PHIVOLCS Earthquake Intensity Scale in Table A1.2

Figure A1.3 Destructive Historical Earthquakes in the Philippines



Note: In red circle are pre-1900 events
Source: PHIVOLCS, 2008

Earthquakes trigger hazards that cause destruction to lives and properties. Hazards associated with earthquakes are commonly referred to as seismic hazards, such as ground shaking, ground rupture, earthquake-induced landslides, liquefaction and tsunamis. The following sections briefly describe these hazards and their possible impacts.

1.1. Ground Shaking

The main hazard created by seismic earth movements is ground shaking. This term is used to describe the vibration of the ground during an earthquake. During an earthquake, seismic waves travel rapidly away from the source and through the earth's crust. Upon reaching the ground surface, they produce shaking that may last from seconds to minutes (Kramer, 1996).

Earthquake strength is measured in terms of either its magnitude or intensity. Magnitude measures the total energy released at the earthquake's point of origin (below the earth's surface) based on information derived from a seismograph. It is typically reported in Arabic numerals (e.g., 6.3, 7.2). Table A1.1 provides a description of strength of the different earthquake magnitudes.

Table A1.1 Earthquake Magnitude and Description

Magnitude	Description
1	Not felt. Detected only by sensitive seismographs under favorable conditions.
2	Hardly perceptible. Detected by seismographs.
3	"Very feeble". Felt only near the epicenter.
4	"Feeble". Generally felt. But doesn't usually cause any damage.
5	"Moderate" earthquakes. May cause local damages.
6	"Strong" earthquakes. Usually cause local damages
7	"Major" earthquakes. Cause considerable, widespread damages. May be accompanied by surface fault rupture and tsunami
8	"Great" earthquakes. Potentially devastating.
9	Rare earthquakes. Only five recorded since 1900.

Source: PHIVOLCS

The other measure of earthquake strength is intensity. Intensity is the perceived strength of an earthquake based on relative effects to people and structures on the earth's surface. The intensity scale consists of a series of certain key responses such as people awakening, movement of furniture, and finally - total destruction. It is reported as Roman numerals. Note that assigning intensity levels generally does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

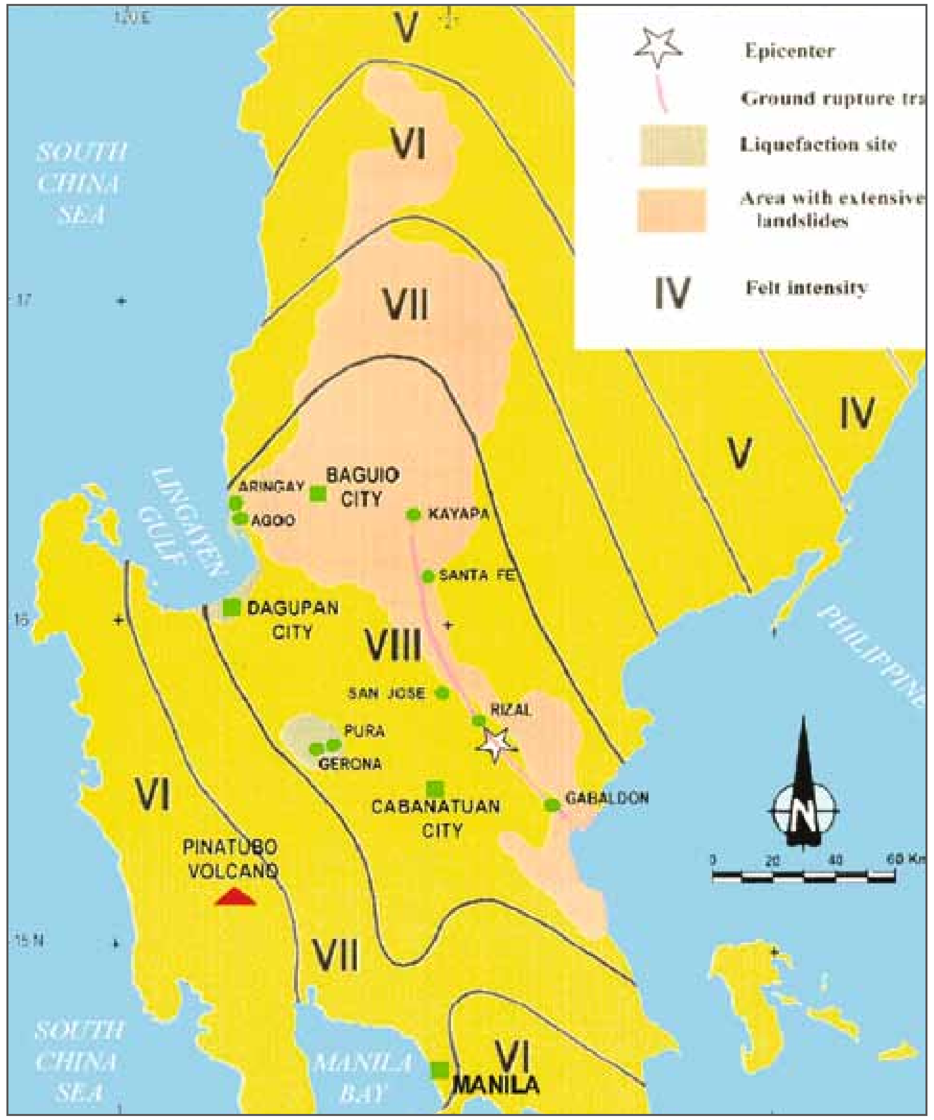
The Philippines uses the PHIVOLCS Earthquake Intensity Scale (PEIS) shown in Table A1.2, which helps explain the intensity assigned to a specified location based on observations made on the consequences from the earthquake event. Figure A1.4 provides an example of an assignment of different intensities, during the 1990 North Luzon Earthquake. Cities of Baguio, Dagupan and Cabanatuan and municipalities of Agoo, Aringay, Kayapa, Rizal, San Jose, Pura, Gerona and Gabaldon experienced an Intensity VIII earthquake, revealing very destructive conditions. Metro Manila, on the other hand,

Table A1.2 PHIVOLCS Earthquake Intensity Scale

PEIS	Description
I	**Scarcely perceptible.** Perceptible to people under favorable circumstances. Delicately balanced objects are disturbed slightly. Still water in container oscillates slowly.
II	**Slightly felt.** Felt by individuals at rest indoors. Hanging objects swing slightly. Still water in container oscillates noticeably.
III	**Weak.** Felt by many people indoors especially in upper floors of buildings. Vibration is felt like one passing of a light truck. Dizziness and nausea are experienced by some people. Hanging objects swing moderately. Still water in container oscillates moderately.
IV	**Moderately strong.** Felt generally by people indoors and by some people outdoors. Light sleepers are awakened. Vibration is felt like a passing of heavy truck. Hanging objects swing considerably. Dinner plates, glasses, windows and doors rattle. Floors and walls of wood framed buildings creak. Standing motor cars may rock slightly. Liquids in containers are slightly disturbed. Water in containers oscillates strongly. Rumbling sound may sometimes be heard.
V	**Strong.** Generally felt by most people indoors and outdoors. Many sleeping people are awakened. Some are frightened, some run outdoors. Strong shaking and rocking felt throughout building. Hanging objects swing violently. Dining utensils clatter and clink; some are broken. Small, light and unstable objects may fall or overturn. Liquids spill from filled open containers. Standing vehicles rock noticeably. Shaking of leaves and twigs of trees are noticeable.
VI	**Very strong.** Many people are frightened; many run outdoors. Some people lose their balance. Motorists feel like driving flat tires. Heavy objects or furniture move or may be shifted. Small church bells may ring. Wall plaster may crack. Very old or poorly built houses and man-made structures are slightly damaged though well-built structures are not affected. Limited rockfalls and rolling boulders occur in hilly to mountainous areas and escarpments. Trees are noticeably shaken.
VII	**Destructive.** Most people are frightened and run outdoors. People find it difficult to stand in upper floors. Heavy objects and furniture overturn or topple. Big church bells may ring. Old or poorly-built structures suffer considerable damage. Some well-built structures are slightly damaged. Some cracks may appear on dikes, fish ponds, road surface or concrete hollow block walls. Limited liquefaction, lateral spreading and landslides are observed. Trees are shaken strongly. (Liquefaction is a process by which loose saturated sand lose strength during an earthquake and behave like liquid.)
VIII	**Very destructive.** People panicky. People find it difficult to stand even outdoors. Many buildings are considerably damaged. Concrete dikes and foundation of bridges are destroyed by ground settling or toppling. Railway tracks are bent or broken. Tombstones may be displaced, twisted or overturned. Utility posts, towers and monuments may tilt or topple. Water and sewer pipes may be bent, twisted or broken. Liquefaction and lateral spreading cause man-made structures to sink, tilt or topple. Numerous landslides and rockfalls occur in mountainous and hilly areas. Boulders are thrown out from their positions particularly near the epicentre. Fissures and faults rupture may be observed. Trees are violently shaken. Water splash or slop over dikes or banks of rivers.
IX	**Devastating.** People are forcibly thrown to ground. Many cry and shake with fear. Most buildings are totally damaged. Bridges and elevated concrete structures are toppled or destroyed. Numerous utility posts, towers and monuments are tilted, toppled or broken. Water sewer pipes are bent, twisted or broken. The ground is distorted into undulations. Trees are shaken very violently with some toppled or broken. Boulders are commonly thrown out. River water splashes violently and slops over dikes and banks.
X	**Completely devastating.** Practically all man-made structures are destroyed. Massive landslides and liquefaction, large scale subsidence and uplifting of land forms and many ground fissures are observed. Changes in river courses and destructive seiches in large lakes occur. Many trees are toppled, broken and uprooted.

Source: PHIVOLCS

Figure A1.4 The 1990 Luzon Earthquake Intensity Map



Source: PHIVOLCS, 2008

experienced an Intensity VII earthquake revealing destructive conditions.

The one currently used in the United States is the Modified Mercalli Intensity Scale (MMIS) composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction. Table A1.3 presents an abbreviated description of the 12 levels of the MMIS.

Table A1.3 Modified Mercalli Intensity Scale

MMIS	Description
I	Not felt except by a very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Damage slight in especially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly-built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Damage considerable in especially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

Source: http://earthquake.usgs.gov/learning/topics/mercalli.php

The severity of the impact of ground shaking at any point depends on a number of factors, including magnitude of the earthquake, distance from the rupture and the local geological conditions, which may either amplify or reduce the earthquake waves (Kramer, 1996). One general observation is that damage is usually more severe for buildings founded on unconsolidated material than in rock (Kramer, 1996).

Typically, the nearer one is from the epicenter, the greater is the magnitude and the intensity. As one moves farther from the origin, the intensity decreases (Smith, 1996). Most of the memorable images of the 1990 North Luzon earthquake are the damage from structural collapse (e.g., low and tall buildings, towers and posts that tilted, split, toppled or collapsed, broken foundation of roads, railroad tracks and bridges, dislocated water pipes and other utility installations, and other forms of mass movement) which had resulted in a great number of fatalities and extensive economic loss.

1.2. Ground Rupture

Ground ruptures are new or renewed movements of old fractures along faults. The presence of ground rupture is evidence of an active fault. If it is in an area near a fault

line, then a strong ground shaking may result in damage. If structures rest on the fault line, they may be sheared off along the direction of the fault.

Neither damage nor loss of life is likely from a ground rupture unless houses, schools and other buildings are on top of an active fault. A buffer zone of at least 5 meters away from the fault trace is one mitigation measure to avoid loss or damage.

1.3. Earthquake-induced Landslides

The severe shaking in an earthquake can cause natural slopes to weaken and fail, resulting in landslides. Depending on the degree of ground shaking, level of susceptibility and soundness of structures, landslides can cause damage to infrastructure, such as cracking, toppling and even collapse; burying of settlements; or flooding in downstream areas due to deposition. Earthquake-induced landslides can be divided into three main categories: disrupted slides and falls, coherent slides, and lateral spreads and flows (Kramer, 1996).

Disrupted slides and falls include rock falls, rock slides, rock avalanches, soil falls, disrupted soil slides, and soil avalanches. These happen when earth materials are sheared, broken, and disturbed. These usually occur in steep terrain and can produce extremely rapid movements and devastating damage. Rock avalanches and rock falls have historically been among the leading causes of death from earthquake-induced landslides (Kramer, 1996).

Coherent slides generally consist of a few coherent blocks that translate or rotate on relatively deeper failure surfaces in moderate to steeply sloping terrain. They include rocks and soil slumps, rock and soil block slides, and slow earth flows. Most coherent slides occur at lower velocities than disrupted slides and falls (Kramer, 1996).

Lateral spreads and flows generally involve liquefiable soils. Sliding can occur on flat slopes and produce very high velocities due to the low residual strength of these materials.

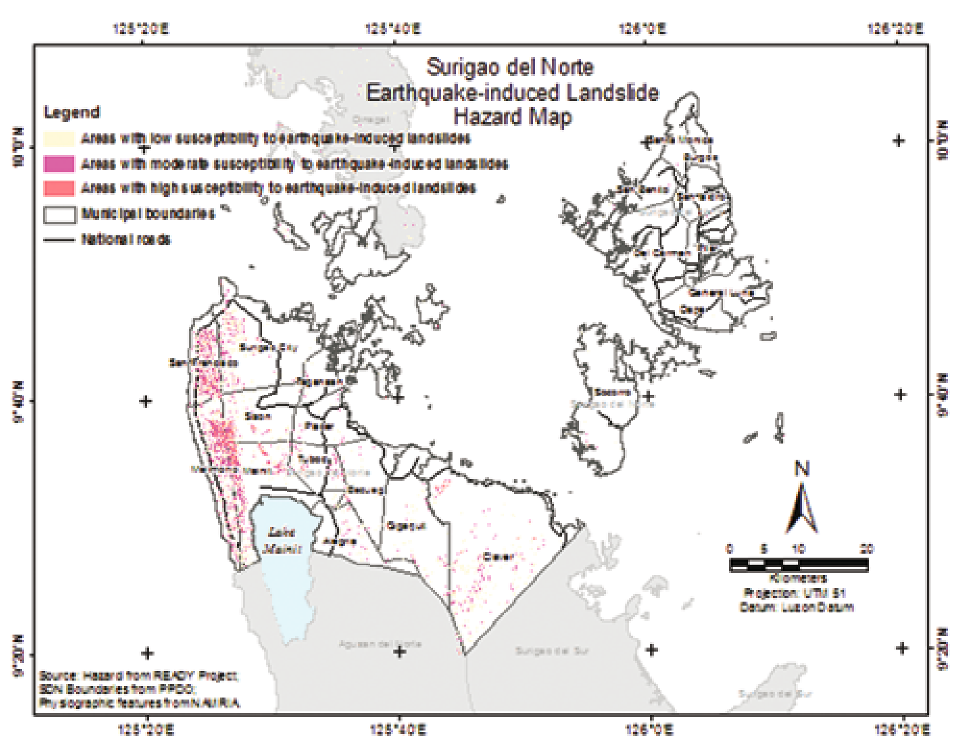
Occurrence of landslides during an earthquake is determined largely by local conditions. Many factors, including geologic and hydrologic conditions, topography, climate, weathering and land use, influence the stability of slopes and the characteristics of landslides. In general, landslides are likely to happen when the following conditions are present: thick soil cover or highly fractured soils, weathered rocks in the slopes, weak soils, steep slopes, highly saturated soils and strong earthquakes (Bautista, 2008).

Information on the susceptibility to landslides of a region or province has been mapped out by the Department of Environment and Natural Resources' Mines and Geosciences Bureau (DENR-MGB), an example of which is shown in Figure A1.5. The map shows areas in Surigao del Norte that are prone to earthquake-induced landslides, mainly in the municipalities of Alegre, Gigaguit, Claver, Sison and Mainit and Surigao City.

Information on landslides can be obtained from previously published documents such as geologic maps, soil survey and /or agricultural maps, topographic maps, natural hazard maps, and geological and geotechnical engineering reports. Other sources of information may include aerial photographs and other forms of remote sensing.

In the absence of maps, field scanning may be conducted to observe tell-tale signs of a landslide-prone area, although the final findings should be verified by hazard experts. Features such as scarps; tension cracks; bulges; hummocky terrain; displaced ditches, channels and fences; cracked foundations, walls, or pavements; and leaning trees or poles can be identified and mapped as evidences of instability. The locations

Figure A1.5 Earthquake-induced Landslide Hazard Map



Source: Hazard Map from READY Project, 2008

of streams, springs, seeps, ponds and moist areas as well as differences in vegetative cover can provide evidence of altered or disrupted water flow caused by slope instability (Kramer, 1996).

1.4. Liquefaction

Liquefaction is a process where particles of loosely-consolidated and water-saturated deposits of sand are rearranged into a more compact state. This results in the squeezing of water and sediments towards the surface in the form of "sand fountain" and creating a condition resembling "quicksand". In this phenomenon, the strength of the soil is reduced to a point where it is unable to support structures (Kramer, 1996).

Liquefaction commonly occurs in areas that are water-saturated (shallow water table), low-lying and situated in typically loose (unconsolidated) foundation or in sandy or silty deposits. Typical examples of these areas are river banks, abandoned rivers, flood plains, coastlines and swamps.

The liquefaction encompasses several related phenomena, among which are lateral spread, subsidence and sand boils.

Lateral spread involves the horizontal displacement of surface blocks as a result of liquefaction in a subsurface layer. Characterized by incremental displacements during earthquake shaking, it can produce a variable range of displacements. It can produce damage in the abutments, foundations and superstructures of bridges, pipelines, bridge piers and other structures with shallow foundations, especially those located near river channels or canal banks on floodplains (Kramer, 1996).

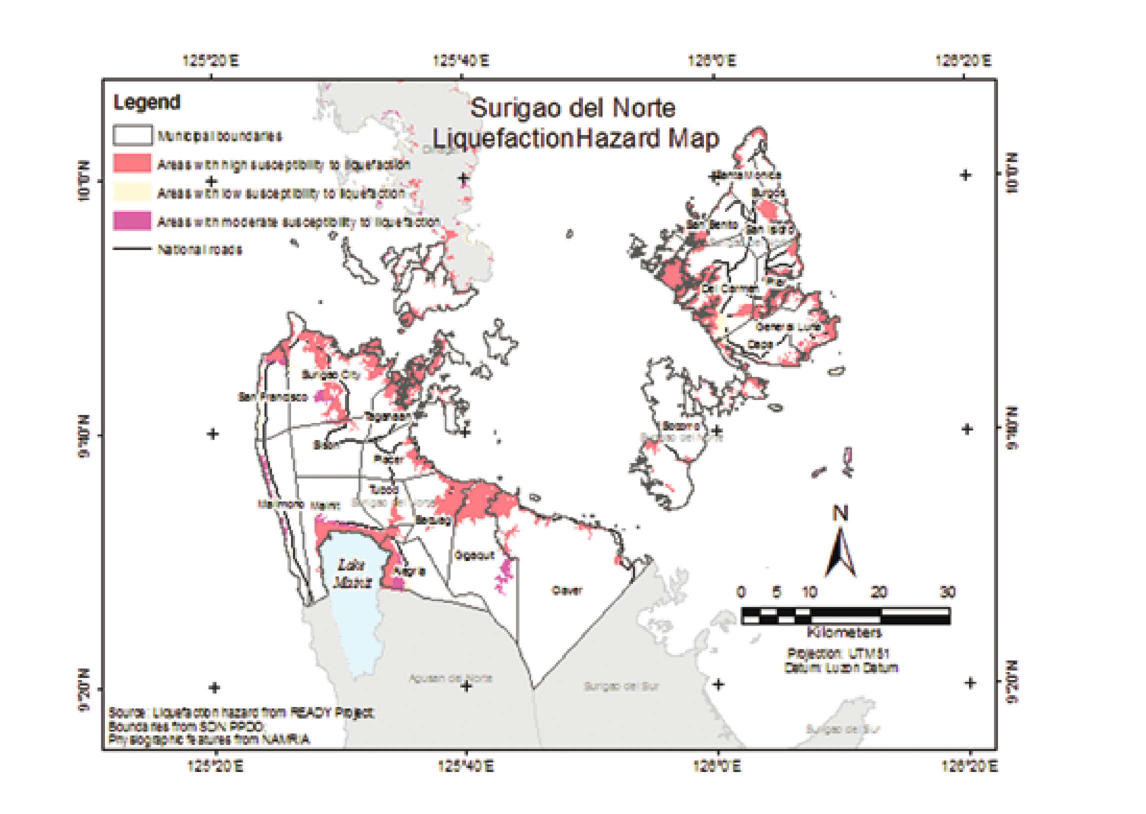
Loss of bearing strength usually occurs when a shallow layer of soil liquefies under a building. Large deformations within the soil mass (e.g., settling arising from rearranging, to loss of water pressure, compaction) cause structures to settle and tip arising from compaction.

Level ground liquefaction does not involve lateral displacements but is easily identified by the presence of sand boils produced by groundwater rushing to the surface. Although not particularly damaging by themselves, sand boils indicate the presence of high ground water pressures whose eventual dissipation can produce subsidence and damage differential settlements (Kramer, 1996).

PHIVOLCS has mapped areas susceptible to liquefaction in Surigao del Norte

(Figure A1.6). The map shows high and moderately susceptible liquefaction areas near downstream and coastal areas of Surigao City, Taganaan, Bacuag, Gigaquit, San Francisco, Malimono and municipalities of Mainit and Alegria. Structures on top of liquefaction areas can tilt or sink during major earthquakes.

Figure A1.6 Liquefaction Hazard Map



Modified from source: PHIVOLCS, 2008

1.5. Tsunami

A tsunami is a Japanese term for "harbor waves". This is a series of waves generated by various geological processes typically originating from vertical displacements of the ocean floor associated with a strong and shallow earthquake (Intensity VI and above). Though possible, less common sources of tsunamis are coastal or submarine landslides, infrequently by submarine volcanic eruptions and very rarely by meteor impact. Tsunamis may travel as fast as 880 kilometers per hour (kph) with wave heights of less than a meter in deep ocean. It slows down to around 80 to 45 kph near shorelines with much of its energy transformed to height increases of 10 to 30 meters. Given its speed coming from a nearer source, it may provide little warning and

evacuation time to nearby coastal municipalities as opposed to tsunamis originating farther offshore such as from other continents. Table A1.4 shows these two types of tsunami and existing warning mechanisms in the country.

Tsunamis can create extensive damage such as flooding of low-lying areas, drowning, erosion of the land, forceful impact on structures, uprooting of trees, and pollution of wells, among others. More recent tsunamis that occurred in the country are the 1992 Eastern Mindanao Tsunami, 1994 Mindoro Tsunami and the 1976 Moro Gulf Tsunami. The physical destruction from tsunamis occurs through various ways. Flotation

Table A1.4 Types of Tsunami and Existing Warning Mechanism for Tsunamis in the Philippines

Type	Source	Lead Time Earthquake to Tsunami	Existing Warning Mechanism
LOCAL	Trench or fault in Philippine region, usually less than 200 km from the shoreline	2-20 minutes	Community-based Must rely on natural signs such as moderate to intense shaking in coastal area, rapid sea level retreat or rise, unusual sound
DISTANT Regional or Trans-Pacific	Trench or fault outside the Philippine region (ex. 1960 Chile, Japan, Hawaii)	1-24 hours	International centers*: PHIVOLCS National Disaster Coordinating Council (NDCC) *Pacific Tsunami Warning Center, NW Pacific Tsunami Information Center

Source: PHIVOLCS

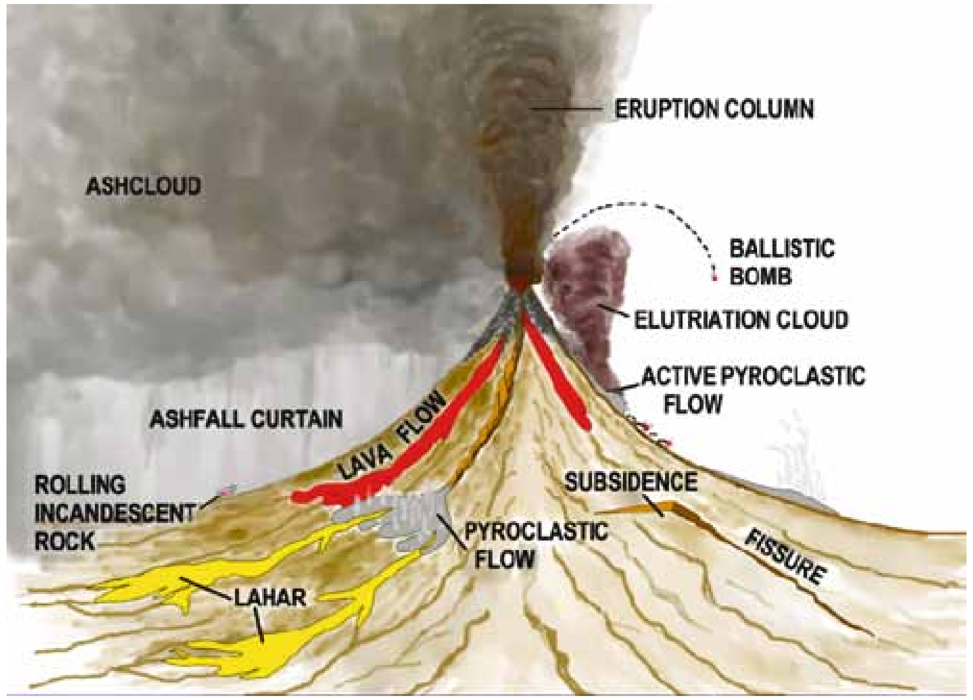
and drag forces can move houses. Flooding can turn floating debris, such as boats and vehicles, into projectiles and smash into other structures. Strong wave currents undermine harbor foundations and can lead to the collapse of bridges and sea walls. Fire and pollution often result from the spillage of oil and other toxic materials in storage places such as ports. A quantification of the risks from these different destructive events requires more documentation on local tsunamis in the country and was not included in the computation of risks in these Guidelines.

2. VOLCANIC HAZARDS

Volcanic hazards arise from active and potentially active volcanoes in the Philippines. *Active* volcanoes are those that erupted within historical times (within the last 600 years) such that, accounts of these eruptions were documented by man. Volcanoes that had eruptions within geological times (less than or equal to 10,000 years) are also called active. *Potentially active* volcanoes are morphologically young looking, but with no historical records of eruption. An *inactive* volcano has no recorded eruptions in the last 10,000 years.

Volcanic hazards may come from various possible activities, such as eruption and may come in the form of ash falls, ballistic bombs, pyroclastic flow, subsidence, fissures, rolling incandescent rocks and other wind- and rain-induced movements, like ash

Figure A1.7 Volcanic Hazards



Source: PHIVOLCS, 2008

curtains and lahars.

Volcanic hazards can be classified into primary and secondary phenomena. The primary phenomena include pyroclastic flows, air-fall tephra, lava flows and volcanic gases. Secondary phenomena include ground deformation, lahars, landslides and tsunamis and seiches.

Primary volcanic hazards are associated with the products ejected by the volcanic eruption. Explosive volcanic eruptions are usually accompanied by pyroclastic flows. The literal meaning of pyroclastic is “fire broken” (Smith, 1996). These flows result from frothing of molten magma at the vent of the volcano when gas bubbles expand and burst explosively to fragment the lava. Eventually, a dense cloud of lava fragments

is ejected to form a turbulent mixture of hot gases and pyroclastic material (volcanic fragments, crystals, ash, pumice and glass shards) which then flows down the flank of the volcano (Smith, 1996).

Airfall tephra comprises all the fragmented material, which is ejected by the volcano and subsequently falls to the ground. The materials spewn may range in size from so-called “bombs” (>32mm in diameter) to fine ash and dusts (< 4mm in diameter). The coarser, heavier particles fall out first close to the volcano vent, while the finer dust may be deposited as far as hundreds of kilometers away depending on wind directions (Smith, 1996). The degree of a hazard created by an air-fall tephra varies greatly. It can result in breathing problems for people; poor visibility; damage to roofs; damage to vehicles and utilities; and injury to grazing animals especially if tephra contains fluorine or other toxic chemicals, which can contaminate pasture and water supplies (Smith, 1996).

Lava flow is characterized by a quiet emission of fluid from the crater. This flow is channeled along gullies connected to the crater. The advancing flow may fill up these gullies and channels and eventually create new pathways. The flow may terminate at mid-slopes or at the base of the volcano depending on the fluidity and supply of lava.

Lava flows pose the greatest threat to human life when these emerge rapidly from fissure eruptions rather than from central-vent volcanic eruptions. The lavas may be fluid or viscous and are determined by its chemical composition, especially the proportion of silicon dioxide. Thick lava blankets sterilize the land for many years, creating food shortages and possibly famine (Smith, 1996).

Volcanic gases are released by explosive eruptions and lava flows. The gaseous mixture commonly includes water vapour, hydrogen, carbon monoxide, carbon dioxide, hydrogen sulphide, sulphur dioxide, sulphur trioxide, chlorine and hydrogen chloride in variable proportions (Smith, 1996).

Among the secondary volcanic hazards, ground deformation arises from the volcano growing from within by magma intrusion and as layers of lava and pyroclastic material accumulate on surrounding slopes. It may result in overloading and over-steepening of slopes that may eventually lead to mass movement (landslides) or failure of volcanic edifices.

Lahars or volcanic mudflows occur widely on flanks of volcanoes. Lahars may occur in association with any volcanic event, whether explosive eruption or effusive lava flow (Smith, 1996). The widespread accumulation of volcanic ash in lowland valleys commonly results in an increased threat of river flooding and sediment redeposition. Lahars can be more devastating than other hazards because these can affect low lying and populated areas far from the volcano (PHIVOLCS, 2008).

It is important to map volcanic hazards so that proper measures, such as evacuation, are put in place should eruptions happen. In the case of Mayon Volcano, PHIVOLCS has designated a 6-km radius permanent danger zone where settlements and economic activities are not allowed or are restricted. This zone is reflected in Figure A1.8.

The map in Figure A1.8 also shows three levels of susceptibility from ashfall from Mt. Mayon medium–scale eruption events. The red circle shows the first danger area, i.e., permanent danger zone while the red dashed outline indicates additional areas highly susceptible to pyroclastic (air-borne volcanic debris) and lahars (lava flows) and liable to be evacuated during eruptions. Settlements on the flanks of volcanoes and lying in the historical paths of mud and lava flows are naturally in danger. Also contributing to risks are structures with roof designs not resistant to ash accumulation, the presence of combustible materials, and the lack of evacuation plan or warning systems.

B. HYDROMETEOROLOGIC HAZARDS

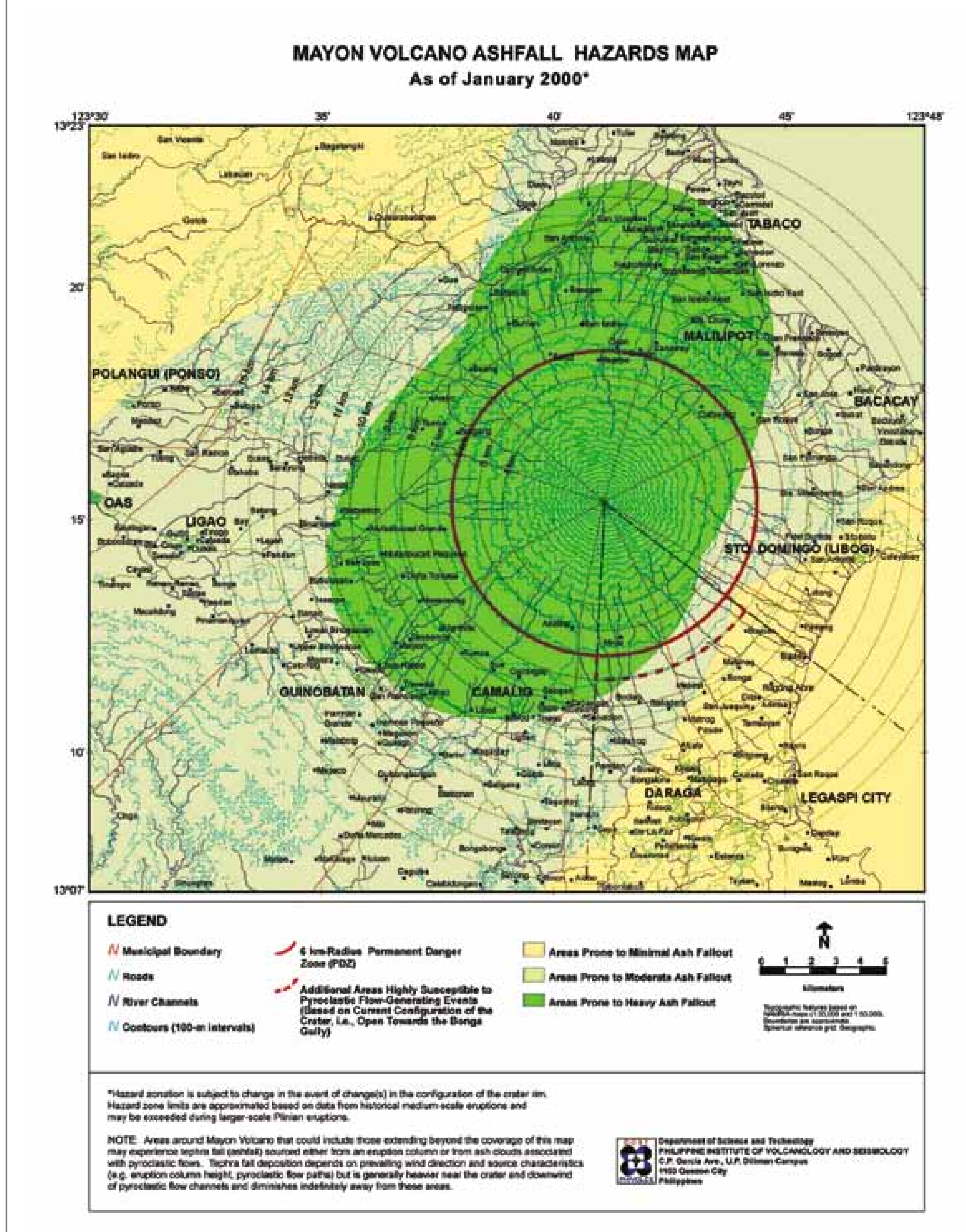
Hydrometeorologic hazards are natural processes or phenomena of atmospheric, hydrologic or oceanographic nature, which may cause loss of life, injury, property damage, social and economic disruption or environmental degradation. Hydrometeorologic hazards can be single, sequential or combined in their origin and effects (United Nations International Strategy for Disaster Reduction, 2004).

Hydrometeorologic hazards include: floods, debris and mud floods; tropical cyclones, storm surges, thunder/hailstorms, rain and wind storms, blizzards and other severe storms; drought, desertification, wildland fires, temperature extremes, sand or dust storms; permafrost and snow or ice avalanches.

Of the hazards under this origin, three were covered by the Guidelines, i.e., storm surge, floods and flashfloods, and rain-induced landslides.

Typhoons, cyclones, tornados are considered as hazard triggers, much like earthquakes that trigger ground shaking. The impact of typhoons, for example, is

Figure A1.8 Volcanic Ashfall Hazard Map



Source: PHIVOLCS, 2008

manifested by damage or loss caused by the flooding after extreme rainfall, or by rain-induced landslides. Wind-related damage from typhoons is not included in the risk assessment because of the complexity of establishing relationships of wind magnitude, duration, impacts and frequency for local conditions. These are subjects of further studies and readers are referred to mandated agencies, e.g., Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) and NDCC, for consultation on loss and damage assessments. While damage from typhoons (wind-related impacts) are important, records of past damage can qualitatively describe areas affected and corresponding impacts from each event can be considered. Hence, it is important to keep incident or damage assessment reports for each municipality as these can be useful for establishing correlations with hazard character and frequency.

1. STORM SURGE

A storm surge is an offshore rise of water associated with a low pressure weather system, typically a tropical cyclone. Here, high winds push on the ocean's surface and causes water to pile up higher than the ordinary sea level. Storm surges have been known to damage nearby coastal structures as a result of wave impact and debris (e.g., boulders, corals) carried by the surge. It can also cause coastal flooding which is especially enhanced when surges happen during high tides. Storm surges are worst when the seafloor slopes gently.

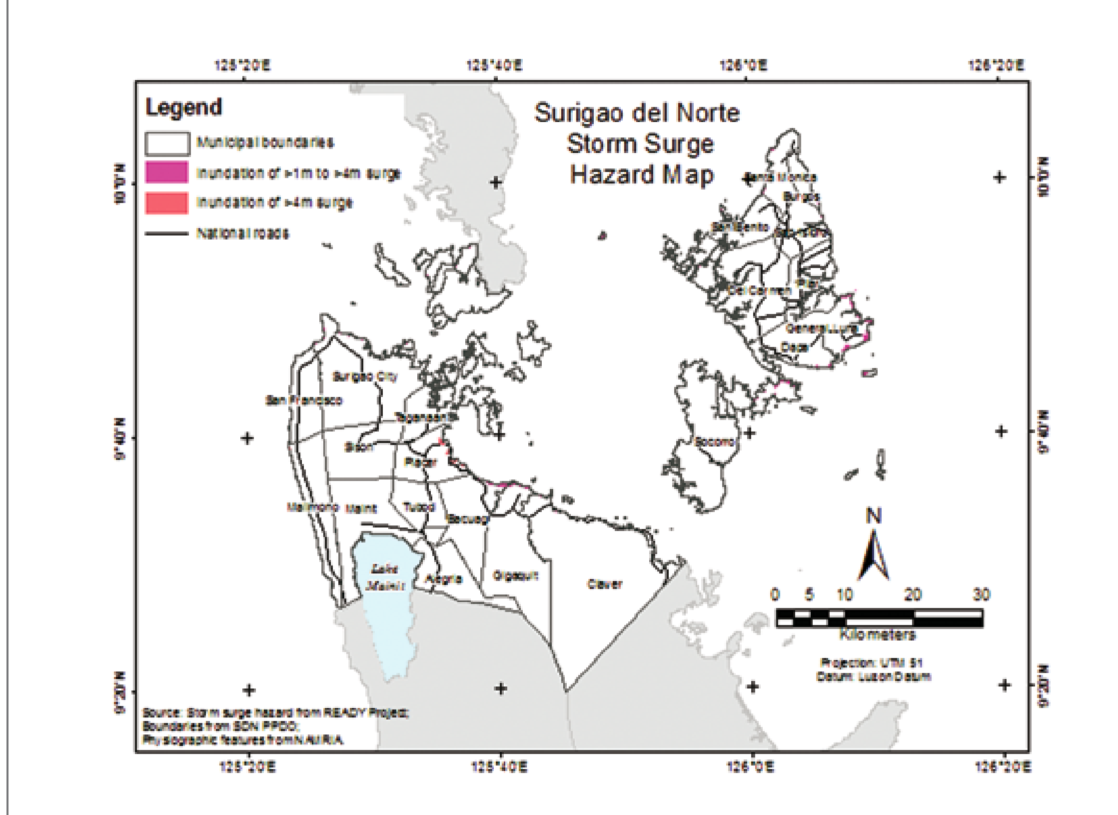
Figure A1.9 is an example of a Storm Surge Hazard Map prepared by PAGASA. From the map, one can conclude that storm surges affect most of the eastern coastlines of Surigao del Norte. Damage and loss in these areas generally arise from stronger tropical cyclone affecting shallow coasts, and possibly from the rise in sea level that can cause flooding and damage in low-lying coastal areas, particularly when the approach of the storm coincides with the occurrence of high tide.

Having settlements in storm-surge zones, lack of resistant buildings as well as timely warning systems and evacuation plans, and low public awareness of destructive forces of storm surges are likely to increase vulnerabilities to this hazard.

2. FLOODS AND FLASHFLOODS

Floods are characterized by a rise in the water level when a body of water, such as a river or lake exceeds its total capacity. Having a slow build up and usually seasonal, floods have many causes. Heavy rains, whether sudden or prolonged, may create several

Figure A1.9 Storm Surge Hazard Map



Modified from Source: PAGASA, 2008

scenarios of flooding and its impact depends also on artificial or human interventions. Although their rise may be gentle and slow, high tides may create floods near shores or lakes but do not cause much damage. The occurrence of high tides may be regularly predicted and hence their impact can be avoided.

Coastal floods occur when strong onshore winds push the water inland, causing a rise in sea level and flooding the low-lying coastal areas. Worst cases may occur if heavy rains coincide with the occurrence of high tide. Factors affecting the force of the hazard may include height of rise of water and velocity of incoming waves.

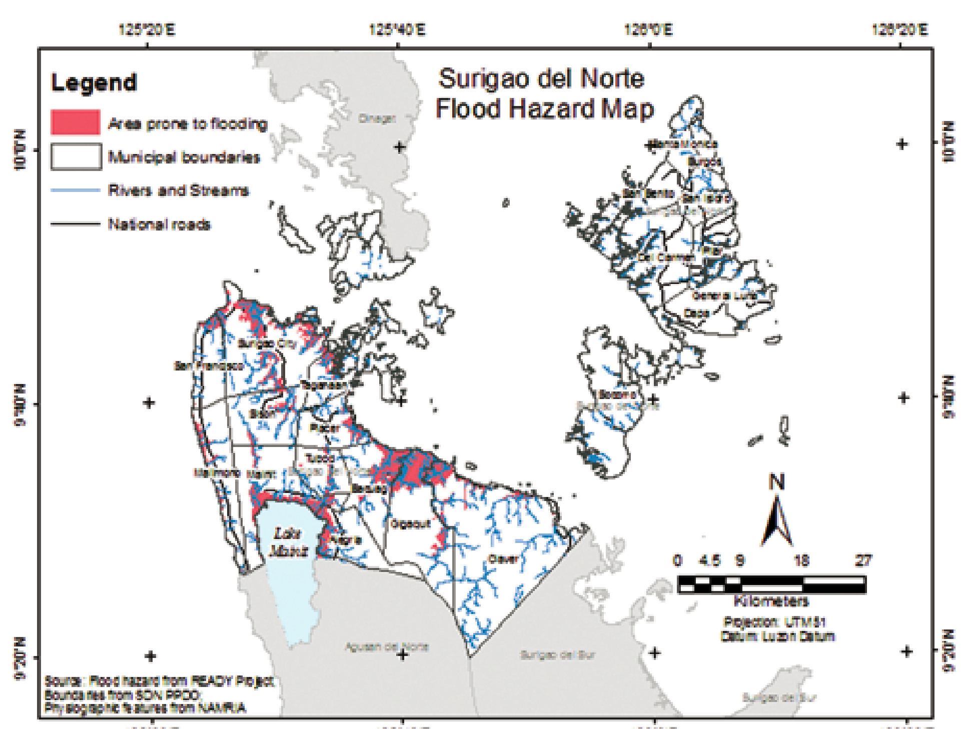
Riverine floods are typically caused by excess overland run-off and stream discharge, where the main channel capacity has been exceeded and hence overtops river banks and flows through its adjacent flood plains. Water rise varies with discharge, but flatter areas typically have higher depths of flow.

Flashfloods occur under various conditions. For example, these occur over steep river channel slopes, on areas with abrupt changes in elevation, and in narrow valleys or river areas which restrict flow of water resulting to damming action. A sudden discharge results in the possibility of accompanying debris materials. Typically these manifest sudden occurrence of floods that abruptly stop. Flashfloods are known to be damaging or destructive.

Other factors that may cause flood flows are dam breaches; blockages of channels arising from deposition of sediments, debris and the like; and the narrowing of sections along waterways like canals, bridges, and culverts which create fast waters in main canals and floodplains. Flooding also affects the land cover, e.g., agriculture, built-up areas, tree canopy, among others.

Figure A1.10 is an example of a Flood Hazard Map for Surigao del Norte that shows the different flood prone areas, typically in floodplains. Most of the areas are located downstream areas of rivers, such as Surigao City, Placer, Taganan, and Bacuag as well as in areas surrounding Lake Mainit. As shown in the map, flood area extents (in

Figure A1.10 Flood Hazard Map



Modified from source: PAGASA, 2008

red) spread laterally and adjacent to these river outlines. This may be caused by river overflow when run-off exceeds the capacity of the channels or when depression results in the flooding of the adjacent low-lying areas (e.g., floodplains).

3. LANDSLIDES

Landslides (or mass movement) are downward and outward movements of materials, including rock and soil due to various causes such as excessive rain, earthquake, volcanic eruption, rapid undercutting by rivers, waves or man's activities.

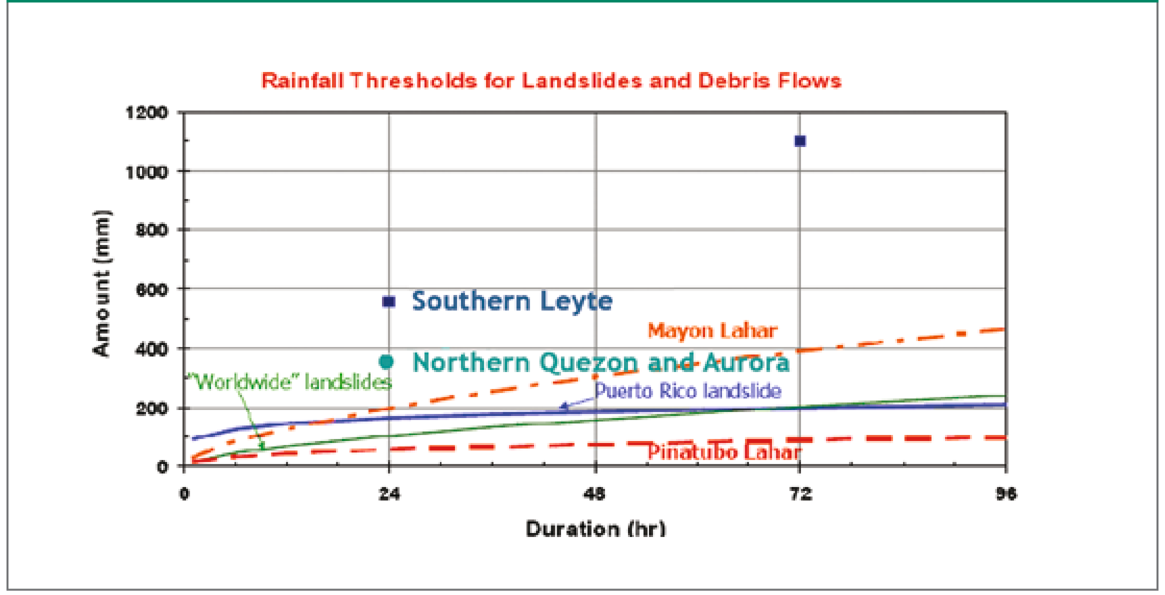
Areas prone to landslides typically include old landslide deposits along, near or beneath steep slopes and downslope of streams and creeks; thick soil or fractured rocks; those along or on top of cut slopes; and developed steep slopes with no appropriate drainage. Human activities sometimes contribute to the susceptibility of areas to landslides. Building structures around or on top of slopes, pipe leakages, septic system and irrigation discharges, and vibrations from machinery and from blasting can increase pressure and weaken the soil.

Rainfall thresholds for landslides, based on worldwide comparisons and trends, reveal that about 100 mm of rainfall per day could trigger a landslide. Based on this observation, independent studies by PHIVOLCS and their experts reveal that the amount of rainfall that triggered landslides in Southern Leyte (2003) and in the Northern Quezon and Aurora (2004) was more than three times the worldwide threshold (Figure A1.11). Mt. Mayon lahar flows showed about 200 mm rainfall per day and Mt. Pinatubo lahar flows were experienced under 100 mm rainfall per day. These figures reveal that rainfall thresholds vary from place to place.

A study by Matsushi (2006) further reveals that although the rainfall in excess of the threshold is necessary, it is not a sufficient condition for landslide occurrence. Other site-specific factors need to be considered as well, such as strength of slope materials or hill slope hydrological processes.

Matsushi's study on shallow landslides on soil-mantled hill slopes with permeable and impermeable bedrocks reveal that the critical combination of rainfall intensity and duration for the permeable sandstone slope recurs with a decadal return period (3 to 200 years), whereas the impermeable mudstone slope has a threshold with a yearly recurrence interval (1.1 to 3 years). The rainfall thresholds incorporate geotechnical soil properties and slope hydrological processes in each hill slope. The longer return period of the threshold implies the lower potential for landsliding, which corresponds

Figure A1.11 Volume of Rainfall, Southern Leyte (2003) and Northern Quezon and Aurora (2004) Compared to Worldwide Rainfall Thresholds



Source: PAGASA, 2008b

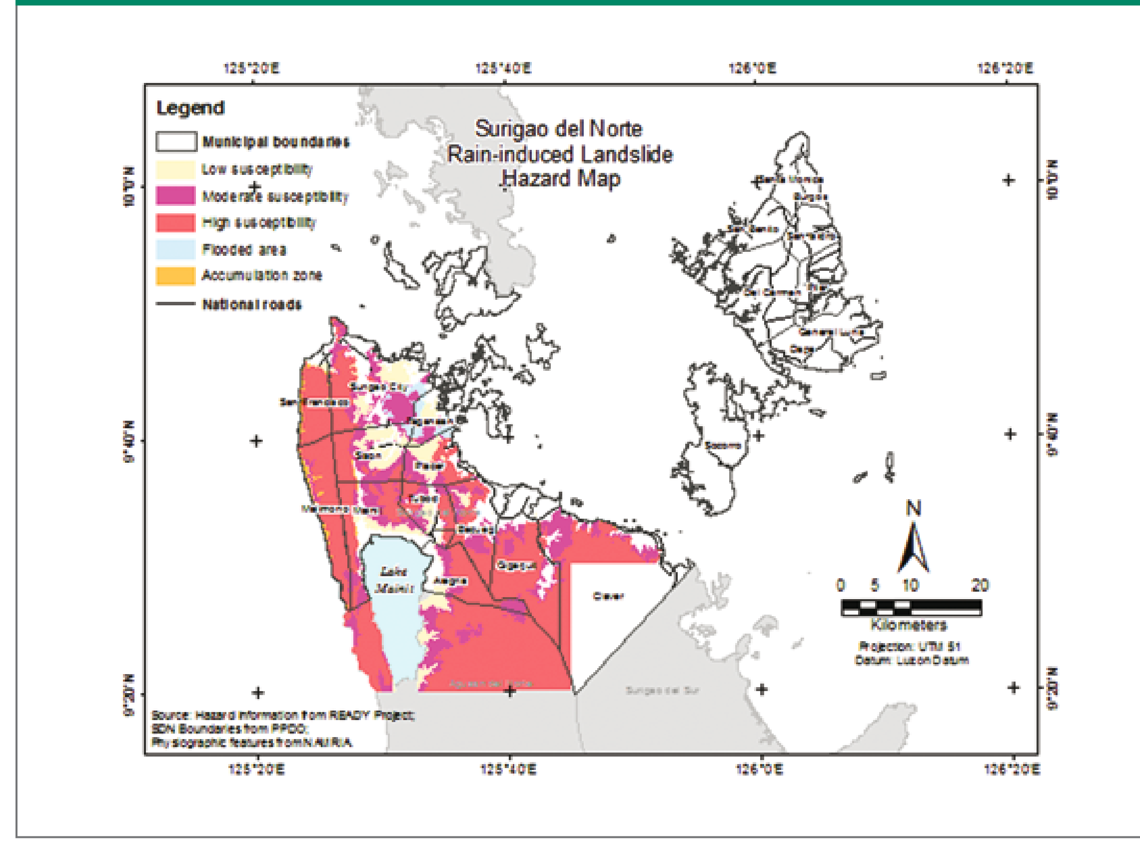
to the lower landslide activity in the hill slopes with permeable bedrocks. The study thus concluded that it is possible to relate the critical rainfall intensity-duration relationship of the type of soil to the rainfall intensity duration frequency information (RIDF) to develop the recurrence interval of the landslide-triggering rainfall.

The analytical procedure in the study for determining the site-specific threshold is applicable to any region where geotechnical soil properties and a certain amount of hydrological data are available. Given this information, residents living in the vicinity of hazardous areas may be able to evacuate following the warnings based on the site-specific critical combination of rainfall intensity and duration.

Figure A.1.12 is an example of a Rain-induced Landslide Map. Large areas in the Province of Surigao del Norte are prone to varying degrees of rain-induced landslides, especially those within moderate and steep slopes such as San Francisco, Malimono, Alegria, and Gigaguit, among others.

DENR-MGB has set four possible levels of susceptibility to landslides (Table A1.5). Each level was defined based on characteristics of slope, cracks, and recent landslide activities. Even without the benefit of a map, one can still identify active landslide areas by looking for cracks or scars, surface depressions, disturbance of the drainage patterns; hummocky topography; and ear-lobe like bulges near base of slopes.

Figure A1.12 Rain-induced Landslide Hazard Map



Modified from Source: DENR-MGB, 2008

Table A1.5 Landslide Susceptibility Levels

Susceptibility Levels	Description
High Susceptibility	Presence of active/recent landslides Large tension cracks that would affect the community Areas with drainages that are prone to landslide damming Steep slopes (21%-55% gradient)
Moderate Susceptibility	Areas with inactive and old landslides Small tension cracks are located away from the community Moderately steep slopes (15%-30%) Small, shallow landslides (< 1.0 m vertical displacement)
Low Susceptibility	Gently sloping to sloping Absence of tension cracks Flat terrain (5-15%)
Possible Accumulation zones	Areas to be likely affected by transported landslide materials

Source: DENR-MGB, 2008c

ANNEX 2
PROBABILISTIC TREATMENT OF HAZARD

This technical annex explains and illustrates the concepts of frequency analysis, return period and the probability of occurrence of hazard events and their application in estimating annual risks.

A. CONCEPTS OF FREQUENCY, RETURN PERIOD AND PROBABILITY OF OCCURRENCE

Table A2.1 is used herein as the working table. Hypothetically, the numbers represent the volume of water discharged from a river resulting in flood and taken to mean that each represents a hazard event (e.g., 38.50 million cubic meters hazard event in 1935 or simply 38.50 event). The material for this hypothetical example was expanded from an example of V.T Chow's Applied Hydrology (1988) on Frequency Analysis.

Table A2.1. Highest Volume of Water Discharged Resulting to Flood (in million cubic meters, MCM)

Year	1930	1940	1950	1960	1970
0		55.9	13.3	23.7	9.2
1		58.0	12.3	55.8	9.7
2		53.0	28.4	10.8	64.0
3		7.7	11.6	4.1	33.1
4		12.3	8.6	5.7	25.2
5	38.5	22.0	4.9	15.0	30.2
6	75.0	17.9	1.7	9.8	14.1
7	17.2	46.0	25.3	62.0	77.0
8	25.4	6.9	58.3	44.3	12.7
9	4.9	20.6	10.1	15.2	

1. FREQUENCY COUNT

To understand the flooding characteristics of the river, a frequency analysis is undertaken. The discrete interval used for the volume of water is 10.0 MCM (up to 80.0 MCM). Then the number of observations falling into each interval is counted. Table A2.2 is the working table for the frequency count. Note that, all in all, there are 44 observations. These are the highest volumes observed for each year.

2. FREQUENCY ANALYSIS

The number of observations, n_i, for a given interval, i, divided by the total number of observations, n, represents the relative frequency for that interval.

The relative frequency is also referred to as the probability, P, that the volume of water x will fall <u>within a given interval</u>, say $(a \leq x \leq b)$ is $P(a \leq x \leq b) = n_{(a \leq x \leq b)}/n$.

For example, $P(0 \leq x \leq 10.0) = 11/44 = 0.250$
$P(10.0 \leq x \leq 20.0) = 12/44 = 0.273$

The probability is a number between 0 and 1. For purposes of these Guidelines, the unit of the probability of occurrence is probability value per year.

Planners also refer to (or sometimes use interchangeably) relative frequency as probability.

Table A2.2 Frequency Count

Year	Volume (MCM)	0≤x ≤10.0	10.0<x ≤20.0	20.0<x ≤30.0	30.0<x ≤40.0	40.0<x ≤50.0	50.0<x ≤60.0	60.0<x ≤70.0	70.0<x ≤80.0
1935	38.5				*				
1936	75.0								*
1937	17.2		*						
1938	25.4			*					
1939	4.9	*							
1940	55.9						*		
1941	58.0						*		
1942	53.0						*		
1943	7.7	*							
1944	12.3		*						
1945	22.0			*					
1946	17.9		*						
1947	46.0					*			
1948	6.9	*							
1949	20.6			*					
1950	13.3		*						
1951	12.3		*						
1952	28.4			*					
1953	11.6		*						
1954	8.6	*							
1955	4.9	*							
1956	1.7	*							
1957	25.3			*					
1958	58.3						*		
1959	10.1		*						
1960	23.7			*					
1961	55.8						*		
1962	10.8		*						
1963	4.1	*							
1964	5.7	*							
1965	15.0		*						
1966	9.8	*							
1967	62.0						*		
1968	44.3					*			
1969	15.2		*						
1970	9.2	*							
1971	9.7	*							
1972	64.0							*	
1973	33.1				*				
1974	25.2			*					
1975	30.2				*				
1976	14.1		*						
1977	77.0								*
1978	12.7		*						
Total Number or Frequency		11	12	7	3	2	6	1	2

3. CUMULATIVE FREQUENCY

The sum of relative frequencies is referred to as cumulative frequency.

For example, the cumulative frequency of intervals (0≤x≤10.0) and (10.0≤x≤20.0) is represented by probability of the combined intervals, *P(x≤20.0)*.

$$(x\le 20.0) = \frac{n_{(0\le x\le 10.0)} + n_{(10.0\le x\le 20.0)}}{n} = (11+12)/44 = 0.523$$

Other combined probabilities are:

$$P(x\le 30{,}000) = 0.250+0.273+0.159 = 0.682$$
$$P(x\le 40{,}000) = 0.250+0.273+0.159+0.068+0.045 = 0.795$$

A graphical presentation of the cumulative frequency is shown in Figure A2.1.

Figure A2.1 Cumulative Frequency

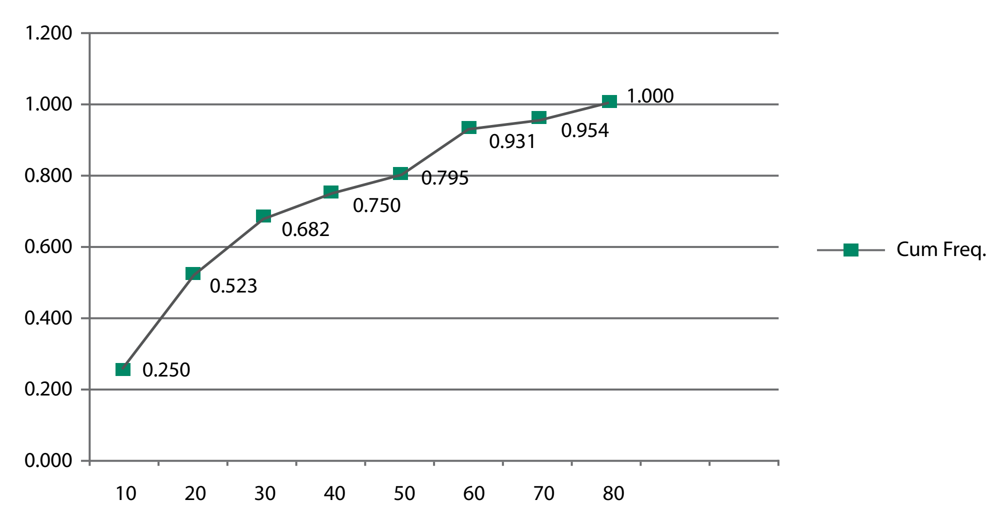


Table A2.3 is the summary table for the frequency, relative frequency and cumulative frequency for each of the identified intervals.

Table A2.3 Frequency, Relative Frequency and Cumulative Frequency

Items	0≤x ≤10.0	10.0<x ≤20.0	20.0<x ≤30.0	30.0<x ≤40.0	40.0<x ≤50.0	50.0<x ≤60.0	60.0<x ≤70.0	70.0<x ≤80.0
Frequency	11	12	7	3	2	6	1	2
Relative Frequency	0.250	0.273	0.159	0.068	0.045	0.136	0.023	0.046
	x ≤ 10.0	x≤ 20.0	x≤ 30.0	x≤ 40.0	x≤ 50.0	x≤ 60.0	x≤ 70.0	x≤ 80.0
Cumulative Frequency	**0.250**	**0.523**	**0.682**	**0.750**	**0.795**	**0.931**	**0.954**	**1.0**

4. RETURN PERIOD

As mentioned earlier, each of the observations in Table A2.1 represents a hazard event. *Would it be possible to know the return period or how often a hazard event represented by a certain volume of water, say x_T recurs?*

From Table A2.1, planners would like to know how often a volume of 50.0 MCM is equalled or exceeded between 1935 and 1978. Note that the first volume which exceeds 50.0 is 75.0 in 1936. The next is in 1940 when the volume was 55.9 MCM. This is interpreted to mean that it took four years when the 50.0 MCM-volume was equalled or exceeded. If one counts recurrences greater than 50.0 MCM, all in all, there were eight recurrences in a span of 41 years from the time the 50.0 MCM volume was equalled or exceeded. The recurrence is counted from the start where the 50.0 MCM was first encountered, so after 1936, the flow was exceeded in 1940, and is counted as one recurrence, between 1940 to 1941 is the second recurrence, 1941 to 1942 is the third recurrence, and so on.

This can also be done by subtracting 1 count of event from the number of events to the right of the 40.0<x≤50.0 range (i.e., 9 -1 =8 recurrences). The start of equalling or exceeding 50.0 MCM is 1936 and is last exceeded in 1977; hence, 1977-1936=41 years of observation. The average recurrence interval or the return period therefore is 41 years/8 or 5.1 years. The return period of the 50.0 MCM volume then is 5.1 or 5 years.

Using the same approach, determine the return period of 60.0 MCM volume event. Start counting recurrence with reference to the 75.0 MCM in 1936. The first recurrence was in 1972, then in 1977 totalling two recurrences. The period of observation is about 41 years starting from 1936. The approximate return period is 41/2 =20.5 yrs or about 21 years.

> The return period, *T* of an event of a given magnitude may be defined as the average recurrence interval between events equalling or exceeding a specified magnitude. The probability of occurrence is related to the return period by *1/T*. *1/T* is also referred to as probability of exceedance.
>
> Hence, under these Guidelines, the probability of occurrence of an event is also referred to as its probability of exceedance.

To show that the probability of occurrence or the probability of exceedance is the inverse of the return period or *1/T*, go back to the cumulative frequencies, as follows:

$P(X \leq 10.0) = 0.250$ (a)
$P(X \leq 20.0) = 0.682$ (b)
$P(X \leq 50.0) = 0.795$ (c)
$P(X \leq 60.0) = 0.931$ (d)

(c) means the probability that a volume X falls within the interval 0 to 50.0 MCM is 0.795 or the probability that the 50,000 volume will not be exceeded is 0.795.

Conversely, the probability that the volume X exceeds the 50.0 MCM volume is 1-0.795 or equal to 0.205. This is the probability of exceedance used in estimating return period. For the 60.0 MCM, the probability that the volume X exceeds the 60.0 MCM is 1-0.931 =14.5 or 15 years.

Taking the reciprocal of 0.205, one gets 4.88, or approximately 5. Based on simple scanning or "eyeballing" of Table A2.3, this is the return period identified as return period of the 50.0 MCM volume flood. Note however that with few observations made with higher events, the return period contains differences with the two approaches. For example, using the counting of recurrence intervals earlier, the return period is 21 years, while the probability of exceedance gives 15 years. The discrepancy is attributed to shortness of period of observation over higher return period events.

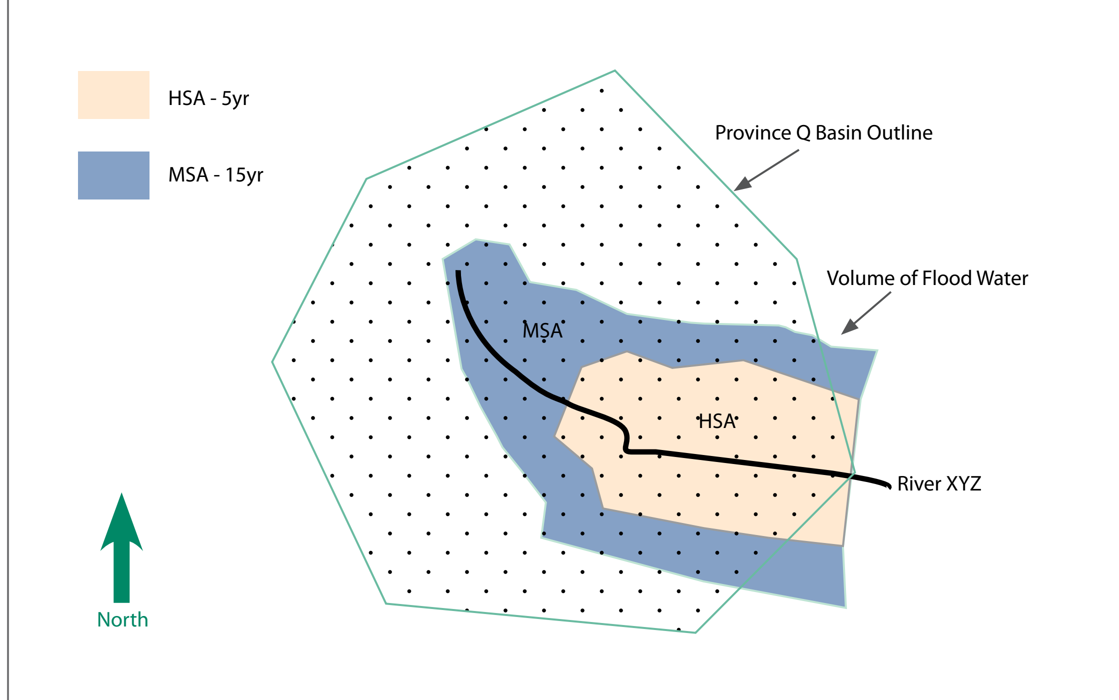
The probability that a flood of volume X exceeds a particular hazard event, say 50.0 MCM, is used in estimating return period. From the above illustration this is equal to 0.205 above and expressed as:

$$P(x \leq 50{,}000) = 0.205$$

B. USING THE PROBABILITY OF EXCEEDANCE OR PROBABILITY OF OCCURRENCE IN COMPUTING FOR ANNUAL RISK

Assume that the above record of volume of flood waters happened in Province Q. Flooded areas in Province Q arising from overflow of River XYZ based from two events (characterized by volume of water) are shown in Map A2.1. It was observed that the 5-year flood event (50.0 MCM of water) covers the high susceptible areas (HSAs); the 15-year flood event (60.0 MCM of water) covers the HSAs and moderate susceptible areas (MSA). Assume further that no intermediate flood volumes or events are known other than this two.

Map A2.1 Hypothetical Flooding Map for Province Q



Recall from the conceptual framework of these Guidelines that risk is measured in terms of risk of fatality and risk of property damage per year. It is computed by the product of the probability of exceedance or probability of occurrence of the hazard and the consequence.

- **For risk of fatality:**

$$R_F = P \times C_F$$

where R_F = risk of fatality (fatality/year)
P = probability of occurrence of hazard event (the difference between reciprocal of return periods of two incremental hazard events)
C_F = consequence in terms of fatality per hazard event

- **For estimating property damage:**

$$R_{PrD} = P \times C_{PrD}$$

where R_{PrD} = risk of property damage (PhP/year)
P = probability of occurrence of hazard event (the difference between reciprocal of return periods of two incremental hazard events)
C_{PrD} = consequence in terms of cost of property damage per hazard event

Table A2.4 shows the details for computation of risk, in this case, property damage.

Table A2.4 Risk Estimates

Hazard Event	Affected Areas	Return period, *(T)*	Probability of Occurrence/Probability of Exceedance, per year *(1/T)*		C_{PrD} (PhP)[1/]	R_{PrD} (PhP/Year)	
						Formula	Value
50.MCM flood	HSA	5 years	*P(X≥50.0)*	0.2050	100 M	-	-
60.MCM flood	HSA, MSA	15 years	*P(X≥60.0)*	0.0667	200 M	C_{PrD}* *P(X≥60.0)* - *P(X≥50.0)*	(200MPhP)* (0.205-0.0667) = 26.66MPhP/year

[1/] Hypothetical

NOTES:

Why use difference of two probabilities or specifically, why use difference between reciprocal of return periods of two incremental hazard events?

1. Go back to the concept on cumulative frequency. Table A2.3 presents the relative and cumulative frequencies for the various events. Note that relative frequency and probability are used interchangeably.

2. Note that the probability of not exceeding or equaling the 60.0 MCM event is the sum of probabilities of all events lower than the magnitude of the 60.0 MCM event (i.e., from 0 to 60.0 MCM, *P(X≤60,000))* or a cumulative frequency of 0.931. The probabiliby of exceeding the 60.0 MCM, i.e., *P(X≥60,000)*, can similarly be computed by:

   P(X≥60,000) = 1-P(X≥60,000) = 1- 0.931=0.069

   It is important to note though that, in the case of the 50.0 MCM event, the probability of exceedance, P(X≥50.0), is:

   P(X≥50.0) = 1-0795 = 0.205

   This goes to show that the probability of exceedance of *P(X≥50.0)* already covers the *P(X≥60.0)*. Thus in order to compute for the risk, the difference of the two probabilities is used; otherwise there will be double counting.

The risk computed is based on the annual probability that the flooding event is at a certain volume defined by a range; that is, between a flood fully occupying the HSA area (5-year event) and a flood event occupying the HSA, MSA (15-year event) areas. This annual probability is computed by taking the differences in their exceedance probabilities. When the flooding event is within this range (50.0 MCM, 5-year event and 60.0 MCM, 15-year event), the damage that results can be represented by their average damage or by taking the damage of the larger event. Note that the risk produced by events below a 5-year event and events exceeding a 15-year event is not known unless other flood volume conditions (other than 50.0 MCM and 60.0 MCM events) are known.

Assume that another flood event partially occupies the HSA areas. This means that the return period is lower. A 20.0 MCM event with a 2.10-year return period was determined by the same process and the damage was PhP90 million. What is the yearly risk obtained between this range - a flood fully occupying the partially occupied HSA area (2.1-year event, PhP90 million) and a flood event fully occupying the HSA (5-year event, PhP100 million) areas? If the greater event damage is PhP100 million, the risk is:

Increment in Risk = 100 (1/2.1 – 1/5) = 100 (0.287) = PhP27.62 million

The yearly risk or expected annual damage therefore contributed from the 20.0 MCM event (2 years) up to the 70.0 MCM (31 years) event is their sum, that is PhP26.66 million + PhP27.62 million = PhP54.3 million/year.

In the case of the hazard maps, only risks from two or three events can be computed, arising from events assumed fully affecting the HSA, HSA and MSA, and HSA, MSA, LSA areas. Hence, knowing intermediate events and their damages improves yearly risk estimates.

C. FINAL NOTE

The calculation of return periods of natural hazards is at best left to the agencies mandated to monitor and map them. In the absence of these information for the probabilistic analysis of hazards, the Guidelines suggest return periods to the different susceptible areas. These assigned return periods are seen as "logical estimates" and serve as a tool to obtain scenarios of different events and to compute possible fatalities and property damage per year.

These approaches require further refinements in correlating return periods to the susceptibility levels identified in hazard maps. It is necessary then to coordinate with the agencies mandated with providing these information and preparing the hazard maps. This would enable planners to specify their requirements for hazard information and maps in the preparation of the physical framework plans and development plans.

ANNEX 3
ASSIGNING RETURN PERIODS

Return periods have a strong correlation with the magnitude of the hazard that affects an area. In the case of earthquakes, previous studies (PHIVOLCS and MMDA, 2004 and Federal Emergency Management Agency, undated) reveal that low magnitude earthquakes occur more frequently or have short return periods and are less destructive, while high magnitude earthquakes occur less frequently and are very destructive. Thus, in order to determine the impact of earthquake on an area there is a need to determine the range of magnitude of the earthquakes that have the capability of causing damage.

The methodology for assigning return periods for earthquake-related hazards, volcanic-eruptions, hydrometeorologic hazards has been discussed in Chapter 4. In this Annex, the methodology is discussed in greater detail, specifically for earthquake-related hazards. Additional examples are also presented here while the methodologies for volcanic eruptions and hydrometeorologic hazards are just reiterated .

A. ASSIGNING RETURN PERIOD FOR EARTHQUAKE-RELATED HAZARDS

Return periods were derived based on studies undertaken on seismic hazard of Thenhaus, et al (1994).

Thenhaus and associates provided ground motion hazard estimates to describe the geographic extent and frequency of earthquake occurrence of 21 seismic source zones in the country. From their analysis of documented information on past earthquakes over a 400-year period (1589 to 1992) in the Philippines, they were able to compute for the incremental annual rates of earthquake occurrence for each seismic source zone. Results are in Table A3.1.

Table A3.1 Annual Rates of Earthquake Activity by Magnitude Intervals and Seismic Source Zones

ZONE	5.2aMs<5.8	5.8Ms<6.4	6.4aMs<7.0	7.0aMs<7.3	7.3aMs<8.2
1	0.30526	0.11331	0.04288	0.01607	0.00602
2	0.22282	0.08351	0.03130	0.01173	0.00440
3	0.52997	0.19863	0.07444	0.02791	0.01946
4	0.14769	0.05536	0.02075	0.00778	0.00291
5	0.01789	0.00971	0.00251	0.00094	0.00035
6	0.16699	0.06259	0.02346	0.00879	0.00329
7	0.33713	0.12636	0.04735	0.01775	0.00665
8	0.32081	0.12024	0.04505	0.01689	0.00633
9	0.06367	0.02387	0.00894	0.00335	0.00126
10	0.15240	0.06442	0.02724	0.01151	0.00488
10a	0.06307	0.02666	0.01127	0.00467	0.00202
10b	0.03743	0.01582	0.00669	0.00283	0.00120
11	0.23881	0.08951	0.03354	0.01257	0.00471
12	0.15595	0.05845	0.02191	0.00821	0.00308
13	0.13050	0.04891	0.01833	0.00687	0.00257
14	0.08423	0.03157	0.01183	0.00444	0.00166
15	0.41920	0.15712	0.05888	0.02207	0.00827
16	0.07380	0.02535	0.00871	0.00299	0.00103
17	0.90212	0.30990	0.10646	0.03658	0.01256
18	0.24471	0.08406	0.02887	0.00991	0.00341
19	0.04165	0.01430	0.00492	0.00169	0.00058
20	0.12550	0.04311	0.01481	0.00508	0.00175
21	0.19292	0.06628	0.02276	0.00782	0.00269

Source: Thenhaus, et al, 1994

The numbers under each magnitude (Ms) interval is the frequency of occurrence for each seismic zone. The frequency of occurrence is the number of events of a given magnitude per unit time (the number of earthquakes of a certain magnitude, Ms, in *n* years). The reciprocal of frequency is *period*, the average interval between events of a given magnitude (Tonkin and Taylor Ltd., 2006) or the return period. For example, the number of earthquakes in Zone 3 of Magnitude 5.2 to < 5.8 has 0.52997 annual rate of earthquake activity. It means that the return period of earthquakes of Magnitude 5.2 to < 5.8 in Zone 3 is around two years, which is the reciprocal of the given frequency (annual rate). Another example, the return period of earthquakes Magnitude 7.0 above to < 7.3 in Zone 19 has a return period of around 592 years.

Thus, to translate the frequencies in Table A3.1 into return periods, the results are in Table A3.2.

Table A3.2 Derived Return Period For Each Earthquake Magnitude Interval per Zone in the Philippines

ZONE	5.2aMs<5.8	Return Period	5.8Ms<6.4	Return Period	6.4aMs<7.0	Return Period	7.0aMs<7.3	Return Period	7.3aMs<8.2	Return Period
1	0.30526	3.3	0.11331	8.8	0.04288	23.3	0.01607	62.2	0.00602	166.1
2	0.22282	4.5	0.08351	12.0	0.03130	31.9	0.01173	85.3	0.00440	227.3
3	0.52997	1.9	0.19863	5.0	0.07444	13.4	0.02791	35.8	0.01946	51.4
4	0.14769	6.8	0.05536	18.1	0.02075	48.2	0.00778	128.5	0.00291	343.6
5	0.01789	55.9	0.00971	103.0	0.00251	398.4	0.00094	1063.8	0.00035	2857.1
6	0.16699	6.0	0.06259	16.0	0.02346	42.6	0.00879	113.8	0.00329	304.0
7	0.33713	3.0	0.12636	7.9	0.04735	21.1	0.01775	56.3	0.00665	150.4
8	0.32081	3.1	0.12024	8.3	0.04505	22.2	0.01689	59.2	0.00633	158.0
9	0.06367	15.7	0.02387	41.9	0.00894	111.9	0.00335	298.5	0.00126	793.7
10	0.15240	6.6	0.06442	15.5	0.02724	36.7	0.01151	86.9	0.00488	204.9
10a	0.06307	15.9	0.02666	37.5	0.01127	88.7	0.00467	214.1	0.00202	495.0
10b	0.03743	26.7	0.01582	63.2	0.00669	149.5	0.00283	353.4	0.00120	833.3
11	0.23881	4.2	0.08951	11.2	0.03354	29.8	0.01257	79.6	0.00471	212.3
12	0.15595	6.4	0.05845	17.1	0.02191	45.6	0.00821	121.8	0.00308	324.7
13	0.13050	7.7	0.04891	20.4	0.01833	54.6	0.00687	145.6	0.00257	389.1
14	0.08423	11.9	0.03157	31.7	0.01183	84.5	0.00444	225.2	0.00166	602.4
15	0.41920	2.4	0.15712	6.4	0.05888	17.0	0.02207	45.3	0.00827	120.9
16	0.07380	13.6	0.02535	39.4	0.00871	114.8	0.00299	334.4	0.00103	970.9
17	0.90212	1.1	0.30990	3.2	0.10646	9.4	0.03658	27.3	0.01256	79.6
18	0.24471	4.1	0.08406	11.9	0.02887	34.6	0.00991	100.9	0.00341	293.3
19	0.04165	24.0	0.01430	69.9	0.00492	203.3	0.00169	591.7	0.00058	1724.1
20	0.12550	8.0	0.04311	23.2	0.01481	67.5	0.00508	196.9	0.00175	571.4
21	0.19292	5.2	0.06628	15.1	0.02276	43.9	0.00782	127.9	0.00269	371.7

Although the indicative return periods for varying intensity and seismic zone are available, this issue needs to be confronted: how are magnitude and return period assigned for each of the three levels of susceptibility (HSA, MSA, LSA)?

First is determine the range of magnitude for high, moderate, and low susceptible areas. Second is collapse the five magnitude ranges of Thenhaus into three ranges to correspond to the three susceptible areas (HSA, MSA, and LSA) defined in the hazard maps.

1. DETERMINING MAGNITUDE INTERVALS FOR HSA, MSA, LSA

Magnitude intervals for each susceptibility area are determined using *g value*s. As mentioned earlier, the ground–motion hazard estimates of Thenhaus were obtained from a model of 21 seismic source zones that describe the geographic extent and frequency of the earthquake occurrence for major tectonic elements of the Philippine region.

Each area/location in the Philippines has its corresponding Peak Ground Acceleration, measured in *g value*. The *g value* dictates how strong an earthquake can be, given soil conditions in the area (soft or medium soil, or rock). For purposes of these Guidelines, a *g value* under medium soil conditions is used as a conservative estimate. Also, since the return periods will be used in estimating potential damage to property, it is assumed that structures are not built on soft soil (e.g., sandy, loamy soil).

The primary criterion for determining soil condition at any given time is the age of the soil. In time, a soil column will compact and increase in density. Thus, older soils are generally harder than young soils. Definitions of site conditions given by Fukushima and Tanaka (1991) and taken from Japan Society of Civil Engineers are as follows: Hard: (a) ground older than Tertiary (older than approximately 65 million years), or (b) thickness of Pleistocene deposit (deposit is younger than about 2 million years) above bedrock is less than 10 m; Medium: (a) thickness of Pleistocene deposit above bedrock is greater than 10 m. or (b) thickness of Holocene deposit (deposit is younger than about 10,000 years) above bedrock is less than 10 m, or (c) thickness of Holocene deposit is less than 25 m and thickness of soft deposit is less than 5 m; Soft: any other soft ground such as reclaimed land. To be conservative, It is suggested to use map in Figure A2.2 for identifying the *g value*, unless the area falls under reclaimed land.

However, there is no direct equivalent *g value* for each Ms under the Richter Scale which was used in Thenhaus' paper. But there is a one-to-one correspondence between Ms (Richter Scale), and other accepted earthquake scales, i.e., the Modified Mercalli Intensity Scale (MMIS), and the local equivalent, PHIVOLCS Earthquake Intensity Scales (PEIS). There is also a one-to-one correspondence between MMIS and *g value*. Thus, the equivalent of Ms to MMIS should be obtained first, followed by the one-to-one correspondence between MMIS and *g value*. The results are in Tables A3.3 and A3.4. This is done to establish the link between magnitude of the hazard event and intensity of damage. Once the magnitude is known, the kind of corresponding damages expected can be estimated. For example, as shown in Table A3.3, if the magnitude of the potential event is from 7.0 – 7.3, the impact on the area will be "Disastrous."

Table A3.3 Modified Mercalli Intensity Scale (MMIS) and Richter Scale (Ms)

MMIS (1)		Level Of Damage (2)	Ms (3)
I-IV	Instrumental to Moderate	No damage.	≤4.3
V	Rather Strong	Damage negligible. Small, unstable objects displaced or upset; some dishes and glassware broken.	4.4 - 4.8
VI	Strong	Damage slight. Windows, dishes, glassware broken. Furniture moved or overturned. Weak plaster and masonry cracked.	4.9 - 5.4
VII	Very Strong	Damage slight-moderate in well-built structures; considerable in poorly-built structures. Furniture and weak chimneys broken. Masonry damaged. Loose bricks, tiles, plaster, and stones will fall.	5.5 - 6.1
VIII	Destructive	Structure damage considerable, particularly to poorly built structures. Chimneys, monuments, towers, elevated tanks may fail. Frame houses moved. Trees damaged. Cracks in wet ground and steep slopes.	6.2 - 6.5
IX	Ruinous	Structural damage severe; some will collapse. General damage to foundations. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground; liquefaction.	6.6 - 6.9
X	Disastrous	Most masonry and frame structures/foundations destroyed. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Sand and mud shifting on beaches and flat land.	7.0 - 7.3
XI	Very Disastrous	Few or no masonry structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Rails bent. Widespread earth slumps and landslides.	7.4 - 8.1
XII	Catastrophic	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted.	> 8.1

Source: FEMA, 2008

Table A3.4 shows that earthquakes with Ms 5.0 or lower generally do not cause significant damage. However, intensity VI - VII (MMIS) (i.e., Ms 4.9 – 6.1 and corresponding to *g value* ≤0.21) is capable of only slight to moderate damage in well-built structures but considerable in poorly–built structures. Ms 7.0 and higher are already devastating.

Thus, in the context of these Guidelines the magnitude interval of 4.9 – 6.1 is considered as the lower limit of the magnitude range. Further more, the upper limit of the magnitude is assigned as > 7.0 because the Philippines has encountered earthquakes of the size magnitude 7.5 in many areas. In between those ranges are the moderate events.

Table A3.4 Magnitude (Ms), Modified Mercalli Intensity Scale (MMIS), PHIVOLCS Earthquake Intensity Scale(PEIS) and Peak Ground Acceleration (PGA, *g values*)

Ms	MMIS	PEIS	Description (See Table A1.2)	PGA (*g values*)
</= 4.3	I	I	**Scarcely perceptible**	0.0005
	II	II	**Slightly felt**	0.0009
	III	III	**Weak**	0.0011
	IV	IV	**Moderately strong**	0.0050
4.4 - 4.8	V	V	**Strong**	0.0100
4.9 - 5.4	VI	VI	**Very strong**	0.1200
5.5 - 6.1	VII	VII	**Destructive**	0.2100
6.2 - 6.9	VIII,IX	VIII	**Very destructive**	0.3600 – 0.5300
7.0-8.1	X,XI	IX	**Devastating**	0.7100 - 0.8600
>8.1	XII	X	**Completely devastating**	>1.1500

Source: PHIVOLCS and MMDA, 2004

Table A.3.5 shows the assignments and correspondence of values of different scales. This will be used to determine the return period for each magnitude interval along all the seismic zones in the Philippines. The range is further calibrated into three classes of magnitude intervals.

Table A3.5 Comparative scales with PGA *(g values)*

PGA *(g values)*	PEIS	MMIS	Ms	Return Period
≤0.21	VI-VII	VI-VII	4.9 – 6.1	?
0.36 -0.53	VIII	VIII-IX	6.2 – 6.9	?
> 0.53	IX-X	X-XI	> 7.0	?

With this information, the range of magnitudes to high, moderate and low susceptible areas can thus be set. It is assumed that moderately strong but potentially damaging events to strong events affect high susceptible areas. Furthermore, only very strong events can create greater coverage which may include all susceptible areas defined in the hazard maps. Thus, magnitude intervals are assigned for each susceptibility area (Table A3.6).

Table A3.6. Range of Earthquake Magnitudes per Affected Area

Level of Susceptibility	Affected Areas	Magnitude (Ms)
HSA	HSA	4.9 – 6.1
MSA	HSA, MSA	6.2 – 6.9
LSA	HSA, MSA, LSA	> 7.0

These intervals are generally consistent with the principle adopted by Thenhaus et. al., where Ms 5.0 was not included in their analysis as is does not generally cause significant damage. A maximum magnitude of Ms >7.0 was maintained for all seismic source zones because: (a) earthquakes of Ms 7.5 have occurred in many areas of the country; and (b) the inventory of seismogenic faults and active geologic structures is incomplete for most areas.

It is emphasized that these assumptions are made solely for obtaining risk estimates for prioritizing large areas such as those covered by regions or provinces, and therefore may not apply for city/municipal or site-specific planning.

2. ASSIGNING RETURN PERIODS: SAMPLE CASE

In Chapter 4, the procedure on assigning the return period for earthquake-related hazards was presented with Surigao del Norte as a case. The Peak Ground Acceleration Value for Medium Soil and the Map on Seismic Source Zones of the Philippines that were included in Chapter 4 are again included here in Annex 3 to facilitate referencing. Additional maps in this annex are Peak Ground Acceleration Value for Soft Soil and Peak Ground Acceleration Value for Rock.

Here is another example of a stepwise procedure on how to assign return periods.

Step 1. Identify the *g value* of the province or region in Figure A3.1, the Peak Ground Acceleration Value for Soft Soil. For a region where there is more than one *g value*, analysis will be per province. It is assumed that the zone where the province is located serves also as the source of the earthquake.

Example: Pangasinan has a g value of 0.6

Step 2. Using the table below, identify the equivalent Richter Scale Magnitude of the *g value* (if *g value* is between 0.21 and 0.36, use 0.36-0.53 *g value*)

PGA *(g)*	PEIS	MMIS	Ms
≤0.21	VI-VII	VI-VII	4.9 – 6.1
0.36 -0.53	VIII	VIII,IX	6.2 – 6.9
> 0.53	IX-X	X,XI	> 7.0

Step 3. Identify which earthquake zone the province or region is located from Figure A3.4, on the Seismic Zone Map. If the area overlaps two or three seismic zones, choose the zone which corresponds to higher return period to avoid underestimation.

Example: Pangasinan is located in Zone 8.

Step 4. Now that the *g value* and seismic zone have been identified, the corresponding return period in Table A3.2 is then determined. If the magnitude overlaps in two ranges in Table A3.2, use the upper value in the magnitude range to avoid underestimation.

Example: Pangasinan, located in Zone 8, and g value of 0.6 use Magnitude >7.0.

Step 5. Assign the return period of all hazard events following this template.

Magnitude, Ms	Return Period	Affected Areas
4.9 – 6.1	?	HSA
6.2 – 6.9	?	HSA, MSA
> 7.0	?	HSA, MSA, LSA

The return period obtained from step 5 will be the worst case scenario. Meaning, in the case of Pangasinan, its worst case scenario is a >7 magnitude earthquake, with a 158-year return period. Areas affected are HSA, MSA and LSA.

To fill up the return period of the lower intensity hazard event, refer again to Table A3.2. Using the upper value of magnitude 7.0, the return period (Zone 8) is 22.

Finally, to fill up the lowest intensity hazard event, refer again to Table A3.2. Using the upper value of 6.4, the return period (Zone 8) is 8.

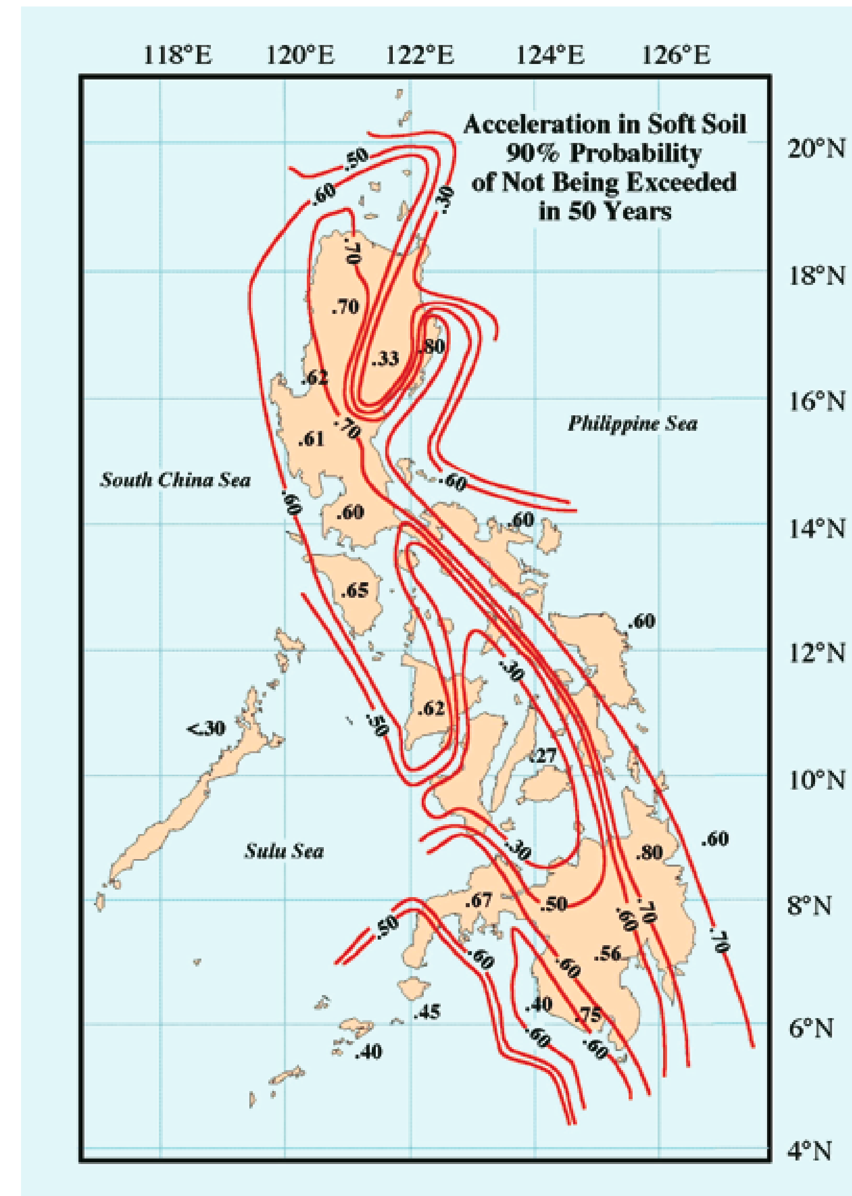
The return period and corresponding area matrix can be developed for any other province or capital city using the above-mentioned procedure.

Table A3.7 Return Period and Affected Areas: Pangasinan

Magnitude, Ms	Return Period	Affected Areas
4.9 – 6.1	8	HSA
6.2 – 6.9	22	HSA, MSA
> 7.0	158	HSA, MSA, LSA

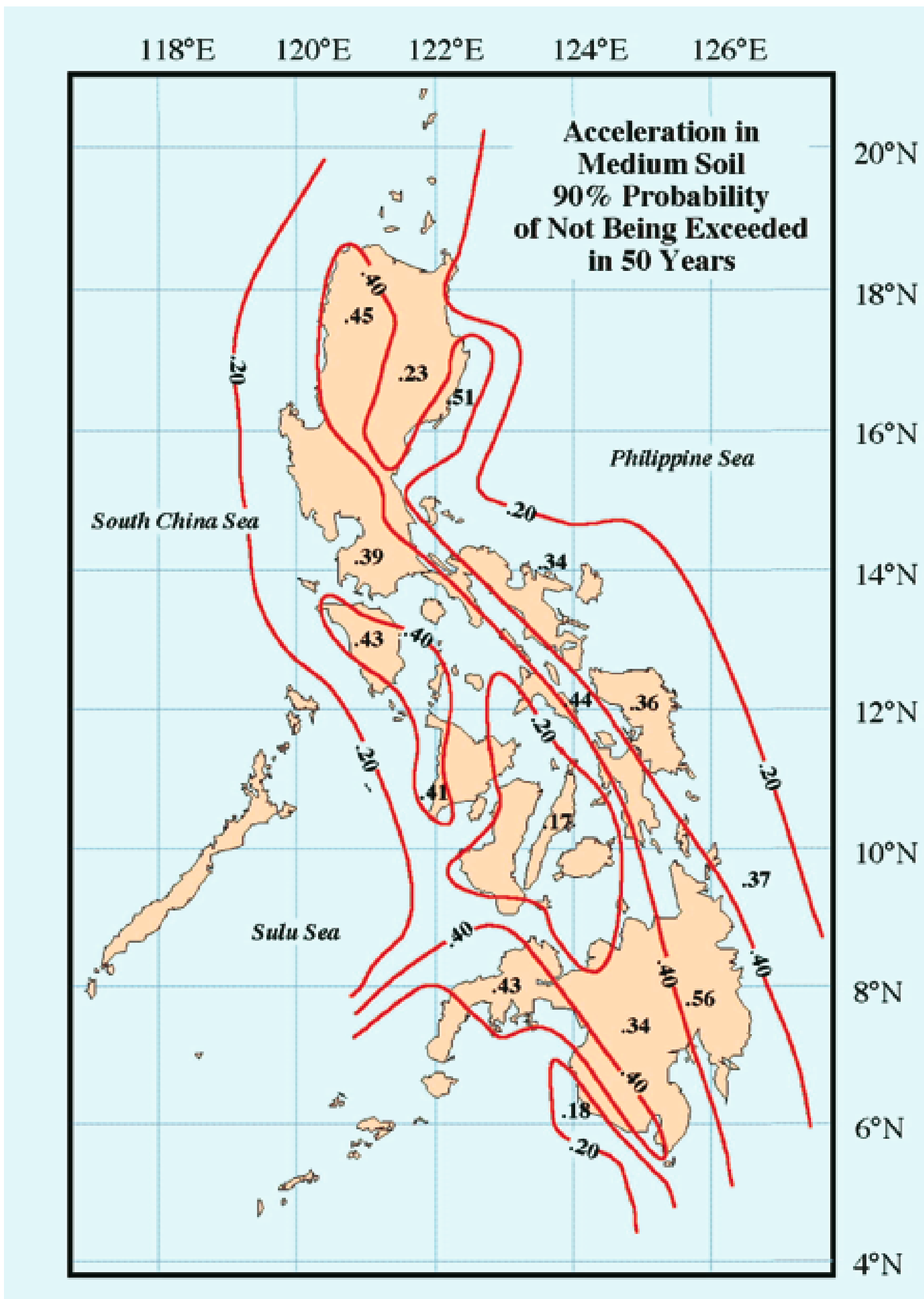
The concept of developing this matrix in three classes can be used to develop the matrix for other hazards. However, the magnitude or intensity interval corresponding to return period of other hazards must be derived from their historical data or inquiry from mandated agencies. Furthermore, it is suggested to use the same classes of magnitude interval in developing the factor for fatality and property damage matrix.

Figure A3.1 Peak Ground Acceleration (PGA) Value for Soft Soil



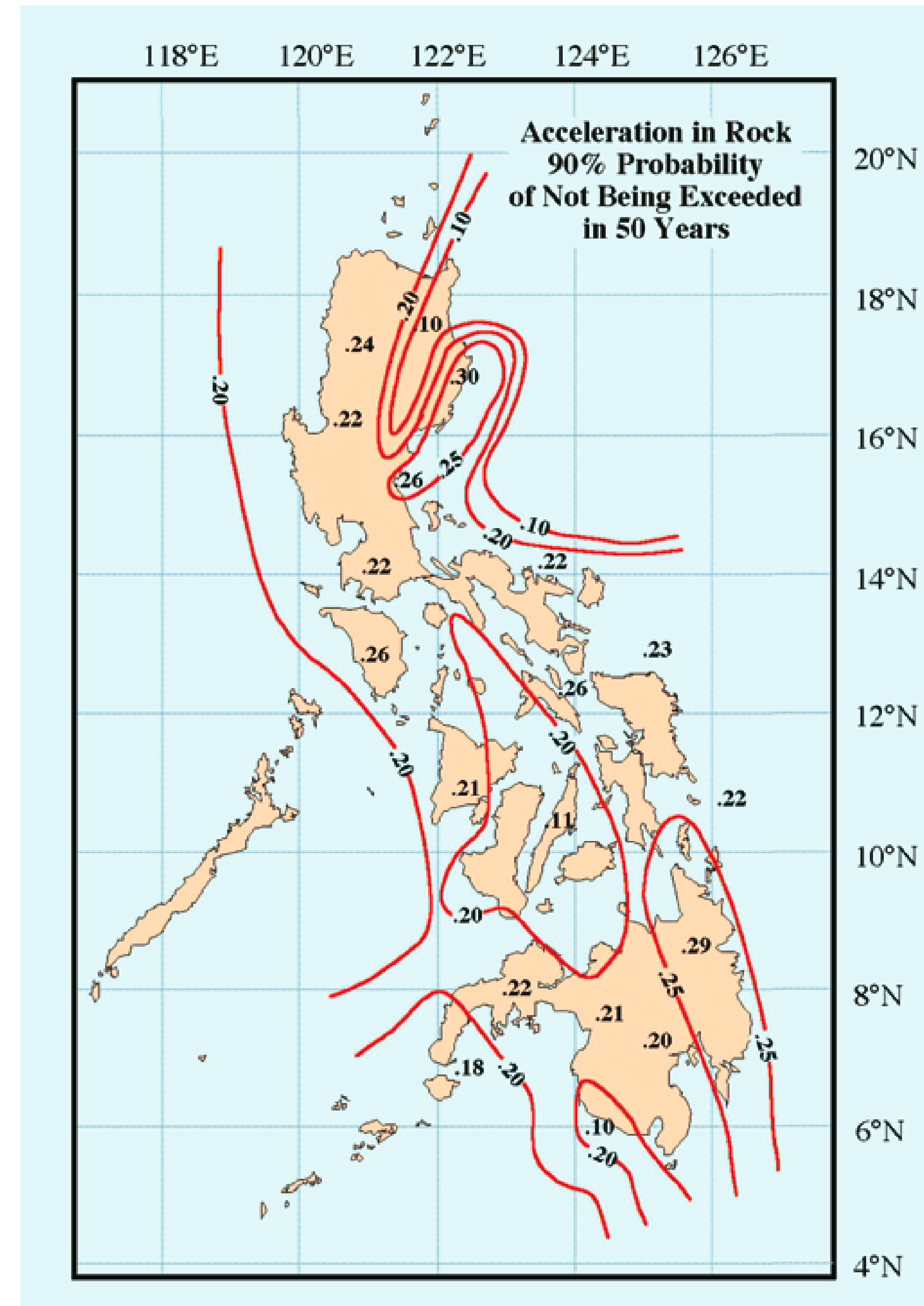
Source: Thenhaus, et al

Figure A3.2 Peak Ground Acceleration (PGA) Value for Medium Soil



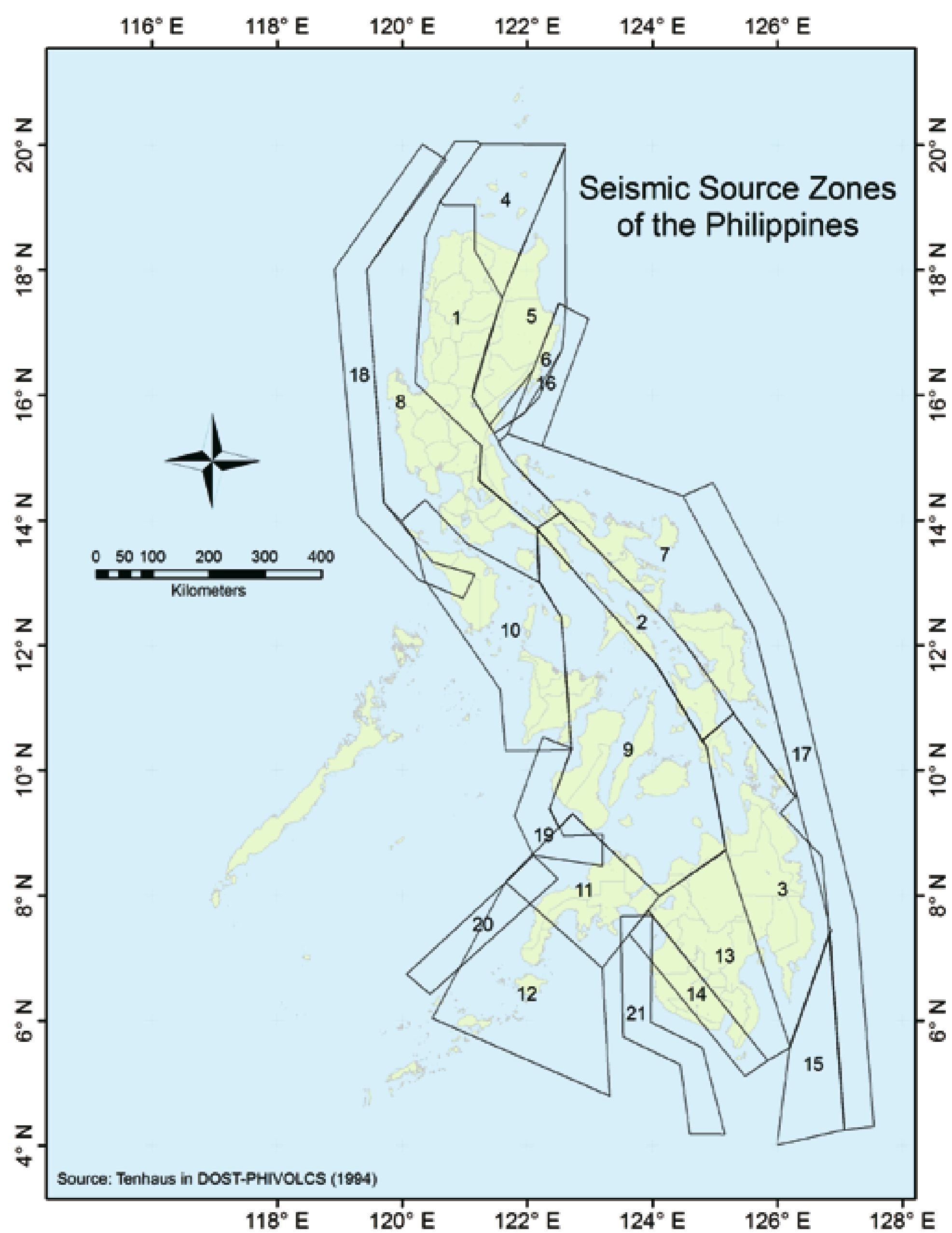
Source: Thenhaus, et al

Figure A3.3 Peak Ground Acceleration (PGA) Value for Rock



Source: Thenhaus, et al

Figure A3.4 Seismic Zones in the Philippines



B. ESTIMATING RETURN PERIOD FOR VOLCANIC HAZARDS

Recall definition of active and inactive volcanoes in Annex 1. Volcanic hazards arise from active and potentially active volcanoes in the Philippines. *Active* volcanoes are those that erupted within historical times (within the last 600 years). Volcanoes that erupted within geological times (less than or equal to 10,000 years) are also classified as active volcanoes. *Potentially-active* volcanoes have no historical records of eruption. An *inactive* volcano has no recorded eruption in the last 10,000 years. Volcanic hazards are ash falls, ballistic bombs, pyroclastic flow, subsidence, fissures, rolling incandescent rocks and other wind- and rain-induced movements, like ash curtains and lahars.

Based on information from National Disaster Coordinating Council-Office of Civil Defense (NDCC-OCD) and PHIVOLCS, some volcanic activities have longer return periods. Iriga Volcano in Camarines Sur only had a single eruption since 1628, which makes it 380 years dormant. Mt. Banahaw in Quezon, Laguna has only erupted once since 1730, which makes it 278 years dormant. Mt. Pinatubo had erupted in 1991 after more than 600 years of dormancy.

There were 52 recorded eruptions (1616-2006) from Mt. Mayon in Albay, Bicol Region. Mt. Bulusan, in the same region recorded about 15 eruptions with the latest in 2006-2007. Mt. Kanlaon in Negros Oriental has shown regular volcanic activities from mild to strong eruption at least once in a decade. Taal Volcano in Batangas had 33 eruptions with the latest in 1977.

The definition of active volcanoes was used to identify rare events. Table 4.7 (from Chapter 4) is divided into frequent (300 years and below), likely (300-600 years) and rare (above 600 years). The assignment of the return period and the coverage of susceptible areas will depend on specific areas where volcanoes are located, as earlier described. Compared to hydrometeorologic hazards, the susceptible areas under volcanic hazards are typically more confined near the source of eruption.

Table 4.7 Indicative Return Period for Volcanic Events

Hazard Occurrence	Indicative Return Period in Years	Susceptibility	Affected Areas
Many events are frequent over a lifetime (frequent)	300 and Below	HSA	HSA
A single event is likely over a lifetime (likely)	Above 300 -600	MSA	HSA,MSA
A single event is rare over a lifetime (rare)	Above 600	LSA	HSA, MSA, LSA

C. ESTIMATING RETURN PERIODS FOR HYDROMETEOROLOGIC HAZARDS

Chapter 4 already discusses in detail the estimation of return periods for hydrometeorologic hazards. The methodology was guided by Rainfall Intensity Duration Frequency (RIDF) with Surigao del Norte as case. Information that may be generalized from the RIDF are as follows:

a. For flood hazards, when the duration of the rainfall is equal or longer than the travel time of surface flow water from the farthest point up until an outlet point (e.g, a downstream point), most areas of the drainage area contributes to the peak flow. In big drainage areas, longer duration rainfall creates this condition even in smaller drainage areas when short duration is accompanied by intense rainfall. As the event becomes rarer (i.e., higher return period of say 25, 50 or more years), the volume of rain increases and flood volume increases and reaches wider areas. Hence, smaller rainfall return periods (below 10 yrs) are initially assigned with smaller drainage areas (e.g. urban drainage areas, 100 hectares or so) as HSA in hazard maps where higher flood flows can be expected, and higher return periods (above 10 years) to cover wider areas defined by all susceptible areas, i.e., HSA, MSA and LSA. This size may vary from 100 hectares to flood plain sizes of 10,000 hectares and beyond. (Source: Ponce, V.)

b. For rain-induced landslides, the return period depends on the return period of rainfall and site conditions. Steep slopes are more susceptible than those areas with moderately steep slopes or flat terrain. Nonetheless, 150 to 200 millimeters of rainfall per day, in general, may be enough to trigger landslides, based on an investigation by PHIVOLCS and Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA).

c. An intense, short duration rainfall is likely to create landslides in HSAs; and longer duration rainfalls are likely to increase landslide occurrences in wider areas (i.e., MSA and LSA).

Table 4.8 Surigao Del Norte Rainfall Intensity-Duration-Frequency Data (based on 36 year record)

Computed Extreme Values (in mm) of Precipitation

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	16.3	24.7	31.8	37.8	47.5	57.4	64.2	74.5	83.8	90.8	100.1	108.6	143.5	177.9	204.8
5	24.5	37.2	48.2	56.9	71.1	85.4	95.2	111.0	125.5	136.8	151.5	164.6	216.8	269.1	308.9
10	29.9	45.5	59.0	69.6	86.8	104.0	115.8	135.2	153.1	167.3	185.6	201.7	265.4	329.4	377.8
15	32.9	50.2	65.1	76.7	95.6	114.5	127.3	148.8	168.6	184.5	204.8	222.6	292.8	363.5	416.7
20	35.0	53.5	69.4	81.7	101.8	121.8	135.5	158.3	179.5	196.5	218.2	237.2	311.9	387.3	443.9
25	36.7	56	72.7	85.6	106.5	127.5	141.7	165.7	187.9	205.8	228.6	248.5	326.7	405.7	464.9
50	41.8	63.8	82.8	97.4	121.2	144.9	161.0	188.4	213.8	234.3	260.5	283.2	372.2	462.3	529.5
100	46.8	71.6	92.9	109.2	135.8	162.1	180.1	210.8	239.5	262.6	292.2	317.7	417.4	518.4	593.6

Equivalent Average Intensity (in/mm/hr) of computed extreme values

Return Period (yrs)	5 mins	10 mins	15 mins	20 mins	30 mins	45 mins	60 mins	80 mins	100 mins	120 mins	150 mins	3 hrs	6 hrs	12 hrs	24 hrs
2	195.6	148.2	127.2	113.4	95	76.5	64.2	55.9	139.7	45.4	40.0	36.2	23.9	14.8	8.5
5	294	223.2	192.8	170.7	142.2	113.9	95.2	83.3	209.2	68.4	60.6	54.9	36.1	22.4	12.9
10	358.8	273	236	208.8	173.6	138.7	115.8	101.4	255.2	83.7	74.2	67.2	44.2	27.5	15.7
15	394.8	301.2	260.4	230.1	191.2	152.7	127.3	111.6	281.0	92.3	81.9	74.2	48.8	30.3	17.4
20	420	321	277.6	245.1	203.6	162.4	135.5	118.7	299.2	98.3	87.3	79.1	52.0	32.3	18.5
25	440.4	336	290.8	256.8	213	170.0	141.7	124.3	313.2	102.9	91.4	82.8	54.5	33.8	19.4
50	501.6	382.8	331.2	292.2	242.4	193.2	161	141.3	356.3	117.2	104.2	94.4	62.0	38.5	22.1

PAGASA, 2007

As such, the suggested return period for hydrometeorological hazards are shown in Table 4.9 (from Chapter 4)

Table 4.9 Indicative Return Period for Hydrometeorologic Events

Hazard Occurrence	Indicative Return Period in Years	Susceptibility	Affected Areas
Many events are frequent over a lifetime (Frequent)	5	HSA	HSA
A single event is likely over a lifetime (Likely)	25	MSA	HSA,MSA
A single event is rare over a lifetime (Rare)	100	LSA	HSA,MSA, LSA

C. Summary Frequency Table

Table 4.10 (from Chapter 4) summarizes the return period for all hazards covered by these Guidelines.

Table 4.10 Summary Frequency Table

Origin	Hazards	Hazard Occurrence	Return Period[1/]
Geologic	Earthquake-related Earthquake-induced landslide Ground shaking Ground rupture Liquefaction	4.9 – 6.1 (Frequent)	5
		6.2 – 6.9 (Likely)	13.4
		> 7.0 (Rare)	51.4
	Volcanic eruptions	Frequent	300 and Below
		Likely	Above 300 -600
		Rare	Above 600
Hydrometeorologic	Rain-induced landslide Storm Surge	Frequent	5
		Likely	25
		Rare	100
	Floods [2/]	Frequent	≤10
		Likely	>10

1/ The figures for geologic hazards except volcanic eruptions are for Surigao del Norte. Each province should compute for their return periods based on their *g value* and zone, as described in these Guidelines.

2/ These are only applicable to areas prone to flooding as reflected in flood susceptibility maps or flood hazard maps. It will be up to the planner to assess flooding in the area based on past occurrences to determine whether they are frequent or likely events with the corresponding return period of ≤10 or >10, respectively. In the computations for Surigao del Norte, where floods are likely events, a return period of 100 years was used.

ANNEX 4
MEASURING DIRECT AND INDIRECT IMPACT OF NATURAL DISASTERS IN THE PHILIPPINES

The negative impacts of disasters may be grouped into three: economic, humanitarian and ecological. Economic impacts refer to damages to physical assets and losses in economic activity. Humanitarian impacts include loss of human lives, injuries and psychosocial trauma. Ecological impacts include damages to forests, habitat, flora and fauna. The impacts on one group could also aggravate the situation of the others. For example, humanitarian and ecological damages have repercussions to the economy. Economic losses such as damaged crops due to flooding in the lowlands may push communities into using the forests and other fragile ecosystems for food production.

Economic impacts usually fall under three categories: direct, indirect, and macroeconomic (also called secondary) effects. Direct losses occur from physical damage to assets including public infrastructure (e.g., school buildings, energy distribution lines, residential and nonresidential buildings, industrial plants and factories and agricultural assets). Indirect losses, on the other hand, include declines in production capacity due to damaged machineries of industries, future harvests, reduced income, increased cost in the provision of basic services due to damaged infrastructures and lifelines.

Direct and indirect losses ultimately influence macroeconomic indicators, such as gross domestic product (GDP), consumption, inflation and employment. These macroeconomic indicators are affected not only by the direct impacts of the disasters but also by the reallocation of government resources to relief and reconstruction.

Quick regular disaster impact reporting in the Philippines covers the following:

Affected	Displaced	Missing	Houses Destroyed	Infrastructure Destroyed	Agriculture
Dead	Families	Families	Total	Schoolbuildings	Loss in Corn and Palay Production
Injured	Persons	Persons	Partial	Roads and bridges	
Families				Government buildings	
Persons					

These types of information are gathered from the field and officially communicated by the National Disaster Coordinating Council (NDCC) to the public. The data on affected, displaced and missing persons can be used to estimate supplies and financing for humanitarian aid. Collectively, the monetary value of houses destroyed (private property), agriculture and infrastructure are referred to as damage to property or the direct economic losses. The desirable data for valuing property damage is the replacement cost but it is possible that reported costs may only be for emergency repairs.

A. ESTIMATING DIRECT DAMAGE

Since these Guidelines are intended to guide the land use and physical framework plans of provinces and regions, direct damage may be computed to correspond to the land use components, i.e., settlements, production, protection and infrastructure. However, it is not possible at this time to value everything covered by these land use components. In order to do this, there would be a need for inventory of all structures, economic activities, and environmental systems in order to fully put a value for replacing them when damaged by a hazard event. The approximate location (spatial coordinates) would also be important under the Geographic Information System approach, leading to the use of Global Positioning System and ortho-aerial photos.

For purposes of these Guidelines, the following indicators are used: (a) built-up areas to represent the settlements and some structures in production areas (e.g., commercial and industrial buildings); and (b) agricultural crops to represent the production land use. Monetary value of damage to public infrastructures such as roads, bridges, schoolbuildings, as well as protection areas, particularly the environment and ecosystems are not covered. However, the qualitative impact of disasters on these categories is evaluated in the vulnerability analysis for the priority areas (Step 4 of the risk assessment methodology).

1. BUILT-UP AREAS

Settlement land use areas cover those parts of the province's territory where residential, commercial and institutional buildings are located. The procedure for estimating *value* of built-up areas, however, is not limited to these types of structures. It also covers industrial facilities such as factories (production land use) and other nonresidential structures.

The built-up area is approximated by the floor areas comprising residential and nonresidential buildings. The residential area reflects a composite floor area comprising different types of residential construction covering single detached, duplex type/ quadruplex, apartment, accessoria, residential condominium and other buildings with related functions. The nonresidential buildings reflect a composite floor area comprising different types of residential construction commercial areas, industrial areas, institutional and agricultural buildings and others.

In particular, the commercial floor area is a composite area representing the floor areas of banks, motels, hotels, condominiums, office buildings, stores, and other buildings with related functions. The industrial area considers floor areas of factories, repair shops/ machine shops, refinery, printing press and others. The numbers of the buildings from each type or category of building floor area (i.e., residential and nonresidential) may be used to get a weighted average composite unit cost, which will be used as replacement cost per sq m of floor area.

National Statistics Office (NSO) data on Floor Area and Value of Building Construction, by Type of Building, By Region and Province will be the basic source of information for computing property value (or replacement cost) for the built-up areas. Table A4.1 is a sample table for Region XIII and its component provinces.

Table A4.1 Number, Floor Area and Value of Building Construction, by Type of Building, By Region and Provinces: Philippines, Third Quarter 2007

Region/ Province	Total			Residential			Nonresidential		
	No.	FA (sq m)	Value (1,000)	No.	FA (sq m)	Value (1,000)	No.	FA (sq m)	Value (1,000)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Caraga	516	39,212	215,859	242	26,812	140,352	63	11,706	60,190
Agusan del Norte	335	26,531	123,778	176	19,033	96,722	30	7,257	24,667
Agusan del Sur	58	3,397	23,683	18	1,724	10,319	11	1,538	12,601
Surigao del Norte	108	7,342	55,134	41	5,098	28,213	14	1,926	14,755
Surigao del Sur	15	1,942	13,263	7	957	5,097	8	985	8,166

Source: http://www.census.gov.ph/data/sectordata/2007/sr0834202.htm

The built-up area is approximated by the floor areas comprising the total floor area (TFA) of construction for all type of buildings, generally categorized as residential floor area (RFA) and nonresidential floor area (NRFA).

Looking at the NSO data, the 2000 Census of Population and Housing (CPH) is cumulative, that is, it gives us the snapshot of the floor area (by range) of residential structures in the province. This represents the RFA of the province. NSO began to collect quarterly data beginning 2002. There is no data for 2001.

> Several assumptions are used in determining the value of property of built-up areas using floor area and value of building construction of NSO. One, the residential floor area generated by the 2000 CPH is also assumed to be the total floor area. Two, there is no data for 2001, and it is therefore assumed that the 2000 census data is maintained for 2001. The resulting "underestimation" in a way compensates for the assumption that all construction permits were translated to actual construction.
>
> The user may wish to compute for the 2001 data and the nonresidential floor area for 2000 using growth rate or time series methodologies.
>
> For accurate data, the user may have to undertake an inventory of the number or the floor area and value of all structures in the locality.

1.1 Deriving TFA from 2000 CPH

With reference to Table A4.2, columns (1) and (2) represent the data from the 2000 Census of Population and Housing (CPH). In order to derive the Total Floor Area (TFA) from these information, obtain first the average area (column 3) in the given range, multiply this with the corresponding number of households then sum up this floor area by average range to get the TFA for a given municipality. The same procedure has been applied for all municipalities of Surigao del Norte. The results are shown in Table A4.3. Based on these assumptions, the TFA is also the RFA.

Table A4.2 2000 Total Floor Area per Household, Alegria, Surigao del Norte

No. of Households (1)	Area Range(sq m) (2)	Ave. Area in Range(sq m) (3)	Total Floor Area(sq m) (1) * (3) = (4)
317	<=10	10	3,170
318	10 to 20	15	4,770
352	20 to 30	25	8,800
419	30 to 50	40	16,760
187	50 to 70	60	11,220
138	70 to 90	80	11,040
125	90 to 100	95	11,875
394	100 to 140	120	47,280
68	Not Reported	Take average of all ranges above =55.625	3, 783
Alegria Town TFA			**118,698**

Table A4.3 2000 Total Floor Area, by Municipality, Surigao del Norte

Municipality	Average Area (sq m)									
	10	15	25	40	60	80	95	120	N/A	TFA
	317	318	352	419	187	138	125	394	68	118,698.0
Bacuag	94	404	486	551	278	140	72	247	25	106,940.6
Burgos	231	116	62	90	53	30	22	10	5	18,348.1
Claver	333	688	647	672	479	157	43	24	96	110,310.0
Dapa	1,473	967	500	478	153	90	48	62	66	92,906.3
Carmen	557	486	385	503	281	148	73	91	57	92,330.6
Gen. Luna	557	625	473	442	184	66	55	53	42	74,691.3
Gigaquit	119	475	746	748	365	197	123	277	98	144,921.3
Mainit	443	1,064	980	677	398	318	205	387	104	192,990.0
Malimono	306	721	508	535	320	113	78	140	90	105,431.3
Pilar	75	231	256	307	184	145	137	254	30	90,698.8
Placer	695	1,117	835	740	281	167	106	155	68	136,852.5
San Benito	322	128	122	145	63	31	13	17	18	24,526.3
San Francisco	733	562	346	241	105	41	29	129	70	65,758.8
San Isidro	39	144	251	321	159	96	37	40	22	48,423.8
Sta. Monica	360	128	224	221	156	152	82	73	25	59,420.6
Sison	352	525	362	303	91	72	33	62	145	62,425.6
Socorro	82	377	602	866	652	270	98	62	39	135,804.4
Surigao City	3,163	4,999	3,877	3,358	2,105	1,392	851	1,699	514	888,836.3
Tagana-an	88	480	516	686	298	175	107	150	29	110,078.1
Tubod	268	563	502	423	165	66	39	65	50	70,061.3
Surigao del Norte										2,750,453.1

1.2 Computing for the TFA of reference year

In the absence of 2001 data, the 2000 data are assumed to be constant up to year 2001. To compute for the 2007 data, the quarterly data from 2002 to 2007 (up to 3rd quarter only as of publication) are added to the 2000 data.

Table A4.4 shows Surigao del Norte TFA and RFA as of 3rd quarter of 2007.

Table A4.4 Surigao del Norte TFA and RFA as of 3rd Quarter 2007

Year	Qtr	TFA (sq m)	RFA (sq m)
2000		2,750,453.1	2,750,453.1
2002	1	34,461.0	15,848.0
	2	41,297.0	18,092.0
	3	9,293.0	9,207.0
	4	18,304.0	16,986.0
2003	1	41,971.0	39,425.0
	2	20,840.0	14,695.0
	3	48,355.0	23,087.0
	4	39,616.0	14,778.0
2004	1	7,893.0	5,166.0
	2	34,672.0	21,428.0
	3	29,701.0	22,305.0
	4	20,022.0	9,986.0
2005	1	14,640.0	10,524.0
	2	18,333.0	13,777.0
	3	7,324.0	6,884.0
	4	9,185.0	7,923.0
2006	1	9,898.0	7,047.0
	2	8,339.0	6,743.0
	3	10,933.0	6,771.0
	4	5,591.0	2,777.0
2007	1	7,659.0	1,827.0
	2	7,813.0	3,483.0
	3	7,342.0	5,098.0
Total as of 3rd Qtr 2007		3,203,935.1	3,034,310.0

1.3 Computing for the TFA and RFA per municipality

In the absence of municipal data for 2002 onwards, the proportionate share of the municipality to the provincial data is computed using the 2000 data in Table A4.3. This share is assumed to be constant and shall be applied to the reference year provincial data to get the municipal breakdown of the TFA and RFA for that reference year.

To get the municipal breakdown for Surigao del Norte as of 3rd quarter of 2007, the municipal share was computed using the TFA data per municipality in Table A4.3. For Alegria, the proportionate share of the municipality is the TFA of Alegria divided by the provincial TFA or (118,698.0 / 2,750,453.1) or 0.043. This share is assumed to be the same in computing for the RFA. This proportion is then applied to the 2007 RFA and TFA data (columns 3 and 4 of Table A4.5).

Table A4.5 2007 TFA and RFA Data of Surigao del Norte, by Municipality

Municipality	TFA (2000)	Municipality Proportion	RFA (2007)	TFA (2007)
	(1)	(2)	(3)	(4)
Alegria	118,698.0	0.0432	130,948.1	138,268.4
Bacuag	106,940.6	0.0389	117,977.3	124,572.5
Burgos	18,348.1	0.0067	20,241.7	21,373.3
Claver	110,310.0	0.0401	121,694.4	128,497.4
Dapa	92,906.3	0.0338	102,494.6	108,224.3
Carmen	92,330.6	0.0336	101,859.5	107,553.6
Gen. Luna	74,691.3	0.0272	82,399.7	87,006.1
Gigaquit	144,921.3	0.0527	159,877.7	168,815.3
Mainit	192,990.0	0.0702	212,907.3	224,809.3
Malimono	105,431.3	0.0383	116,312.2	122,814.3
Pilar	90,698.8	0.0330	100,059.3	105,652.8
Placer	136,852.5	0.0498	150,976.2	159,416.1
San Benito	24,526.3	0.0089	27,057.5	28,570.1
San Francisco	65,758.8	0.0239	72,545.4	76,600.8
San Isidro	48,423.8	0.0176	53,421.3	56,407.7
Sta. Monica	59,420.6	0.0216	65,553.0	69,217.6
Sison	62,425.6	0.0227	68,868.2	72,718.0
Socorro	135,804.4	0.0494	149,819.9	158,195.2
Surigao City	888,836.3	0.3232	980,567.5	1,035,383.6
Tagana-an	110,078.1	0.0400	121,438.6	128,227.3
Tubod	70,061.3	0.0255	77,291.9	81,612.7
Surigao del Norte	2,750,453.1	1.0000	3,034,310.0	3,203,935.1

1.4 Calculating the unit value of TFA and RFA.

From Table A4.1, as shown again below, divide column (3) by column (2) to derive the unit value of the TFA; divide column (6) by column (5) to get the unit value of the RFA; divide column (9) by column (8) to get the unit value of NRFA. The results are shown in Table A4.6.

Table A4.1 Number, Floor Area and Value of Building Construction, by Type of Building, By Region and Provinces: Philippines, Third Quarter 2007

Region/ Province	Total			Residential			Nonresidential		
	No.	FA (sq m)	Value (1,000)	No.	FA (sq m)	Value (1,000)	No.	FA (sq m)	Value (1,000)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Caraga	516	39,212	215,859	242	26,812	140,352	63	11,706	60,190
Agusan del Norte	335	26,531	123,778	176	19,033	96,722	30	7,257	24,667
Agusan del Sur	58	3,397	23,683	18	1,724	10,319	11	1,538	12,601
Surigao del Norte	108	7,342	55,134	41	5,098	28,213	14	1,926	14,755
Surigao del Sur	15	1,942	13,263	7	957	5,097	8	985	8,166

Source: http://www.census.gov.ph/data/sectordata/2007/sr0834202.htm

Table A4.6 Unit Cost of TFA, RFA and NRFA for Surigao del Norte,Current Prices (3rd quarter 2007)

Category	Unit Value (PhP/sq m)
RFA	5,534
NRFA	7,661
TFA	7,509

1.5 Calculating for Property Value of Built-Up Areas in Surigao del Norte

The unit values, particularly TFA and RFA, are then multiplied to get the property value for built-up areas in Surigao del Norte. The results are shown in Table A4.7. Columns (2) and (5) came from Columns (3) and (4) of Table A4.5.

Table A4.7 2007 TFA and RFA in sq m and Value, Surigao del Norte

Municipality (1)	RFA 2007		TFA 2007	
	sq m (2)	PhP (3)	sq m (4)	PhP (5)
Alegria	130,948.1	724,666,652.40	138,268.4	1,038,257,296.80
Bacuag	117,977.3	652,886,203.70	124,572.5	935,414,735.50
Burgos	20,241.7	112,017,525.20	21,373.3	160,491,741.30
Claver	121,694.4	673,456,826.80	128,497.4	964,887,044.50
Dapa	102,494.6	567,204,985.80	108,224.3	812,656,016.90
Carmen	101,859.5	563,690,262.80	107,553.6	807,620,340.40
Gen. Luna	82,399.7	456,000,053.40	87,006.1	653,328,507.90
Gigaquit	159,877.7	884,763,292.80	168,815.3	1,267,633,803.30
Mainit	212,907.3	1,178,228,927.60	224,809.3	1,688,093,107.80
Malimono	116,312.2	643,671,731.90	122,814.3	922,212,813.50
Pilar	100,059.3	553,727,912.60	105,652.8	793,346,904.80
Placer	150,976.2	835,502,224.50	159,416.1	1,197,055,609.30
San Benito	27,057.5	149,736,235.80	28,570.1	214,532,763.30
San Francisco	72,545.4	401,465,984.80	76,600.8	575,195,487.10
San Isidro	53,421.3	295,633,566.20	56,407.7	423,565,381.80
Sta. Monica	65,553.0	362,770,453.50	69,217.6	519,754,937.10
Sison	68,868.2	381,116,367.40	72,718.0	546,039,821.30
Socorro	149,819.9	829,103,438.40	158,195.2	1,187,887,826.50
Surigao City	980,567.5	5,426,460,648.40	1,035,383.6	7,774,695,227.50
Tagana-an	121,438.6	672,041,047.30	128,227.3	962,858,603.70
Tubod	77,291.9	427,733,304.10	81,612.7	612,829,668.10
Surigao del Norte	3,034,310.0	16,791,871,540.00	3,203,935.1	24,058,348,891.20

2. PRODUCTION AREAS

Production areas comprise intensive and multiple uses geared towards food production, cash crops and extraction of natural resources for their economic value. These areas include: production forests (in slopes below 50% and predominantly with second growth dipterocarps with brush and grass), alienable and disposable forest, agricultural lands (e.g., rice lands, sugarcane, corn and other croplands), agro industrial estates (e.g., piggery and poultry farms, processing industries, etc.) and aquaculture areas.

The values applied to the various land components would depend mainly on the majority type of the land cover. While it is possible to obtain the various parcels for each cover, the task may be tedious initially (at provincial or regional level) when aggregated from the municipal levels. For example, in obtaining areas and values for production forests, one has to determine location and coverage, as well as spacing of trees and the existing growth stages. For agricultural areas, the type of crops, coverage, stage of growth and type of irrigation afforded would actually determine unit costs. Hence, simplifications can be made for the valuation. One way is to reduce coverage and consider only main agriculture production units, take average costs over the area assuming production values at an aggregated level (e.g., province or region), and assume that the agricultural crops are at their mature stages (i.e., greater damages expected for harvestable crops). Buildings in farms and processing industries may have been counted in the built-up areas and hence are no longer included in the estimates. Their segregation from the built-up areas and inclusion in these sections may not be necessary since the factors used to proportion damage costs are applied uniformly regardless of use or crop type. For aquaculture areas, valuation may be based on a per hectare value depending on the type of aquaculture products. Typically, for example, the stage of growth of the fish is important in valuation – fries, fingerlings or matured fish. The values may be obtained from municipal agricultural offices or from the Bureau of Fisheries and Aquatic Resources.

In the Guidelines, valuing focuses on agricultural lands. In valuing agricultural crops for damage assessment, replacement cost or the production cost per hectare is used. In general, the unit costs may be obtained from municipal, city and provincial agricultural offices. It would be ideal to use provincial or regional data but, in their absence, the national estimates of the Bureau of Agricultural Statistics (BAS) of the Department of Agriculture (DA), as follows, can be used:

Table A4.8 All Palay: Production Costs and Returns by Season, 2007 Prices

ITEM	DRY	WET	AVERAGE
	(Pesos per Hectare)		
Gross Returns	41,392	43,616	42,609
Cash Cost	12,675	12,811	12,699
Non-cash Cost	9,651	10,294	9,981
Imputed Cost	8,240	7,385	7,805
Total Cost	30,566	30,489	30,486
Net Returns	10,826	13,127	12,124
Net Profit-Cost Ratio	0.35	0.43	0.40
Cost per Kg (Pesos)	8.20	7.91	8.02

Source: DA-BAS, 2008

Table A4.9 All Corn: Production Costs and Returns by Season, 2007 Prices

ITEM	DRY	WET	AVERAGE
	(Pesos per Hectare)		
Gross Returns	27,227	23,549	25,211
Cash Cost	8,159	8,660	8,397
Non-cash Cost	2,225	2,222	2,225
Imputed Cost	6,985	6,007	6,490
Total Cost	17,369	16,889	17,112
Net Returns	9,858	6,660	8,099
Net Profit-Cost Ratio	0.57	0.39	0.47
Cost per Kg (Pesos)	6.62	6.78	6.78

Source: DA-BAS, 2008

Table A4.10 Other Major Crops: Production Costs and Returns by Season, 2007 Prices

ITEM	MANGO	PINEAPPLE	COFFEE	EGGPLANT
	(Pesos per Hectare)			
Gross Returns	122,020	182,676	43,608	116,396
Cash Cost	30,933	47,370	16,743	64,786
Non-cash Cost	3,955	534	882	2,255
Imputed Cost	17,070	13,766	7,603	31,326
Total Cost	51,968	61,670	25,228	98,367
Net Returns	70,062	121,006	18,380	18,029
Net Profit-Cost Ratio	1.35	1.96	0.73	0.18
Cost Per Kilogram	9.35	1.65	31.97	10.12

Source: DA-BAS, 2008

Table A4.11 Production Costs of Major Crops in the Philippines

Item	Production cost (in Pesos per Hectare)
All Palay (average)	30,486
All corn (average)	17,112
Mango	51,968
Pineapple	61,670
Coffee	25,228
Eggplant	98,367

Source: DA-BAS, 2008

3. INFRASTRUCTURE

Potential costs of damage to major infrastructure and public utilities can also be computed. Estimating the cost of potential damage does not only reveal the magnitude of the losses and damages from a disaster but also initially estimates in advance the reconstruction and rehabilitation costs. Further, it should be used to assess and justify the implementation of the necessary intervention measures to mitigate and reduce the potential damages and losses to the region /province. Ideally, the costs attendant to the mitigation is justified when such costs are far less than the estimated costs of potential damages and losses. The damage cost estimation of infrastructure therefore provides the bases for the social and political acceptability of mitigation proposals.

However, it is best to value only those infrastructures and utilities that are critical to the region or province, such as:

a. Those needed to realize the desired urban form or spatial strategy (e.g., roads, airports, ports);
b. Those that support production activities (e.g., irrigation, impounding systems, etc.);
c. Those that serve as lifelines to communities during disasters or ensure health and safety of settlements/population;
d. Those that provide protection and reduce vulnerability of areas from natural hazards (e.g., flood control dikes, slope stabilizing retaining walls, etc.); and
e. Those that are used to provide a level of service (e.g., community water supply and distribution levels 1, 2, 3, etc.).

Unlike damages applied on built-up and agricultural areas where aggregate values are obtained, computing for cost of damage on these elements are site-specific and only requires determining the cost of rebuilding the road or section of a road that may be damaged. For example, cost of damage to roads, bridges and other supporting structures by region can be availed from regional offices of the Department of Public Works and Highways (DPWH). This agency conducts its own damage estimation and values the damages at reestablishment or cost of repair per kilometer, as illustrated by the following examples from the repair cost for roads in CARAGA region, 2007:

6.1 m	gravel to PCCP	(outside the urban area)	11,060,000.00
6.1 m	gravel to PCCP	(within the urban area)	13,030,000.00
6.1 m	asphalt to PCCP	(outside the urban area)	11,980,000.00
6.1 m	asphalt to PCCP	(within the urban area)	13,960,000.00
6.7 m	gravel to PCCP	(outside the urban area)	12,150,000.00
6.7 m	gravel to PCCP	(within the urban area)	14,120,000.00
6.7 m	asphalt to PCCP	(outside the urban area)	13,160,000.00
6.7 m	asphalt to PCC	(within the urban area)	15,130,000.00

Computing for replacement cost depends on the type of infrastructure or utilities, and that for each type, different variables should be considered. It is therefore advisable to consult with experts or mandated agencies on how to value infrastructures and utilities. Table A4.12 below can be used as a guide.

Table A4.12 Infrastructure and Utilities for Damage Cost Estimation

Type	Cost to estimate	Relevant Agency
Roads, bridges and other support and flood control structures	• Construction cost per sq m for buildings • Cost of repair per km for roads and bridges	Consult DPWH regional or district offices. Assess damages on infrastructure and public works such as flood control, national and local roads and bridges and other vital installation and facilities.
Hospitals	• Construction cost per building • Cost of equipment	The Department of Health (DOH) assesses damage on health facilities and status of health services including water and sanitation.
Schools	• Construction cost per classroom • Cost of equipment	The Department of Education (DepEd) conducts assessment on the effects on the education sector, school facilities/ buildings and provides an inventory of school buildings used as evacuation centers.
Power plants, dams, grid stations and transmission lines	• Cost to restore or repair facility	The Department of Energy (DOE) conducts damage assessment on power generating facilities. The power generating offices can be consulted to estimate the cost of the power plants, transmission lines and grid stations. The National Power Corporation (NPC) may also have the information on cost of repair or restoration, especially of transmission lines.
Communication centers, railway stations, bus terminals, ports and harbors, airports	• Cost to restore or repair facility	The Department of Transportation and Communications conducts damage assessment on communication and transport facilities. Other agencies who could provide additional information are the Philippine Ports Authority (PPA) for ports, and Air Transportation Office (ATO) for airports.

4. PROTECTED AREAS

Valuing forests, protected sanctuaries, or watersheds is difficult. Nonetheless, putting a value to protected areas emphasizes the need to protect and to restore them into their original state after a disaster.

What the Guidelines could suggest at this time is on the cost of reforestation. Again, computing for replacement cost depends on what is inside the protected areas. The region or province is thus advised to consult with experts or mandated agencies on existing or proposed methods on how to estimate cost of replacing what are in the protected area, such as DENR's cost of reforestation below (DENR MC/19, 2000):

Reforestation cost per hectare:
2m x 3m = P43,146/ hectare
5m x 2m = P33,267 / hectare
4m x 4 m = P21,907 / hectare

B. ESTIMATING INDIRECT DAMAGE

1. AGRICULTURE SECTOR

In the agriculture, livestock and fisheries sectors, indirect effects include reduced yields in future crops, no planting of future crops, reduced fishing, loss of employment, and differential impact on women.

The DA implements a comprehensive methodology in assessing the damages to crops, livestock and fishery incurred by farmers and fishermen during disasters. Information such as type and variety of crop, growth stage of crop, area planted, wind speed, amount of rainfall, among others are gathered to determine the degree in which crops are salvageable or recoverable. The methodology also incorporates some assumptions on average crop productivity and input costs. This set of information is then used to compute the volume and value of production loss as a result of the disaster.

2. INDUSTRY SECTOR

In trade and industry, indirect effects include reduced production, temporary employment losses, and the differential impact on women. Following are the available methodologies for indirect damage cost estimation:

2.1 Manufacturing
When hazard events impact utilities, these may cause disruption over a period of time. For example, toppled electrical posts in some parts of the city may cause brownouts for a few hours to days; while major damages can cause brownouts for weeks. As a result of a loss of utility, manufacturing firms may limit their production or even close for a number of days until services are restored. Although these firms usually have back-up facilities in their possession, these units cannot sustain power for a longer period and at some point a pause in production becomes necessary. Hence for estimating losses, determining the number of days of operation disrupted and the per day loss in net income may be undertaken.

2.2 Mining
The data available for the mining industry can be obtained from the list of mining and quarrying establishments. The establishments are categorized based on the number of employees and the industry group. By number of employees, the establishment is grouped into two, one with an average employment of less than 20 and the other with more than 20 (Census, 2007). By industry group, the establishments are divided into the following groups: (a) extraction and production of crude petroleum, and natural gas; (b) coal mining; (c) gold ore mining; (d) stone quarrying, clay and sand pits; (e) other nonmetallic mining and quarrying; (f) copper ore mining; (g) chromites ore mining; and (h) other metallic ore mining. The potential damage to each mining group can be estimated by the reduction in income per day due to disruption of mining operations.

3. POWER, WATER AND TRANSPORTATION AND COMMUNICATION SECTORS

3.1 Power Supply
While the Guidelines do not suggest the estimation of the wide range of indirect losses, the discussions herein provide the definitions of some of the indirect costs obtained from the post-disaster assessment by NDCC-OCD. In the case of power, indirect effects include only the reduction in income due to fall in demand. The damage cost due to power loss can be calculated by the number of potential subscribers affected, or through income losses to the power provider due to nonprovision of power service per day multiplied by the number of days of power disruption.

3.2 Water Supply
For water, indirect effects include only the reduction in income due to fall in water demand. The indirect cost of the water is basically the loss in income of the water provider per day and can be calculated by determining the number of potential subscribers affected for specific days.

3.3 Transportation
In the transport sector, indirect effects include income loss due to the cancellation and delay of numerous trips (e.g., land, sea and air). A simple estimation can be made by summing up all different modes of transport trips: (Income lost per air trip x Number of trips/day) + (Income lost sea trip x Number of trip/day) + (Sum of the income lost by different modes of the road trip whether by jeepney, bus, etc + Number of trip/day).

3.4 Telecommunication
For estimating telecommunication indirect loss, the same concept as estimating cost of water production loss can be used. The data should be collected from telephone service providers. The concept is based on the loss of income per day and can be calculated by knowing the number of potential subscribers affected due to the disruption of telecommunication service for a specific number of days.

C. FUTURE DIRECTIONS FOR DISASTER DAMAGE DATA GATHERING AND ESTIMATION IN THE PHILIPPINES

These Guidelines recognize the usefulness of estimating risks in guiding disaster management approaches. The methodologies to estimate risks to life and to property provide indications on where the needs for intervention are more urgent, or what mitigation measures are appropriate. However, the analysis can be further enhanced by strengthening the mechanism for valuing indirect losses from disasters, which would provide a more comprehensive and accurate account of their social, economic and environmental impacts.

The Economic Commission for Latin America and the Carribean (ECLAC) developed a methodology for assessing the direct and indirect effects of natural disasters and their consequences on the social wellbeing and economic performance of the affected country or area. The ECLAC asserts that the assessment need not entail quantitative precision but must be comprehensive enough to include the complete range of effects and their cross-implications on the economic and social sectors, physical infrastructure

and environment. With these estimates, it is possible to determine the extent of reconstruction requirements and for identifying and undertaking reconstruction and mitigation programs and projects (ECLAC and IBRD, *Handbook for Estimating the Socio-Economic and Environmental Effects of Disaster,* 2003). The methodology proposed by ECLAC in assessing disaster damages is useful for decision-making purposes in all the aspects of disaster mitigation, preparedness and prevention.

The NDCC through the Office of Civil Defense (OCD) tested the ECLAC methodology in assessing the socioeconomic impact of Typhoon Harurot (UNESCAP-NDCC, 2005). The test revealed that there are certain limitations to the methodology that include, among others:

- limited or unavailability of data;
- rate of depreciation of the damaged infrastructure not reflected when replacement or cost of repair is computed;
- lack of criteria for valuing destroyed or damaged structures; and
- impact across populations and their vulnerability are not counted.

A modified Disaster Impact Calculator was eventually developed by OCD and UNESCAP. The Calculator is a software application (in MS Excel) where users can input and store data and calculate damages, the output of which serves as a rapid impact assessment tool for estimating damages incurred from a disaster event. The Calculator was a response to the recommendations of various agencies to retrofit ECLAC's method to the Philippine setting. The Calculator provides, among others, standard content and format in tabulating the damages, including a list of preidentified type of data that will be gathered from the field; a standard conversion of damaged areas comprising lands and crops in monetary value; and national, regional and provincial and other local macroeconomic indicators.

The ECLAC method as developed by NDCC has six steps in calculating total damages:

a. Direct damages are assessed using cost of repair or replacement cost, as the case maybe, for the tangible assets or stocks;
b. Indirect damages are estimated using the principle of opportunity cost incurred by the agents in the economy due to the disruption of economic activities;
c. Indirect damages for agriculture, trade and industry, tourism and other services are then multiplied to their corresponding gross value added (GVA) ratios derived from the National Input-Output-Accounts;

d. The resulting losses, expressed in nominal GVA are then adjusted for inflation using a price deflator. The losses are then summed up and expressed in terms of percentage point loss in the GDP growth rate;
e. Upon determination of the percentage point/s taken away from the GDP, the potential tax revenue loss per percentage point reduction in GDP is then calculated through the use of a tax elasticity; and
f. The total damage and losses to the economy are then summed up.

A crucial factor in using the ECLAC calculator is availability of data, as the formula on estimating damage can only work if certain information is available. Indeed, planning and policy decisions may benefit regions and provinces which are able to gather, store, maintain and update information on damages and fatalities, and then transform these information to knowledge that will help them act on their risks.

To address problems arising from data inaccuracy, limited coverage, and disaggregation, the NDCC has revised report formats to capture direct losses, while measuring indirect losses through the ECLAC methodology (Provention, CRED, & UNDA, 2006). Even though NDCC through OCD, had been compiling data for a national disaster database since 1990 (Communiqué, 2003), the period of collection is still short and the data collected are more on direct damages.

Nonetheless, the following challenges can be incorporated in proposed policy on data collection to ensure effective application of the modified ECLAC method in the future:

- Come up with standard data collection technique that can be applicable across all the actors involved;
- Develop analytical systems in generating data not for need analysis only but also for the use of disaster risk reduction activities; and
- Promote the collection of indirect damage data.

The Child Rights-Based Disaster Management Study of NDCC suggested improvements in the data collection system to improve damage risk assessments.

The study suggests that an inventory of the area at its predisaster state would be needed in order to establish baseline of the number of population and the potential number of affected. This will help identify members of the population who could be affected in a disaster. This will help identify their location, condition and characteristics that are important in determining their physical condition (see vulnerability analysis in Chapter 4). Other factors that must be included are:

- replacement costs for these elements;
- importance;
- existing vulnerability functions;
- ID of their type and their location; and
- Contents of buildings.

D. RAPID EARTHQUAKE DAMAGE ASSESSMENT SYSTEM

The Rapid Earthquake Damage Assessment System (REDAS) is a seismic hazard simulation software developed by PHIVOLCS that aims to produce hazard and risk maps immediately after the occurrence of a strong and potentially damaging earthquake. The REDAS software can be used to conduct seismic hazard and risk assessment, sort earthquake data parameters, produce map of different sizes, perform screen digitization, and develop risk database.

Essentially, the REDAS provides a computer simulation of the effects of an earthquake or other natural disaster (typhoons, tsunamis) on a specific location after the disaster happens. In the case of the July 1990, a 7.8 magnitude earthquake struck Luzon in 1990 where the epicenter of that quake was located at 15º 42’ N and 121º 7’ E near the town of Rizal, Nueva Ecija, northeast of Cabanatuan City. Once the magnitude and epicenter of the quake are entered in REDAS, the software will produce a digital map that shows the expected extent and magnitude of shaking in areas like Baguio, Pangasinan, La Union, Manila, etc.

The software provides information on particular areas where danger of earthquake-induced landslides and liquefaction (mixing of solid and groundwater), and other hazardous effects. Knowing the possible location that effects of earthquake may be strongly felt to an area will enable disaster officials to make quick, more effective decisions about relief and rescue operations.

The REDAS includes a database of information that includes multi-hazards maps that include the geological features of an area and the natural disasters to which such an area is susceptible. REDAS may incorporate data on the elements at risk through direct digitations or keyboard entry. Therefore, it can be used as an alternative to commercial GIS software packages.

For rapid hazard damage assessment, REDAS is a handy tool for local disaster management. REDAS can immediately plot identified active faults so that a user can determine the earthquake's magnitude and extent of coverage even without the assistance of the agency concerned in detecting such eventualities.

PHIVOLCS is currently upgrading the system to cover other hazards.

E. RECOMMENDATIONS

1. Conduct an inventory of the population based on a selected political unit (e.g., barangay or municipality) to identify the location of families, settlements, their numbers, and their socioeconomic conditions. (e.g., status of health, housing type and conditions);

2. Should groupings or clustering be needed in order to differentiate population on the basis of socioeconomic conditions, establish the basis of groupings. (e.g., structure type, income, condition of housing, etc.);

3. Establish valuation for these elements based on repair costs and replacement costs; and

4. Database and map the different groupings or population indicating their location, numbers or their densities. The total population is the sum of the population of different groups in a barangay or municipality.

During a hazard event,

5. Consult with hazard experts. Establish the magnitude or intensity and coverage of the hazard experienced by the affected areas. In case of floods, for example, determine the depth of flooding and coverage; for tsunami, the height of waves during landfall; landslide, height of debris covering built up areas; and earthquake, ground shaking peak ground acceleration/intensity. Typically, these can be determined if a monitoring system is in place to establish these hazard characteristics; and
6. Collect disaster information on affected areas (i.e., barangay, municipality/city or their subareas).

The vulnerability of the population in terms of death, injury or harm may be developed from disaster reports. The form reports and standard templates are

provided by NDCC after 24 hours upon occurrence of disaster and Level II report formats for Regional Disaster Coordinating Councils (Memorandum No. 210, series of 2005).

The following are sample matrices that may used to collect disaster data.

Sample Data Collection Table 1: **Casualties, Affected and Displaced**

Casualties	Names	Age	Sex	Address/Barangay.	Cause
Dead	1.				
	2.				
Injured	1.				
	2.				
Missing	1.				
	2.				
	…				

Source: NDCC-OCD, 2006b

Sample Data Collection Table 2: **Details of Affected Population**

Location (Name of Barangay/details)	Affected Population	
	Needing Assistance	Not-Needing Assistance

Source: NDCC-OCD, 2006b

Sample Data Collection Table 3: **Details of Displaced Population**

Location/Date	Total Number Rescued and Evacuated		Name of Evacuation Centers
	Families	Persons(Disaggregate victims by age)	

Source: NDCC-OCD, 2006b

Sample Data Collection Table 4: **Status of Evacuees**

Name of Evacuees	Age	Sex	Place of Origin	Evacuation Centers

Source: NDCC-OCD, 2006b

Sample Data Collection Table 5: **Incidents Monitored at the Height of Disaster**

Incidents (examples)	Hazard Description	Date/Time Occurrence	ID/Location	Effects	Actions Taken
Landslides					
Flash floods					
Sea Mishaps					
Tornado					

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 6: **Monitoring of Flood Areas/Affected Areas**

ID/ Location	Mun./ City	Barangays Affected	Magnitude (ex. depth of water and duration) and Reference	No. of Affected		No. Displaced	
				Family	Person	Family	Person

Modified from Source: NDCC-OCD, 2006b
Note: this table can be used to obtain aggregation of affected population and areas. ID/Location is an identifier for mapping.

It would be helpful to categorize the various buildings, infrastructure and utilities. This may help reduce the number of vulnerability matrices and manageability of computations. Estimates of replacement costs may be prepared with the inventory.

Sample Data Collection Table 7: **Details of Damaged Houses**

House/building type category	Details of damage	Location	Totally	Partially	Estimated Cost

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 8: **Details of Damaged Agricultural Production**

Type	Location	Crops			Livestock		Fisheries	
		Has	MT	Cost	Heads	Cost	Has	Cost

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 9: **Details of Damaged Infrastructure**

Inventory ID	Location	Names of Roads and Bridges/ Type	Description of Damage	Estimated Cost

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 10: **Flood Control Projects**

Flood Control Projects	ID/Location/Type	Names of Roads/Bridges	Description of Damage	Estimated Cost

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 11**: Public Buildings**

Public Buildings	ID/Location/Type	Names of Buildings	Description of Damage	Estimated Cost

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 12: **Other Buildings**

Private Buildings	ID/Location/Type	Names of Establishment	Description of Damage	Estimated Cost
Commercial establishments				
Industrial Companies				
Other Institutions				

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 13: **Lifelines-Water Facilities**

Facilities	ID/Location/ Type	Names of Facilities	Description of Damage	Estimated Cost	Service Provider on Site
Pumps					
Wells					
Tanks					
Pipes					

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 14: **Lifelines-Electrical Facilities**

Facilities	ID/Location/ Type	Names of Facilities	Description of Damage	Estimated Cost	Service Provider on Site
Transmission Lines					
Power Stations					
Distribution Lines					
Others					

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 15: **Lifelines-Communication Facilities**

Facilities	ID/Location/ Type	Names of Facilities	Description of Damage	Estimated Cost	Service Provider on Site
Telecom Lines					
Print/Broadcast Media					
Others					

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 16: **Transportation /Access Facilities**

Roads	ID/Location/ Type	Name of Road	Description of Damage	Estimated Cost	Service Provider on Site
National					
Provincial					
City/Municipal					
Barangay					

Modified from Source: NDCC-OCD, 2006b

Sample Data Collection Table 17: **Lifelines-Access Facilities**

Bridges	ID/Location/ Type	Name of Bridge	Description of Damage	Estimated Cost	Service Provider on Site
Concrete					
Bailey					
Wooden					
Others					

Modified from Source: NDCC-OCD, 2006b

ANNEX 5
DERIVING FACTORS FOR FATALITY AND FACTORS FOR PROPERTY DAMAGE

These Guidelines use the following mathematical expression to compute for risk:

Risk = Hazard x Elements at risk x Vulnerability

- where *hazard* is expressed in return period (derived in Chapter 4 and Annex 3);
- *elements at risk* are the exposed population, expressed in lives lost; and property, expressed in peso value of property damage (derived in Annex 4); and
- *vulnerability* expressed in degree of loss from 0 to 1 or 0 to 100% expressed as factor for fatality and factor for property damage (derived in Chapter 4 and Annex 5).

The factors developed in these Guidelines estimate the probable proportion of fatalities to the population and probable proportion of damage to properties from a hazard event. This is part of the second step, Consequence Analysis, of the disaster risk assessment methodology described in Chapters 3 and 4 of the Guidelines.

Factor for fatality is a multiplier from 0 to 1 that represents the portion of the total exposed population that has potential to be killed in a given location as a consequence of a hazard event of a specific magnitude. The basic premise is that likelihood of fatality is affected by concentration of population (i.e., population density) in the hazard prone areas, such that less dense areas will have lower fatality levels as compared with high dense areas.

On the other hand, factor for property damage is defined as a percentage of the total exposed property that has potential for damage as a consequence of a hazard event of a specific magnitude.

A. FACTOR FOR FATALITY

The factors for fatality, shown using a series of matrices, were estimated from disaster damage and loss data at the national level and from comparisons of different hazard events. The numbers are basically indicative.

1. EARTHQUAKE-RELATED HAZARDS

Factors for fatality for earthquake-related hazards were based on the Metropolitan Manila Earthquake Impact Reduction Study (MMEIRS) prepared by Philippine Institute of Volcanology and Seismology (PHIVOLCS), Japan International Cooperation Agency (JICA) and the Metro Manila Development Authority (MMDA).

MMEIRS simulated a scenario (called Model 8) in case West Valley Fault (an inland fault) triggers a 7.2 magnitude earthquake (PEIS, VIII) and affects a high density area like Metro Manila. Using data on past earthquake magnitude, population density and physical structures, results revealed that the possible percentage of fatality against the population was 0.3 percent, for a population density of 1,500/km^2.

The same value was used in these Guidelines to compute for potential fatality in earthquake-related hazards under a worst case scenario, i.e., magnitude of > 7.0. This is because the *g value* of Metro Manila (0.39 *g*) is almost at the midrange of the *g value*s of the country's seismic zones (0.17-0.56 *g*), in medium soil. However, this default value will overestimate potential impact to provinces with lower *g value*s (i.e., Cebu, Bohol, Negros Oriental and Siquijor in Region 7 and Cagayan, Isabela, and Quirino in Region 2) and underestimate for provinces with higher *g value*s (i.e., Davao, Compostela Valley, and Davao Oriental in Region 11).

A review of recorded earthquake events by NDCC from 1968 to 2003 gives credence to the use of the MMEIRS estimate. Table A5.1 shows that in eight out of nine earthquake events, fatalities as a percentage of the total affected population do not exceed 0.3 percent.

There is uncertainty in defining rates from historical reviews because the potential number of affected population per unit area (e.g., per sq km) is not predefined and that the reporting system typically presents aggregates and not rates over a fixed geographic area. This is also a similar problem in coming up with other fatality and damage rates from other hazards. Hence, the value taken from the MMEIRS studies is used here since the rate is based on a fixed boundary. The factor for fatality of 0.3 percent can be used as benchmark in these Guidelines for hazard events of worst case scenario, i.e., with magnitude > 7.0.

Table A5.1 Past Earthquake Occurrences

Occurrences	Areas Affected	No. of Fatalities	No. of Affected Population	Indicative Factor for Fatality
1968 2-Aug	Casiguran, Aurora and Metro Manila (Ruby Tower)	270	No Data	
1973 17-Mar	Ragay Gulf Calauag, Quezon	5	1,840	0.002717
1976 17-Aug (7.8 Ms)	Region IX (Pagadian City, Zamboanga del Sur, Zamboanga City, Basilan and Sulu Region XII (Sultan Kudarat, Maguindanao, Cotabato City, Lanao del Sur and Lanao del Norte)	3,792	362,136	0.010471
1990 16-Jul	Luzon Earthquake (Baguio City)	1,283	1,255,249	0.001022
1994 15-Nov	Oriental Mindoro (almost all parts)	83	134,712	0.000616
1999 12-Dec	Metro Manila and Region I	6	356	0.016854
2000 28-Jul	Batanes	0	8,992	0
2002 6-Mar	Mindanao, South Cotabato , Sultan Kudarat Sarangani, Davao del Sur	8	40,073	0.0002
2003 15-Feb	Masbate, Eastern Samar	1	5,531	0.000181
	Total	5,448	1,808,889	0.003775

Source: NDCC and CRED, 2007

For purposes of estimating the factors for moderate events of magnitude 6.2-6.9 and low events of magnitude 4.9-6.1, it is assumed that potentials for fatality across these ranges are linear. Since there are three levels of event (HSA, MSA, LSA or Frequent, Likely and Rare), the factors for fatality and property damage are distributed proportionally across these levels of event as well as across population density levels. Thus, the highest magnitude level of >7.0 is twice more destructive in terms of risk of fatality than the next magnitude level (6.2-6.9) and thrice more destructive than the lowest magnitude level of 4.9-6.1. The same analogy holds true for the various population density levels. The factor for fatality in areas with high population density (500 persons/sq km) is two times higher than the medium population density (250-500) and three times higher than the low population density (<250 persons/sq km).

The factor for fatality for each level of susceptibility is derived as follows:

a. Divide the estimated factor for fatality of 0.3 percent for magnitude > 7 by 3 to get 0.1 percent. Thus, the factor for fatality of 0.1 percent shall be assigned to low population density level (<200persons/sq km), 0.2 percent factor for fatality for medium population density level (250-500 persons/sq km), and 0.3 percent for high population density level (> 500 persons/sq km). See last row of Table A5.2.

b. Repeat the same procedure in step a) but this time, use the 0.2 percent value and divide it by 3 to get 0.066 percent. This will be the difference in the factor for fatality for each population density levels under the magnitude range of 6.2 – 6.9. Thus, the factor for fatality of 0.066 percent shall be assigned to the low population density level; double this value for the medium population density level; and triple the value for the high population density level. See second to the last row of Table A5.2.

c. Repeat the same procedure in step a) but this time using the value of 0.1 percent and divide it by 3 to get the difference of 0.33 percent for magnitude range 4.9 – 6.1.

Table A5.2 Factors for Fatality for Earthquake-related Hazards (except Liquefaction)

Magnitude of earthquake (Ms)	Affected Area	Factor for fatality based on population density (person/km²) /1,2		
		< 250	250 – 500	>500
4.9 – 6.1	HSA	3.30×10^{-4}	6.60×10^{-4}	1.00×10^{-3}
6.2 – 6.9	HSA MSA	6.60×10^{-4}	1.33×10^{-3}	2.00×10^{-3}
> 7.0	HSA MSA LSA	1.00×10^{-3}	2.00×10^{-3}	3.00×10^{-3}

It has to be emphasized that these values are estimates which warrant refinement and subject to historical reviews and possibly earthquake simulations. The damage estimates require local scenarios to adjust the values to local conditions.

2. HAZARDS FROM VOLCANIC ERUPTIONS

The factors for fatality for volcanic eruptions were computed based on the 100-year data of the Center for Research and Epidemiology of Disasters-Emergency Database (CRED-EM/DAT) presented in Table A5.4. The table presents the aggregated number of fatalities against the number of affected populations from 19 volcanic eruptions recorded in 1905-2005.

There were a total of 2,996 fatalities from volcanic eruptions, out of the 1,541,518 total affected population. Following the formula for factor for fatality, F_F = no. of dead/ no. of affected persons, this results in a factor for fatality of 0.002, for a 100-year period. Since volcanic hazards have return periods of 300 years as worst case scenario, the 0.002 factor was assigned to frequent events (>500 person/km² density), as shown in Table A5.3.

Then, similar to the computation done on earthquake related hazards, the factors for fatality and property damage are distributed proportionally across these levels of events (HSA, MSA, LSA, or Frequent, Likely, and Rare). This results in a factor of 6.00 x 10^{-3} for worst case scenario. It follows the assumption that with stronger eruptions, fatality rates increase, since coverage may be wider and the intensity greater. The factors for fatality are shown in Table A5.3.

Table A5.3 Factors for Fatality for Volcanic Eruption

Hazard Event	Affected Area	Factor for fatality based on population density (person/km²)		
		< 250	250 – 500	>500
Frequent	HSA	6.66×10^{-4}	1.33×10^{-3}	2.00×10^{-3}
Likely	HSA MSA	1.33×10^{-3}	2.66×10^{-3}	4.00×10^{-3}
Rare	HSA MSA LSA	2.00×10^{-3}	4.00×10^{-3}	6.00×10^{-3}

Event rates should normally consider specific volcanoes as reference; hence the average taken here does not consider these assumptions. Local studies to establish rates of occurrence and consequence on active volcanoes need to be pursued.

Table A5.4 Disaster Damage and Loss Data from Past 100 years (1905 to 2005) by events

Hazard	# of Events	Killed	Injured	Homeless	Affected	Total Affected	Damage US $(000)
Volcano	19	2,996	1,188	79,300	1,461,030	1,541,518	227,959
Factor: 0.002	*Ave. per event*	*158*	*63*	*4,174*	*76,896*	*81,133*	*11,998*
Flood	63	2,661	570	500,841	9,930,999	10,432,410	431,231
Factor: 0.0002	*Ave. per event*	*42*	*9*	*7,950*	*157,635*	*165,594*	*6,845*
Wave / Surge	6	69	0	5,250	1,012	6,262	2,330
Factor: 0.01							
Ave. per event		12	0	875	169	1,044	388

Note: For data to be included in the database, at least one of the following criteria must be fulfilled: 10 or more people reported killed, 100 people reported affected, declaration of a state of emergency, call for international assistance.

Source: NDCC and CRED, 2007

3. HYDROMETEOROLOGIC HAZARDS

3.1. Floods

The 100-year data of CRED-EM/DAT in Table A5.4 registered 63 events, 2,661 fatalities with 10,432,410 population affected and loss of US$431.231million. Taken on an event basis, this translates to about 42 killed, 165,594 persons affected and US$6.845 million in property damage.

An estimate for the factor for fatality based on this record shown is computed as:

Factor for fatality = no. of dead /no. of affected persons
= 42/ 165,594
= 2.54 x 10^{-4} fatality/person (2.54 in 10,000)

Events included in the aggregation are assumed to be independent events that have varied return periods and varying geographic coverage. It is assumed that stronger events (higher return periods, frequent events) contribute to the averages.

A comparison is made from shorter period reports. Table A5.5 shows yearly summary aggregates of affected population, not specific to provinces or smaller areas, and are contributions from different flood events. Based on the period 2001-2006 on flood occurrences in Table A5.5, lower averages of fatality rates have been recorded (5.15 in 100,000 to 1.09 in 10,000).

Table A5.5 Floods Fatality Averages Per Event

Flashfloods / Floods	No. of Incidents	No. of Dead	Affected Persons	Indicative Factor for Fatality
2001	27	61	561,642	1.09 x 10^{-4}
2002	19	70	1,245,602	5.62 x 10^{-5}
2003	46	70	647,650	1.08 x 10^{-4}
2004	42	8	697,122	1.15 x 10^{-5}
2005	28	21	273,305	7.68 x 10^{-5}
2006	1	37	717,931	5.15 x 10^{-5}

Source of basic data: OCD-NDCC

Several factors affect the accuracy of the number such as the actual boundaries of affected population and geographic factors, among others. In view of these limitations, an initial estimate is taken for frequent events using the factor 1x10^{-4} (1 in 10,000).

Stronger events (likely events) are further assumed to create twice the risk for affected areas. Recall in Chapter 4 that hazard flooding maps only classify areas as prone or not prone to flooding.

Having set the upper thresholds for the different events, the corresponding values for population densities (persons/ sq km) less than 250, and the range of 250-500 are assigned values one third and two thirds of the threshold set at 500 persons/sq km, respectively.

Table A5.6 Factors for Fatality for Floods

Hazard Event	Affected Area	Factor for fatality based on population density (person/km²)		
		< 250	250 – 500	>500
Frequent	Flood-prone areas	3.3x10^{-5}	6.6 x10^{-5}	1.0x10^{-4}
Likely	Flood-prone areas	6.6x10^{-5}	1.33x10^{-4}	2.0x10^{-4}

The values used are initial estimates subject to validation for each area.

Box A5.1 Return Period and Factors for Fatality and Damage: Floods

In Chapter 4, it has been clarified that these factors are applicable only to areas that are prone to flooding as reflected in the flood susceptibility maps or flood hazard maps. It will be up to the planner to assess flooding in the area based on past occurrences to determine whether to use frequent or likely factors for fatality. Definitions of frequent and likely events presented in Chapter 3 are as follows:

(a) Frequent – Many events are frequent over a lifetime; and
(b) Likely – A single event is likely over a lifetime.

A return period of ≤10 years is assigned to frequent events and > 10 years for likely events. The Surigao del Norte disaster risk assessment identifies the flood-prone areas as likely events with a return period of 100.

3.2. Rain-induced Landslides

Records on rain-induced landslides (Table A5.7) report the number of persons affected in specific areas. The factors for fatality range from 10^{-2} to 10^{-3}, higher than the values for flood and earthquake events. The danger of using high values, however, may create an impression that landslides cause more deaths per year compared to earthquakes and floods, which may not be accurate for the Philippines.

Thus, it is suggested that the factor for fatality for frequent events (5 years and below) be set to $1x10^{-4}$, comparable with that for floods. Likely events (6 to 25 years) are further assumed to create risk to an individual twice this number; and rare events at thrice the risk. These numbers are assigned to population densities higher than 500 persons/sq km.

Table A5.7 Landslides Data: 2000 and 2003-2006

Year	Areas Covered	No. of Incidents	No. of Dead	No. of Persons Affected	Indicative Factor for Fatality
2000	Landslides	17	247	19,019	$1.30x10^{-2}$
2003	Landslides-most from Region XI	14	170	10,432	$1.63x10^{-2}$
2004	Landslides- most from ARMM,XI,V	14	34	25,948	$1.31x10^{-3}$
2005	Landslides- most from IVB,CAR,XI	9	8	2,234	$3.58x10^{-3}$
2006	Landslides VIII-XI, CAR	13	30	4,305	$6.97x10^{-3}$

Source: NDCC and CRED, 2007

Having set the upper thresholds for the different events, the corresponding values for population densities less than 250 persons/sq km, and the range of 250-500 persons/sq km are assigned values one third and two thirds of the threshold set at 500 persons/sq km, respectively (Table A5.8).

Table A5.8 Factors for Fatality for Rain-induced Landslide

Hazard Event	Affected Areas	Factor for fatality based on population density (person/km²)		
		< 250	250 – 500	>500
Frequent	HSA	$3.3x10^{-5}$	$6.6x10^{-5}$	$1.0x10^{-4}$
Likely	HSA MSA	$6.6x10^{-5}$	$1.3x10^{-4}$	$2.0x10^{-4}$
Rare	HSA MSA LSA	$1.0x10^{-4}$	$2.0x10^{-4}$	$3.0x10^{-4}$

In the absence of more information regarding fatality factors, it is suggested that local values be determined from predefined potentially affected areas using overlays of hazard maps and barangay maps. The affected area may be gridded in squares and future actual affected population and actual fatalities will be counted in these grids. Spatial factors may be obtained differentiating fatality rates for each potentially affected area. Comparisons may then be made across affected areas.

3.2. Storm Surges

Based on the 100-year data by CRED-EM/DAT in Table A5.4, six events of storm surges have been registered, with 61 fatalities among 6,262 people affected and a loss of US$2.3 million. Taken on an event basis, this results in about 12 killed, 1,044 persons affected and US$0.38 million worth of losses. The events are taken to be likely events (6 events in 100 years).

Based on Table A5.4, an estimate for the factor for fatality is computed as:

Factor of fatality = no. of dead / no. of affected persons
= 12/ 1044
= $1.19x10^{-2}$ fatality/person (for likely events)

The average factor for fatality is in the order of 10^{-2} and is quite high. The potential impact areas of coastal surges are limited unlike floods and earthquakes. In a similar argument as with rain-induced landslides, aggregating the values without the proper spatial referencing may cause values to be higher, since it is possible that the affected persons are concentrated in one area and does not represent a proper distribution of fatalities in different coastlines of the country. For example, in August 2006, a storm surge hit Zamboanga del Sur, affecting one city, eight municipalities and seven barangays, with one killed among 4,075 people affected (factor for fatality would be $2.45x\ 10^{-4}$). In 2003, six incidents of storm surges were recorded (OCD-NDCC) resulting in one death and 1,205 affected persons (factor for fatality is $8.3x10^{-4}$).

While these may provide evidence to the argument, the actual fatality factors vary across the country and hence field validation is needed to determine representative values for the various segments of the coastlines. For these guidelines, it is suggested that the values be initially set to $1x10^{-3}$ under likely events.

Table A5.9 Factors for Fatality (Storm Surges)

Hazard Event	Affected Area	Factor for fatality based on population density (person/km²)		
		<250	250-500	>500
Frequent	HSA	$1.67x10^{-4}$	$3.3x10^{-4}$	$5.0x10^{-4}$
Likely	HSA MSA	$3.3x10^{-4}$	$6.7x10^{-4}$	$1.0x10^{-3}$
Rare	HSA MSA LSA	$5.0x10^{-4}$	$1.0x10^{-3}$	$1.5x10^{-3}$

B. FACTOR FOR PROPERTY DAMAGE

1. EARTHQUAKE-RELATED HAZARDS

The same assumptions as those for factors for fatality are followed in determining the factors for property damage across magnitude ranges and property values.

MMEIRS indicates a factor for property damage of 12.7 percent under a 7.2 magnitude (PEIS, VIII) earthquake in a high population density area. The same factor is used for events with magnitude of > 7.0 (worst case scenario).

It is assumed that factors for property damage can be applied to provinces with similar *g value* as Metro Manila. However, using this default value will overestimate risks for provinces of Cebu, Bohol, Negros Oriental and Siquijor in Region 7 and provinces of Cagayan, Isabela, and Quirino in Region 2, and underestimate risk for parts of Davao (0.56 *g value*).

The assumption here is that these factors are only applicable to damage in built-up areas and not for damage to agricultural crops. Generally, earthquake-related hazards have very significant impact on built-up areas.

Table A5.10 Factors for Property Damage (Built-up Areas) for Earthquake-related Hazards

Magnitude of earthquake (Ms)	Affected Area	Factor for Property Damage Per Range of Property Value		
		< 10M	10 M – 100 M	>100 M
4.9 – 6.1	HSA	$1.4x10^{-2}$	$2.8x10^{-2}$	$4.2x10^{-2}$
6.2 – 6.9	HSA MSA	$2.8x10^{-2}$	$5.6x10^{-2}$	$8.5x10^{-2}$
> 7.0	HSA MSA LSA	$4.2x10^{-2}$	$8.5x10^{-2}$	$1.27x10^{-1}$

Again, it has to be emphasized that these values are estimates which warrant refinement and subject to historical reviews and possibly earthquake simulations.

2. HAZARDS FROM VOLCANIC ERUPTIONS

Based on CRED EM-DAT data, average event damage for volcanic eruptions (assumed in these Guidelines as frequent) is US$11,998. Comparing this with the average earthquake event damage:

Scale = Volcanic Damage/Earthquake Damage
= 11.998/40.147
= 0.3

This number means that the scale of potential damage for hazards from volcanic eruptions is 0.3 or 30 percent of earthquake damage. Using 12.7 percent as the value for the factor for damage for earthquakes, the factor for damage for hazards from volcanic eruptions is assumed to be scale (0.3) x (12.7) or 3.8 percent

The value is set for frequent events. The factors for the likely and rare events under the >100 million value are assumed twice and thrice this value following a linear proportion.

Table A5.11 Factors for Property Damage (Built-up Areas) for Hazards from Volcanic Eruptions

Hazard Event	Affected Area	Factor for Property Damage Per Range of Property Value		
		< 10 M	10 M – 100 M	>100 M
Frequent	HSA	$1.30x10^{-2}$	$2.50x10^{-2}$	$3.80x10^{-2}$
Likely	HSA MSA	$2.50x10^{-2}$	$5.00x10^{-2}$	$7.60x10^{-2}$
Rare	HSA MSA LSA	$3.80x10^{-2}$	$7.60x10^{-2}$	$1.14x10^{-1}$

Having set the upper thresholds for the different events, the corresponding values for property values in the range of below PhP10 million, and between PhP10 million – PhP100 million are assigned values one third and two thirds of the threshold set at > PhP100 million, respectively. Similar to earthquake-related hazards, the factors apply to built-up areas.

3. HYDROMETEOROLOGIC HAZARDS

3.1. Floods

A review of related literature indicates that a general approximation of damage would be possibly on result of a study done by the National Disaster Coordinating Council (NDCC) and World Bank entitled "National Disaster Risk Management in Philippines: Enhancing Poverty Alleviation through Disaster Reduction." Similarly, it makes use of the total number of deaths and the total number of affected population presented in Table A5.4 also sourced and summarized from the CRED-EM/DAT database.

The factor for property damage cannot be computed directly since only costs of damage are recorded. The amount of property value from which a percentage is computed should also be available. A scaling of damages is then used to obtain estimates of these percentages (or the factors for property damage).

Based on Table A5.4, the average damage for flood events (assumed in these Guidelines as frequently occurring) is about US$6.845 million. Comparing this with the average earthquake event damage:

Scale = Floods Damage/Earthquake Damage
= 6.845/40.147
= 0.17

This number means that the scale of potential damage for hazards from floods is 0.17 or 17 percent of earthquake damage. Rounding this figure to 15 percent and benchmarking this with MMEIRS value of factor of damage for earthquakes of 12.7 percent, the value for the factor for property damage for earthquakes is (0.15) x (12.7) = 1.9 percent or 2.0 percent.

It is then assumed that for frequent flood events a threshold may be set initially to 2.0 percent. Likely events are further assumed to create risk to an area twice this number. These numbers are assigned property values higher than PhP100 million.

Having set the upper thresholds for the different events, the corresponding factors for property values in the range of below PhP10 million, and between PhP10 million – PhP100 million are assigned values one third and two thirds of the threshold set at PhP100 million, respectively.

Taking the factor of 2 percent at face value for agricultural areas (especially for those planted with crops) is quite low but may be true for built up areas. In most cases, damages are generally higher for agricultural areas arising from a wider coverage of floods and damage to crops. In likely events, it may be assumed, as a first estimate, that the crop areas suffer 100 percent loss or a factor of 1. Table A5.13 presents factors used for crop damage.

Table A5.12 Factors for Property Damage (Built-up Areas) from Floods

Hazard Event	Affected Area	Factor for Property Damage Per Range of Property Value		
		< 10M	10M – 100M	>100M
Frequent	Flood-prone areas	6.67×10^{-3}	1.3×10^{-2}	2.0×10^{-2}
Likely	Flood-prone areas	1.33×10^{-2}	2.67×10^{-2}	4.0×10^{-2}

Table A5.13 Factors for Property Damage (Crops) from Floods

Hazard Event	Affected Area	Factor for Crop Damage Per Range of Property Value		
		< 10M	10 – 100M	>100M
Frequent	Flood-prone areas	1.67×10^{-1}	3.33×10^{-1}	5.00×10^{-1}
Likely	Flood-prone areas	3.33×10^{-1}	6.66×10^{-1}	1.00

Refer to Box A5.1 for explanation on return period and factors for fatality and property damage for floods.

3.2 Rain-induced Landslides

The factor for damage cannot be obtained directly from the records of rain-induced landslides (RIL) since very few data are existing to establish percentages. Based on CRED-EM/DAT data, damage for landslide events (assumed in these Guidelines as frequent events) is US$1.409 million. Comparing this with the average earthquake event damage:

Scale = Flooding Damage/Earthquake Damage
= 1.409/40.147
= 0.035

This means that the scale of potential damage for rain-induced landslides is 0.035 or 3.5 percent of earthquake damage. Benchmarking this with MMEIRS value of factor of damage for earthquakes of 12.7 percent, the value for the factor for property damage for rain-induced landslides is (0.035) x (12.7) = 0.44 percent. For purposes of these Guidelines, this number has been rounded off to one percent.

Table A5.14 Factors for Property Damage (Built-up Areas) from Rain-induced Landslides

Hazard Event	Affected Area	Factor for property damage based on property value /1		
		< 10M	10 M – 100M	>100M
Frequent	HSA	$3.30x10^{-3}$	$6.70x10^{-3}$	$1.00x10^{-2}$
Likely	HSA MSA	$6.70x10^{-3}$	$1.33x10^{-2}$	$2.00x10^{-2}$
Rare	HSA MSA LSA	$1.00x10^{-2}$	$2.00x10^{-2}$	$3.00x10^{-2}$

For frequent rain-induced landslide events (return period of 5 years), a threshold may be set initially to 1.0 percent. Likely events (return period of 25 years) are further assumed to create risk to an area twice this number. These numbers are assigned to property values higher than PhP100 million.

Having set the upper thresholds for the different events, the factors for property values in the range of below PhP10 million, and between PhP10 million - PhP100 million are assigned values one third and two thirds of the threshold set at PhP100 million, respectively.

In general, it may be assumed that like floods, the damage from rain-induced landslides is similarly higher for agricultural areas. The factor of property damage used for the built-up areas (Table A5.14) of 1 percent to 3 percent is quite low for agricultural areas. As a first estimate, assume that loss is taken as 75 percent of the areas affected under rare occurrences. Unlike floods which may cover plain areas, landslides may damage crop areas in slopes and in debris accumulation zones. Flooding may similarly result from obstructions of river ways or create temporary dams of flood waters created by debris and large volumes of sediments.

Table A5.15 Factors for Property Damage (Crops) from Rain-induced Landslides

Hazard Event	Affected Area	Factor for crop damage based on crop value		
		< 10M	10 – 100M	>100M
Frequent	HSA	$8.25x10^{-2}$	$16.75x10^{-2}$	$2.50x10^{-1}$
Likely	HSA MSA	$16.75x10^{-2}$	$33.25x10^{-2}$	$5.00x10^{-1}$
Rare	HSA MSA LSA	$2.50x10^{-1}$	$5.00x10^{-1}$	$7.50x10^{-1}$

3.3 Storm Surges

Based on CRED EM-DAT data, damage for surges (assumed in these Guidelines as likely) averages US$ 0.38 million. Comparing this with the average earthquake event damage:

Scale = Flooding Damage/Earthquake Damage
= 0.38/40.147
= 0.0094

This means that the scale of potential damage for hazards from flooding is 0.0094 or 0.94 percent or approximately one percent of earthquake damage. Benchmarking this with MMEIRS value of factor of damage for earthquakes of 12.7 percent, the value for the factor for property damage for earthquakes is (0.01) x (12.7) = 0.127 percent. However the value may be too low especially for coastal areas. Thus, we assume one percent as the factor to be used for likely events.

Table A5.16 Factors for Property Damage for Storm Surges

Hazard Event	Affected Area	Factor for Property Damage Per Range of Property Value (in PhP)		
		< 10M	10 – 100M	>100M
Frequent	HSA	$1.67x10^{-3}$	$3.30x10^{-3}$	$5.00x10^{-3}$
Likely	HSA MSA	$3.30x10^{-3}$	$6.70x10^{-3}$	$1.00x10^{-2}$
Rare	HSA MSA LSA	$5.00x10^{-3}$	$1.00x10^{-2}$	$1.50x10^{-2}$

Having set the upper thresholds for the different events (> PhP100 million), the corresponding values for property values in the range of below PhP10 million, and between PhP10 million–PhP100 million are assigned values one third and two thirds of the threshold set at PhP100 million, respectively.

ANNEX 6
GIS-BASED DISASTER RISK ASSESSMENT

This annex is divided into three parts. The first introduces the basic concepts of the Geographic Information System (GIS). The second explains the framework and assumptions in conducting disaster risk assessment (DRA) under a GIS environment. The third demonstrates the step-by-step procedure in performing DRA, from hazard analysis to risk prioritization, as outlined in Chapter 4 using a sample GIS dataset. The procedures in encoding and digitizing the maps and table were not included anymore as these can be obtained elsewhere (from GIS texts and software manuals) and varies from one software package to another.

A. FUNDAMENTAL CONCEPTS

GIS is a set of tools for collecting, storing, manipulating and managing spatially-referenced information. Strictly, it applies to computer-based systems. A typical GIS consists of hardware, software, data, people and processes. Spatial features are stored in a coordinate system (latitude/longitude, state plane, Universal Transverse Mercator (UTM), etc.) which references a particular place on the earth. Descriptive attributes in tabular form are associated with spatial features. Spatial data and associated attributes in the same coordinate system can then be layered together for mapping and analysis. GIS is widely used for scientific investigations, resource management, and development planning.

The DRA process discussed in Chapter 4 is iterative and data intensive. Although the calculations can be done manually or through spreadsheets, the computerized platform of a GIS has the following advantages:

a. GIS puts structure and organization to the complex and numerous input planning variables as it allows integration of the various data sets coming from different sources;
b. GIS makes use of reusable sets of information that can be utilized for other planning-related purposes; and
c. GIS is a powerful visualization and evaluation tool able to provide rapid and concise means of presenting DRA results and hence facilitate decision making and policy formulation.

However, GIS is still but a tool that enhances or facilitates analysis. It cannot replace basic planning logic or analytical skills.

To perform DRA in a GIS platform, the following are needed: data set, software, and a method of analysis.

1. GIS DATASET

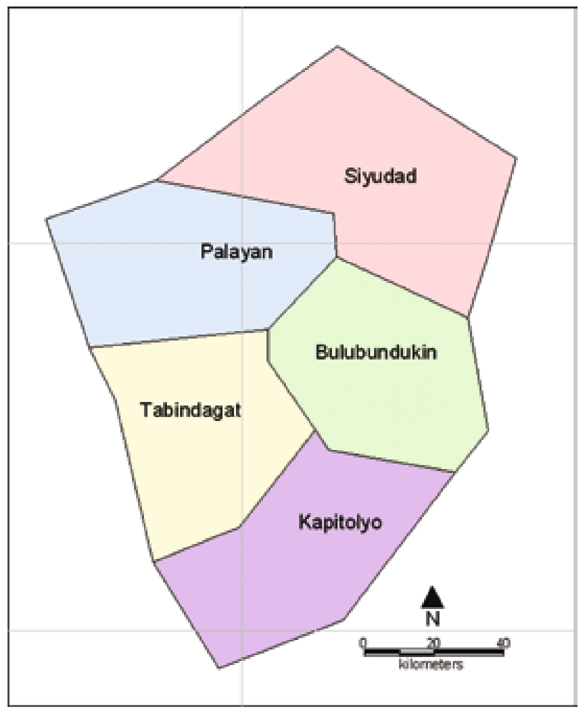
A GIS dataset is composed of a digitized map and an attribute table linked internally with each other. Unlike its paper counterpart, a GIS map contains a single theme or layer like administrative boundary or hazard. Map features can be a point, line or polygon type. Also, each theme contains only one type of feature although there can be many features in a theme.

Consider the hypothetical provincial boundary map shown in Figure A6.1, which is an example of a GIS dataset consisting of five municipalities (features) represented by five polygons. This map has an accompanying attribute table (Table A6.1), which consists of fields or columns that describe the features in the dataset. These feature descriptions are called attributes.

Table A6.1 Attribute Table for Digital Map (Figure A6.1)

MUNI_ID	NAME	AREA	POPULATION
1	Siyudad	1467.22	51200
2	Palayan	1122.93	23043
3	Tabindagat	1014.86	28532
4	Bulubundukin	1029.47	14215
5	Kapitolyo	1086.34	24350

Figure A6.1 Hypothetical Provincial Boundary Map (Dataset)



Each feature is given a unique identifier that is usually located in the first column. In the example above the unique identifier is MUNI_ID, with attributes like the municipality name (NAME), the area in kilometers (AREA), and population (POPULATION).

Fields may be added to the attribute table in which additional description about each feature may be entered by either assigning a value or computing it from existing fields. For example, if the population density is desired for each municipality, a POPU_DEN field can be inserted after the POPULATION field. The value can then be computed for each feature using a formula, e.g., POPU_DEN = [POPULATION]/[AREA]. The values can also be entered directly by keyboard entry or from a look-up table based on criteria from the other fields.

2. SOFTWARE[1]

GIS software forms an important component of a GIS-based DRA. The worked-out example of the DRA methodology presented in the next section was implemented using ArcView® GIS v3.2[2] software platform and has also been tested in ArcGIS v9.2. However, the methodology can also be applied in other GIS software packages as long as the essential routines like sieve mapping (overlays), attribute query and field calculation functions are present.

Implementing a GIS-based DRA may require considerable initial investment because of the costs involved in getting the necessary hardware and software, and the human resource training required to operate the system. The range of prices of GIS software may vary from free[3] to low cost to high end. The price ranges usually correspond to the functional capabilities, ease of use, and the availability of technical support. While computing requirements largely depend on the software procured and the volume of data, an ordinary desktop PC with Pentium® III grade processor with minimum of 512Mb memory and disk space of about 20Gb may be sufficient to carry out the methodology at the scale expected of regional and provincial planning.

However, what should be emphasized is that a successful GIS need not be too expensive. There are open source softwares which can substitute for commercial softwares. If a GIS is procured only for the purpose of doing the DRA, then it may not be worth the effort and investment. The GIS data generated from the DRA process could be (re)used for other physical framework and development planning activities. On the other hand, the hardware could be also used for ordinary, daily and routine tasks like spreadsheet and word-processing applications.

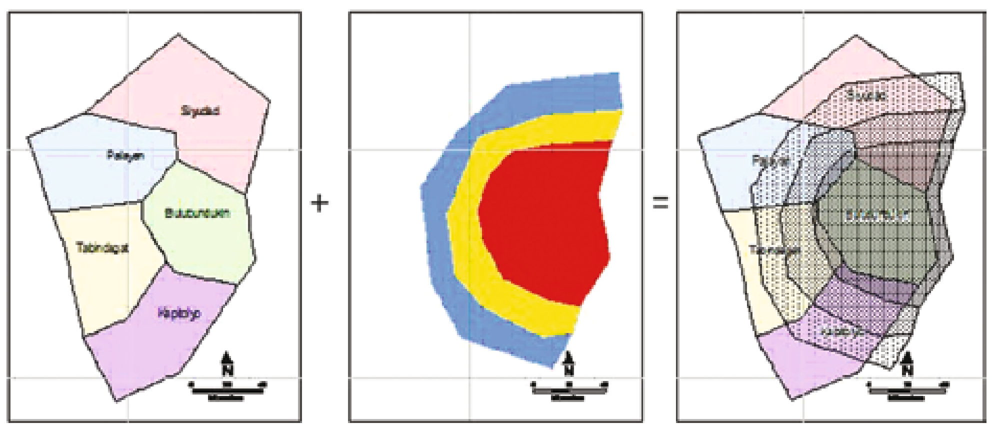
[1] The brand and make of products appearing here are mentioned for illustrative purposes and do not imply endorsement of NEDA.
[2] The choice of this software package was based on the result of surveys of NEDA Regional Offices which shows ArcView to have highest number of users and degree of familiarity.
[3] "Free software" or "open source" software are distributed with a free software license, and whose source code is available to anyone who receives a copy of the software.

3. METHODS OF SPATIAL ANALYSIS

Spatial analysis allows for the combination of two or more input GIS datasets to meet a certain criteria based on spatial relationship of the features present in the input datasets.

The most common spatial analysis is the overlay method using a UNION relationship mode. To illustrate this method, consider the hypothetical provincial boundary map shown earlier.

Figure A6.2 Illustration of Overlays of Different Thematic Maps



(a) Provincial Boundary — (b) Hazard Map — (c) Combined Map Using Overlay Method (Union)

Suppose you want to know which of the municipalities in Figure A6.1 are affected by a hazard. You need to combine the provincial boundary map and the hazard map. Suppose, further, the hazard map has the following attributes:

Table A6.2 Attribute Table for the Hypothetical Hazard Map

HAZARD_ID	LEVEL
1	3
2	2
3	1

The resulting map is illustrated in map (c) of Figure A6.2. It can be seen that the original number of features (five for the provincial boundary and three for hazard) resulted in 20 new features.

The combined table of the boundary and hazard map appears similar to Table A6.3. Each feature would retain a characteristic from the input features depending on the location. For example, the municipality Palayan would still be represented by a single feature since the whole municipality is located within a single hazard zone (LEVEL=3). Municipalities or portions of municipalities not located in the hazard are given a hazard LEVEL of zero. On the other hand, portions of the hazard zones not falling into any municipality feature will not have any entry in the NAME field, as well.

Notice however, that the spatially dependent fields like AREA change in proportion to the size of the resulting features.

Table A6.3 Attribute Table of the Administrative Boundary and Hazard Map Combined Using Map Overlay

FID	MUNI_ID	NAME	AREA	POPU_DEN	HAZARD_ID	LEVEL
0	2	Palayan	28.48	302.71	0	0
1	5	Kapitolyo	17.44	330.53	0	0
2	1	Siyudad	18.16	516.48	0	0
3	3	Tabindagat	11.71	414.63	0	0
4	0		16.24	0.00	1	3
5	0		8.22	0.00	2	2
6	0		18.95	0.00	3	1
7	2	Palayan	8.69	302.71	1	3
8	2	Palayan	18.84	302.71	2	2
9	2	Palayan	20.12	302.71	3	1
10	5	Kapitolyo	14.24	330.53	1	3
11	5	Kapitolyo	20.83	330.53	2	2
12	5	Kapitolyo	21.16	330.53	3	1
13	1	Siyudad	23.68	516.48	1	3
14	1	Siyudad	23.67	516.48	2	2
15	1	Siyudad	33.63	516.48	3	1
16	3	Tabindagat	8.55	414.63	1	3
17	3	Tabindagat	25.29	414.63	2	2
18	3	Tabindagat	23.26	414.63	3	1
19	4	Bulubundukin	69.79	203.68	1	3

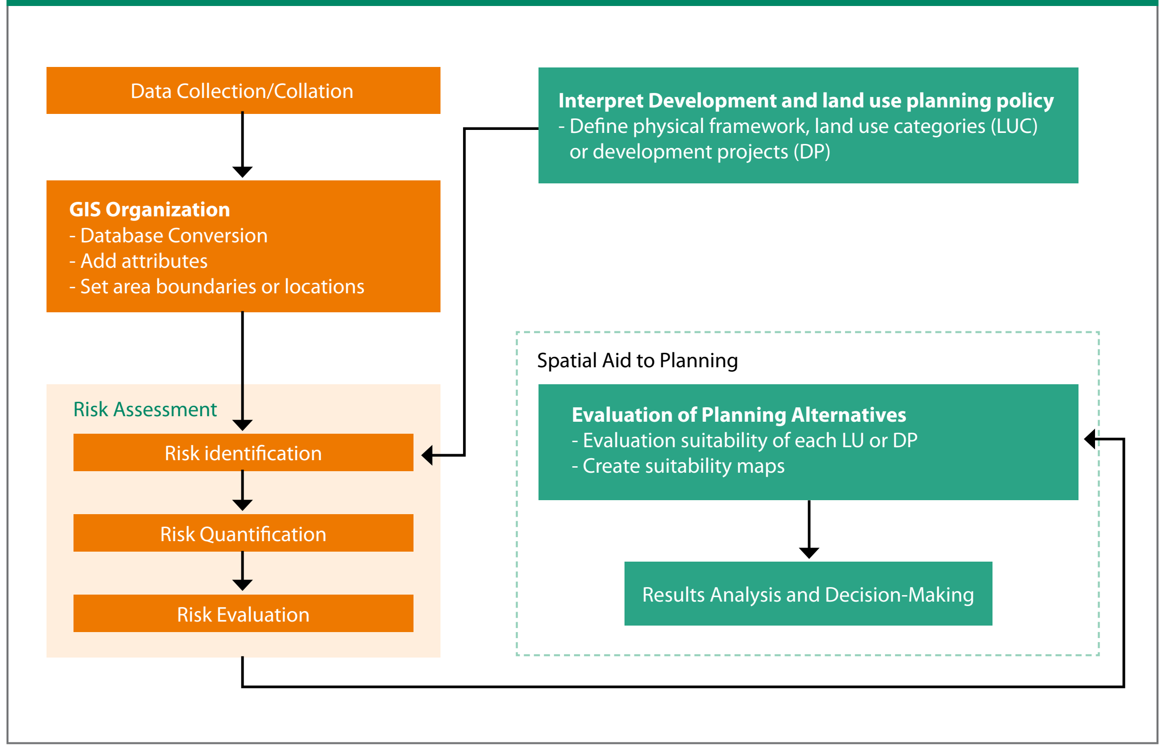
One other mode of overlay is INTERSECT. Through this method, only the portion common to both datasets are retained in the output. Each combination of attributes in the input features results in a separate feature. Figure A6.2 shows an example of the hazard and administrative boundary overlain with each other. It shows that only the portion common to both hazard zone and administrative boundary are retained.

B. GIS-BASED DISASTER RISK ASSESSMENT

1. GIS FRAMEWORK

The GIS framework for disaster risk assessment is as follows:

Figure A6.3 GIS Framework for DRA



Part of the preparatory stages of a GIS-based risk assessment includes collection of data on planning environment as well as of the hazards. The input data can be maps and tabular data in hard copy and/or digital form. The GIS computing environment provides a way to store, process and organize the collected datasets in a spatially-implicit and consistent manner. This component involves conversion of tabular and mapped data to relational databases, adding attribute information to digitized

maps and setting boundaries or locations of the element at risk. In this phase, data integration becomes a challenge especially if data come from various sources. The main risk assessment component involves identifying, quantifying and evaluating the risk, given a certain hazard. The whole process of risk assessment as undertaken in a GIS is discussed in detail in the rest of this Annex. Identifying potential risks require appreciation of current development and existing land use planning policy. The quantification and evaluation of risk also depends on the current and desired physical framework and the prospective development paths. At this stage, defining different land use categories or development options are essential in order to determine risk level relative to the value of the elements at risk. The results of a risk assessment exercise are measures of risk. In a GIS-based environment, risk maps can also be generated to show areas of relatively high risk, safe or unsafe zones and some indications or patterns of commonality or contiguity between or among affected areas.

The results of risk assessment are then used to aid the planning process by evaluating different planning alternatives for a given area against the risk generated by GIS analysis in a highly visual manner. The suitability of a present or future land use or development plan can be checked against the level of risk it is situated in. In this phase, for example, suitability maps can be drawn where planned development is overlain on the risk map. Decisions can then be made calling for either the adoption or rejection of one or many planning alternatives based on the presence and value of associated risks.

2. DATA REQUIREMENTS FOR DISASTER RISK ASSESSMENT

2.1. Hazard Maps

The location of hazards can be found from hazard maps which are being produced by the mandated agencies —Philippine Institute of Volcanology and Seismology (PHIVOLCS), Mines and GeoSciences Bureau (MGB), and Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). On the other hand, the frequency of hazard occurrences is ascertained from analysis of historical data. Multihazard maps have been prepared through the READY Project. The technical reports describe the nature of the hazard level designations.

Table A6.4 shows the minimum contents of the attribute table of each type of map. The same contents are used in demonstrating the DRA methodology in subsequent sections.

Table A6.4 Typical File Attribute Table and Description of GIS Datasets Used

Coverage	Data Field	Meaning/Content/Possible value
Administrative		
1. Barangay boundary	PROVI_ID	Unique province identifier
	PROVI_NAME	Name of the province
	MUNI_ID	Unique identifier for municipality
	MUNI_NAME	Name of the municipality
	BRGY_ID	Unique identifier for barangay
	BRGY_NO	Barangay no.
	NAME_2000	Name of barangay as of 2000
	NAME_2002	Name of barangay as of 2004
	AREA	Area (in hectares)
	PERIMETER	Perimeter (in kilometers)
	POPULATION	Population
	POP_DEN	Population density
2. Municipal boundary	PROVI_ID	Unique province identifier
	PROVI_NAME	Name of the province
	MUNI_ID	Unique identifier for municipality
	MUNI_NAME	Name of the municipality
	MUNI_TYPE	LGU Type
	MUNI_TYPEN	LGU Type in number
	AREA	Area (in hectares)
	PERIMETER	Perimeter (in kilometers)
	POPULATION	Population
	POP_DEN	Population density
	TFA2007	Total floor area by 2007
	TRA2007	Total residential floor area by 2007
3. Provincial Boundary		
Land use and land cover		
Land use	ID	Unique feature identifier
	LU_TYPE	Planning Land use type (text) Settlement Production Protection Infrastructure
	LU_NAME	Specific land use type (DA-BSWM Classification, text) Protection Other land uses Urban area Agriculture Production forest Mining area
	LU_CODE	Numerical equivalent of DA-BSWM classification

Coverage	Data Field	Meaning/Content/Possible value
Community-based Forest Management		
CBFM	CBFM_ID	Unique identifier
	CBFM_NAME	Name of CBFM Community
	CBFM_NO	DENR CBFM Community No.
	PO	Property Owner
	DATE_ISSUE	Date issued
	AREA_HA	Area in hectares
	MEMBERS_NO	No. of Members
	CONTACT_PE	Contact person
Elevation		
Contour	CONTOUR_ID	Unique identifier
	ELEV	Elevation
Elevation	ELEV_ID	Unique identifier
	ELEV	Elevation range (text) in 20m interval
Hazards		
Earthquake-induced landslides	LS_ID	Unique identifier
	LS_LEVEL	Landslide level (text) Areas not susceptible to earthquake-induced landslides Areas with low susceptibility to earthquake-induced landslides Areas with moderate susceptibility to earthquake-induced landslides Areas with high susceptibility to earthquake-induced landslides
	LS_NO	Numeric equivalent of landslide level
	LABEL	label
Earthquake-induced landslide deposition	ID	Unique identifier
	DEPOSITION	(text)
	AREA_KM	Area covered (in square kilometers)
	PERIM_KM	Perimeter (in kilometers)
Ground rupture	GR_ID	Unique identifier
	GR_NAME	Ground rupture (text)
	LENGTH_M	Length (in meters)
Liquefaction	LIQ_ID	Unique identifier
	LIQ_LEVEL	Susceptibility to liquefaction (text) Low Moderate High
	LIQ_NO	Numerical equivalent
Flood prone areas	FL_ID	Unique identifier
	FL_TYPE	Areas Flood prone (1) Not flood prone (0)
	FL_NO	Numeric equivalent of flooding type

Table A6.4 Typical File Attribute Table and Description of GIS Datasets Used

Coverage	Data Field	Meaning/Content/Possible value
Rain-induced Landslides	RIL_ID	Unique identifier
	RIL_TYPE	Landslide feature present (text): No susceptibility Low susceptibility Moderate susceptibility High susceptibility Accumulation zone Flooded area
	RIL_NO	Numeric equivalent of landslide feature present
Storm Surge	SURGE_ID	Unique identifier
	SURGETYPE	Inundation level Inundation of >1m to >4m surge Inundation of >4m surge
	SURGELEVEL	Numeric equivalent of inundation level present
Infrastructure		
LGU Centers	LONGITUDE	Longitude - Geographic coordinates of LGU Center
	LATITUDE	Latitude - Geographic coordinates of LGU Center
	ELEVATION	Elevation of LGU Center
	LOCATED_US	Method of location
	LGU_ID	LGU ID number
	LGU_TYPE	LGU Center type (text) Provincial City Municipality Barangay
	LGU_TYPEID	Numerical equivalent of LGU Center type
	LGU_NAME	Name of LGU Center
	LGU_LOCATI	Textual description of LGU Center
Line Infrastructure	INFRA_ID	Unique ID
	INFRA_TYPE	Infrastructure Type (Number) 1. Power Transmission Line 2. National road
	INFRATYPE_	Numeric equivalent of Infrastructure type
	INFRA_NAME	Name of Infrastructure
	VALUE	The value of infrastructure per unit length (PhP/km)
	YEAR_VALUE	Year valuated

2.2. Administrative Boundary with Population Data

One of the fundamental data for planning is the administrative boundary. In the Philippines, there are three main possible sources of administrative boundary. The first source is the Land Management Service of the Department of Environment and Natural Resources (LMS-DENR) found in each region, particularly the Field Network Survey Party (FNSP). The barangay boundary, plotted in their Cadastral Index Maps (CIMs), is derived during the cadastral surveys and considered more accurate because of the availability of technical description of their metes and bounds. The national mapping agency, NAMRIA, depicts municipal boundaries in their base maps. However, NAMRIA itself claims that these boundaries are approximate. There are five national maps, 13 regional maps and 77 provincial maps available in NAMRIA as of 2007.

Table A6.5 National Maps, as of 2007

Map Sheet No.	Scale	Size
25	13,651,400	49cm x 63cm

Table A6.6 Regional Maps, as of 2007

Scale	Size	Coverage
1:250,000	Varies	Region 1,2,3,5,6,7,8,and CAR
1:250,000	Varies	Region 4 (4 sheets)
1:250,000	Varies	Region 9,10,11 and 12

Table A6.7 Administrative Maps, as of 2007

Region	Province	Map Scale	Region	Province	Map Scale
ARMM	Lanao del Sur	1:150,000	V	Camarines Sur	1:150,000
ARMM	Maguindanao	1:200,000	V	Catanduanes	1:50,000
ARMM	Sulu	1:250,000	V	Masbate	1:200,000
ARMM	Tawi-Tawi	1:250,000	V	Sorsogon	1:150,000
CAR	Abra	1:150,000	VI	Aklan	1:150,000
CAR	Apayao	1:150,000	VI	Antique	1:200,000
CAR	Benguet	1:150,000	VI	Capiz	1:150,000
CAR	Ifugao	1:150,000	VI	Guimaras	1:50,000
CAR	Kalinga	1:150,000	VI	Iloilo	1:200,000
CAR	Mt. Province	1:150,000	VI	Negros Occidental	1:250,000
I	Ilocos Norte	1:150,000	VII	Bohol	1:150,000
I	Ilocos Sur	1:200,000	VII	Cebu	1:250,000
I	La Union	1:50,000	VII	Negros Oriental	1:250,000
I	Pangasinan	1:200,000	VII	Siquijor	1:50,000
II	Batanes	1:150,000	VIII	Biliran	1:50,000
II	Cagayan	1:250,000	VIII	Eastern Samar	1:250,000
II	Isabela	1:200,000	VIII	Leyte	1:250,000
II	Nueva Vizcaya	1:150,000	VIII	Northern Samar	1:200,000
II	Quirino	1:150,000	VIII	Samar	1:200,000
III	Bataan	1:150,000	VIII	Southern Leyte	1:100,000
III	Bulacan	1:150,000	IX	Basilan	1:75,000

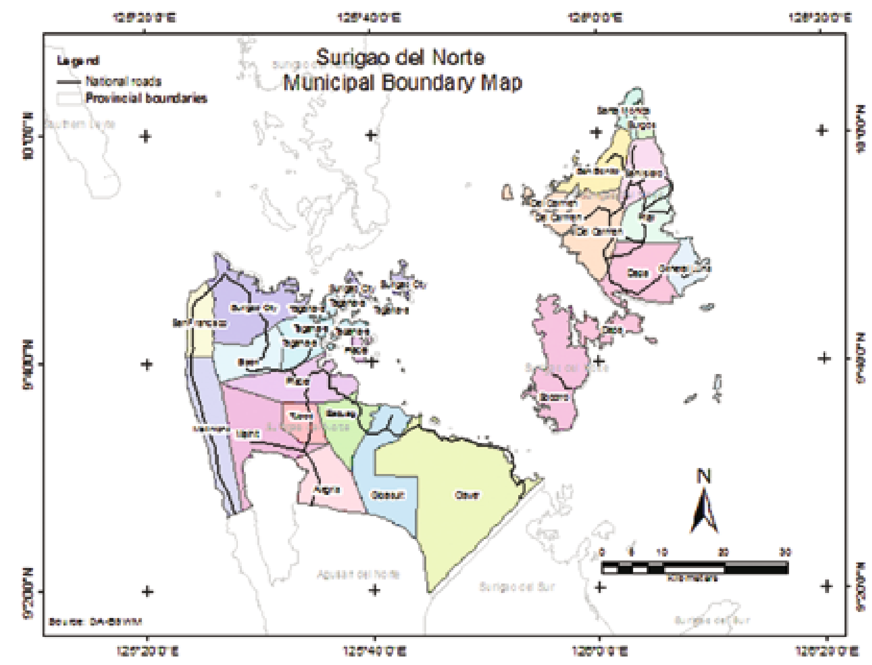
Region	Province	Map Scale	Region	Province	Map Scale
III	Nueva Ecija	1:150,000	IX	Zamboanga del Norte	1:200,000
III	Pampanga	1:75,000	IX	Zamboanga del Sur	1:200,000
III	Tarlac	1:100,000	X	Bukidnon	1:200,000
III	Zambales	1:150,000	X	Camiguin	1:150,000
III	Aurora	1:200,000	X	Misamis Occidental	1:150,000
NCR	Manila	1:50,000	X	Misamis Oriental	1:150,000
IVA	Batangas	1:150,000	X	Surigao del Norte	1:150,000
IVA	Cavite	1:50,000	X	Lanao del Norte	1:150,000
IVA	Laguna	1:150,000	XI	Cotabato South	1:150,000
IVA	Quezon	1:250,000	XI	Davao del Norte	1:150,000
IVA	Rizal	1:100,000	XI	Davao del Sur	1:150,000
IVB	Marinduque	1:50,000	XI	Davao Oriental	1:250,000
IVB	Occidental Mindoro	1:250,000	XII	Cotobato North	1:200,000
IVB	Oriental Mindoro	1:200,000	XII	Sultan Kudarat	1:150,000
IVB	Palawan	1:100,000	Caraga	Agusan del Norte	1:150,000
IVB	Romblon	1:100,000	Caraga	Agusan Del Sur	1:200,000
V	Albay	1:150,000	Caraga	Surigao Del Sur	1:200,000
V	Camarines Norte	1:150,000	Caraga	Surigao Del Norte	1:150,000

The second possible source is the local government units (LGUs) themselves or the municipality or component cities. Usually, these LGUs settled on their own definition of their administrative boundaries that are preferably used in their planning documents like the Comprehensive Land Use Plans (CLUP). The municipal or city boundary is then formed by combining the inclusive barangay boundaries.

The third source is the National Statistics Office (NSO) which also has its data on administrative boundaries up to the level of the barangay. The boundary maps are used as a basis to define the population for each barangay. Subsequently, the population density in succeeding levels of administrative unit (barangays to municipalities to provinces) is computed based on these boundaries.

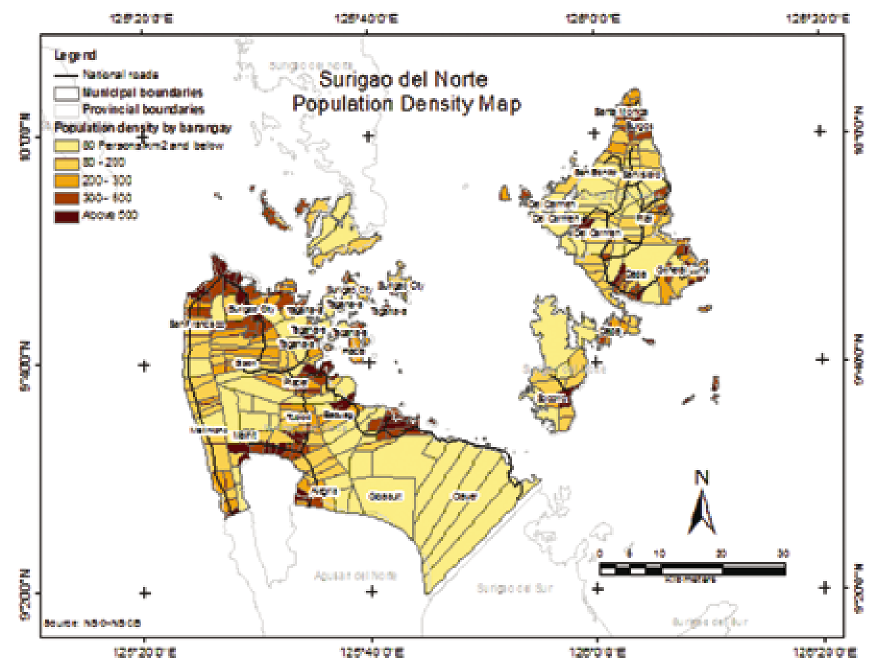
Because of inconsistencies in boundaries from among the sources, questions arise as to which boundary data should be adopted when performing risk assessment. It should be borne in mind that the planning scale is much smaller than these inconsistencies so that boundary conflicts will not significantly affect the outcome of the risk estimates. Therefore, one should not be deterred from proceeding with the DRA on the notion that no accurate boundary data is available.

Figure A6.4 Administrative (Municipal) Boundary Map of Surigao del Norte



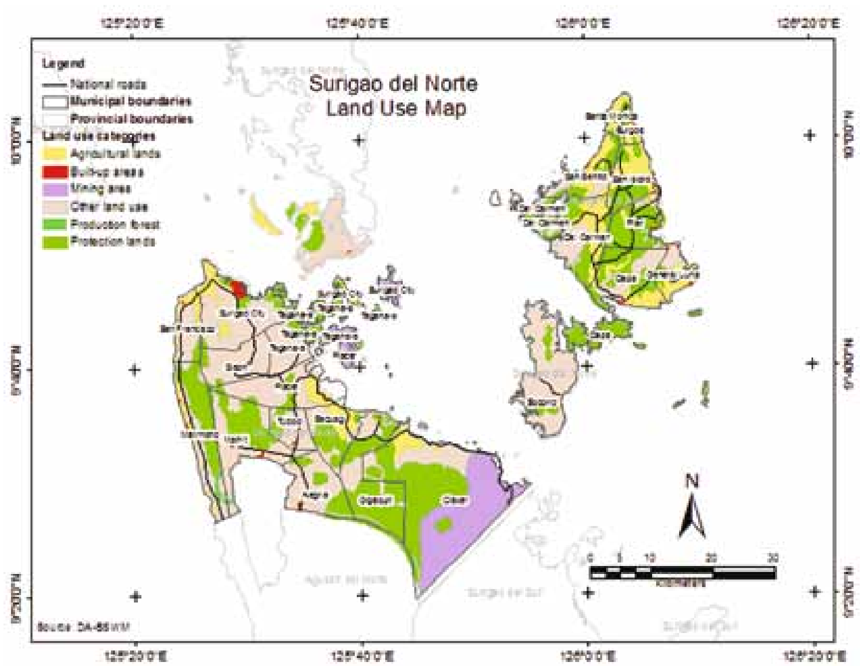
Source: Adapted from Provincial Government of Surigao del Norte

Figure A6.5 Population Density (Barangay Level) Map of Surigao del Norte Province



Source: NSO

Figure A6.6 Land Use Map of the Province of Surigao del Norte



Source: DA-BSWM, undated

There are many sources of land use maps. The Bureau of Soils and Water Management (BSWM) of the Department of Agriculture (DA) produced land use maps for agricultural planning. Most of the Regional Physical Framework Plans (RPFP) make use of these maps. The land use maps from cities and municipalities were generated as a requirement in the formulation of their CLUPs. The land use maps of municipalities and cities within a province can be combined to form a generalized land use map for the province or region.

2.3. Property values

The Guidelines estimate damage to property using data on damage to built-up and agricultural areas. Representative property values for built-up areas may be obtained from the data on residential and nonresidential structures under the Census of Population and Housing of the NSO. Every quarter the NSO releases, in its website, the data on the total floor area constructed and cost of construction summarized by province. The method to compute for the latest total floor area per municipality is presented in Annex 4.

For agricultural areas, the value considered is the cost of production. The agricultural office of every province or municipality may have this data. A national average for rice, corn and other common crops is found in the website of DA.

3. GIS DATA STANDARDS AND MAPPING CONVENTIONS

For the thematic maps to be consistent, certain conventions are used for preparing geographic datasets from their original form (i.e., the paper maps). In a GIS, consistency in coordinate systems used is necessary when performing spatial modelling. Spatial modelling attempts to describe the interaction or processes of real world objects by using map calculation.

The Philippines Reference System of 1992 (PRS92) is the unified reference system for surveys and mapping as provided for by Executive Order (EO) No. 45, series of 1993. For purposes of analysis and preparation of the Guidelines, the PRS92 mapping conventions shall be used with the following parameters:

a. Reference Ellipsoid

The Philippines uses a Clarke 1866 spheroid model with characteristics found in Table A6.8.

Table A6.8 Characteristics of the Clarke's Ellipsoid of 1866

Characteristic	Dimension
Length of the major axis, a	a = 6378206.4 m
Flattening, f	1/f = 294.9786982 m

b. Reference Datum

The Luzon Datum of 1911 is defined by its marker near San Andres Point on Marinduque Island in the Southern Tagalog Region. That point is at station Balanacan (a port name) which contains the characteristics found in Table A6.9.

Table A6.9 Characteristics of the Luzon Datum

Characteristic	Value
Latitude, f	13° 33' 41.000" North
Longitude, l	121° 52' 03.000" East of Greenwich

c. Map Projection

Map projection is a system of converting geographic coordinates (latitude, longitude, height) to flat grid (Northing, Easting, height) plane coordinates. The standard map projection used for base maps in the Philippines is the Universal Transverse Mercator (UTM). The Philippines belong to Zone 51 of the UTM with the exception of Palawan (Zone 50) and small parts of northeastern provinces (Zone 52). The scale factor at the central meridian is 0.9996. The 1:50,000 scale base maps of the NAMRIA are plotted using the UTM projection.

Table A6.10 Characteristics of the Universal Transverse Mercator (UTM) Applied to Philippine Territories

Definition	Value		
	Zone 50	Zone 51	Zone 52
Extent	114º to 120º	120º to 126º	126º to 132º
Longitude of Central Meridian (CM)	117º	123º	129º
Latitude of CM	0º (The Equator)		
Grid Coordinates at CM origin	N_0 = 0 m. E_0 = 500,000 m.		
Scale factor at origin	0.9996		

Major GIS software packages include the PRS92 parameters in their list of reference systems or possess the flexibility to be customized to include PRS92.

Most casual mapmakers use the Global Positioning Systems (GPS) receivers to determine the position of features on the ground. The GPS, however, is based on a set of ellipsoid and datum parameters called the World Geodetic System of 1984 (WGS84). Usually, the WGS84 position measurements are expressed in geographic coordinates (latitude, to longitude. height). Relative to the scales at which regional or provincial plans are prepared, the differences in coordinates between PRS92 and WGS84 should not be very large such that it may be negligible. Those with collected data using a GPS and need to transform the WGS84 coordinates to PRS92 is directed to the Revised Manual of Surveys of the Philippines (DENR Department Administrative Order 98-12, Section 50) for the detailed instructions.

4. DATA SOURCES

Paper maps and tabular data are the common sources of geographic data to be entered in the GIS. These maps or tables are published by mandated agencies. For example,

NAMRIA is responsible for producing topographic data (see Table A6.11 for available Topographic Maps in NAMRIA) while the NSO is expected to collect demographic data. Usually, maps are digitized, edited and verified before they could be processed for GIS-based analysis. On the other hand, nonspatial data such as tables and lists can be entered in the GIS if it contains at least some form of implicit referencing; for example, the location of an area with a certain population count and is known by its place name. If a digitized map contains features with the place name as one of its attributes, then the tabular data could be linked to the digitized map.

Table A6.11 Available Topographic Maps in NAMRIA

Scale	Coverage
1:250,000	Covers the whole Philippines
1:50,000	Most comprehensive topographic map coverage
1:10:000	Metro Manila Provinces of Bulacan, Catanduanes, Aurora, Quirino; Cities of Puerto Princesa, Iligan, Gen. Samoa, Lucena, Tagbilaran, Cagayan de Oro, Bacolod, Bago, Cebu, Baybay, Ormoc, Davao, Tagaytay, Antipolo, Marikina; Municipalities of Balanga, Magalang, Taguig, Pateros, and San Juan.
1:5,000	Covers Urban areas of Bacolod City, Iligan City, Metro Iloilo, Metro Cebu and Cagayan De Oro City

C. RISK ESTIMATION: WORKED-OUT EXAMPLE IN ARCVIEW™

This section presents the step-by-step procedure in disaster risk assessment discussed in Chapter 4 using GIS. The example used is Surigao del Norte, and the hazard is Rain-induced Landslide (RIL).

Based on the procedures as detailed, GIS operations can start only after the Hazard Characterization and Frequency Analysis are completed. Thus, the following should be readied before proceeding with the estimations in GIS:

Hazard Inventory Matrix based on information, maps and data sets collected from mandated agencies

To be able run the risk estimations, shape files of the following maps (including the attribute table) should be readied:

a. Hazard map
b. Population density per barangay map
c. Municipal boundary map
d. Land use map

The minimum attributes needed for each shape file is indicated in Table A6.4. For purposes of demonstration, it is assumed that all attributes in Table A6.4 are available.

The worked-out example will use the default return periods contained in Chapter 4, Table 4.10, **Summary Frequency Table** which contains the estimated return periods of all geologic and hydrometeorologic hazards affecting the region or province.

Four major steps in the disaster risk assessment can be performed in GIS, as follows:

1. Assigning Return Periods
2. Estimating Risk of Fatality
    a. Determining Potentially Affected Population for Every Hazard
    b. Computing Consequence of Fatality per Hazard Event
    c. Estimating Risk of Fatality
3. Estimating Risk of Property Damage
    a. Determining Potentially Affected Property for Every Hazard
    b. Computing Consequence of Property Damage per Hazard Event
    c. Estimating Risk of Property Damage
4. Determining the Composite Priority Score for Each Municipality

1. ASSIGNING RETURN PERIODS

After gathering all maps and preparing the hazard inventory matrix, the next step is to assign the return period for each hazard event. Default values were provided in Chapter 4, in case the hazard map obtained does not provide this information. For hydrometeorologic hazards such as rain-induced landslides, the indicative return periods are as follows:

Table A6.12 Indicative Return Period for Rain-induced Landslides (RIL)

RIL_ID	Level of Susceptibility	Indicative annual probability
1	No susceptibility	0
2	Low susceptibility	100
3	Moderate susceptibility	25
4	High susceptibility	5
5	Accumulation zone	5
6	Flooded area	5

The "Low susceptibility" in table above is equivalent to the LSA indicated in Table 4.9 in Chapter 4; "Moderate susceptibility" is the MSA; and High Susceptibility, Accumulation Zone, and Flooded Area are the HSAs. Table 4.9 though already lumped the accumulation zone and flooded area under HSAs.

The return period should be inputted in the attribute table of the hazard map. In ArcView™, the assignment of probability of occurrences for hazards can be done in the following manner:

a. Open the shape file for the hazard, hazard.shp, and make the file editable **(Theme→ Start Editing).**

b. Open the attribute table (**Theme→ Table** or click on the **Table icon**). In the Edit menu, select **Add Field**.

c. Set field name as RETURN, set the data type as Number with Width set to 8 and 0 Decimal place. Click **OK**.

d. To select rain-induced hazard areas with no susceptibility (Table A6.12, first row), go to **ArcView main menu→Table →Query**. There should be a field called "RIL_NO" which refers to the index of the different susceptibility levels. In the Query dialog box, type:

   ([Ril_no]) = 1.

   Click **New Set**. Those that match the criteria should be highlighted (e.g., with a yellow color).

e. To assign the corresponding return period to each level of susceptibility, set the Right-click on the RETURN field. From the **ArcView main menu → Field→ Calculate**. In the dialog box below the (RETURN) =, type 0. The values for RETURN should change to 0.

f. Follow steps d to e. This time, change the values according to Table A6.12. For example, to select areas with high susceptibility, flooded areas and accumulation zones, type in the query box:

[Ril_type]="High susceptibility") OR ([Ril_type]="Flooded area") OR ([Ril_type]="Accumulation zone")

g. From the **ArcView main menu →Field → Calculate**. In the dialog box below the (RETURN) =, type the corresponding return period (e.g., for High Susceptibility, type 5).

h. Save your modified data (**ArcView main menu → Table →Save Edits**)

At this stage, the attribute table of the hazard map should look like this:

Shape	Ril_id	Ril_type	Ril_no	Return
Polygon	1	Flooded area	6	5
Polygon	2	Moderate susceptibility	3	25
Polygon	3	Low susceptibility	2	100
Polygon	4	High susceptibility	4	5
Polygon	5	Accumulation zone	5	5
Polygon	6	No susceptibility	1	
Polygon	7	Moderate Susceptibility	3	25

2. ESTIMATING RISK OF FATALITY

2.1. Determining Potentially Affected Population (P_{AP}) for Every Hazard

As indicated in Chapter 4 (under Consequence Analysis), the potentially affected population is calculated based on the intersection of the overlays of the hazard map and the population density map.

a. Open the shape file of population density data per barangay and make it ready for editing (**Table→Start Editing**). The barangay population density map should include, at the minimum, the following attributes:

PROVI_NAME	Name of the province
MUNI_ID	Unique identifier for municipality
MUNI_NAME	Name of the municipality
BRGY_ID	Unique identifier for barangay
BRGY_NO	Barangay no.
NAME	Name of barangay
AREA	Area (in hectares)
POPULATION	Population
POP_DEN	Population density

b. Open the attribute table, click on the last column. In the main menu, select Edits menu, and click **Add Field.**

Set field name as FTLFAC, set the data type as Number (width = 2, Decimal places = 0. Click **OK**. In this field, you will indicate which population density grouping the area belongs.

Save the edited shape file popden_brgy.shp (**ArcView main menu →Table→Save Edits**)

c. Set the values for the FTLFAC field according to the population density based on the following grouping:

Population Density Criteria	In the FTLFAC field, type:
([Pop_den] <= 250)	1
([Pop_den] >= 250) and ([Pop_den] <= 500)	2
([Pop_den] > 500)	3

d. To add a FTLFAC level 1 to barangays with population density of less than 250 people per square kilometer, click on the Query Builder icon and in the dialog box, type:

[POP_DEN] <= 250

Click **New Set** and exit. Those that match the criteria should be highlighted (e.g., in yellow color).

e. Click on the FTLFAC field, then go to **ArcView main menu →Field →Calculate**, type 1 in the dialog box. The values for highlighted FTLFAC should change to 1.

f. Do the same steps for barangays with population density of 250-500, and above 500.

Save your modified data (**ArcView main menu →Table → Save Edits**).

g. Now that the population density map has been updated, combine the density map and hazard map. In ArcView, this can be done by following these steps:

Open the shape files popden_brgy.shp and hazard.shp and start editing.
Open the Geoprocessing Extension, go to **File →Extensions→ Geoprocessing**.
Click on the checkbox and Click **OK**.

Go to **View→Geoprocessing wizard→Union two themes→Click Next** >>. Enter the following:

- Select input theme to union: popden_brgy.shp. Make sure that the "Use selected features only" is unchecked; and
- Select polygon overlay to union: hazard.shp. Make sure that the "Use selected features only" is unchecked.

Specify the output file to be popu_risk_hazard.shp. Keep all the default settings as is. Click **OK**.

By combining the population density map and the hazard map, barangays – or parts of barangays – and size of the area that falls under HSA, MSA, or LSA is shown. The combined map should show that one barangay may fall under one or all of these three categories. The combined attribute table also shows how many people are potentially affected in each HSA, MSA, or LSA.

2.2. Computing Consequence of Fatality

a. This step refers to Chapter 4 Section B2.2.1

b. Open the popu_risk_hazard.shp GIS file (if not yet opened). Open the attribute table and start editing.

c. Make sure to update the AREA field first before proceeding. To do this, select the AREA field heading and go to **ArcView main menu→Field →Calculate.** Type:

([Shape].ReturnArea)/1000000.

d. A field is then added for the consequence per event. Start estimating the consequence for the High Susceptibility Areas (HSAs) and name this field CONSEQH. To add a new field, open the attribute table, click on the last column and select **Add Field.**

Set field name as CONSEQH, (width:18, Decimal places: 8). Click **OK**.

Recall that HSAs are those delineated by hazard agencies as highly susceptible to the given hazard, or frequent events with return period of five years or less.

The divisor "1000000" is used to get area in square kilometers because ArcView's default unit is square meters. Also, it is likely that the attribute table resulting from the union of population density and hazard maps will have more than one columns of "Area." This is normal since all fields are being combined in the Union command.

As a rule, though, you only need one "Area" attribute for the entire process. It is suggested that you retain only the first "Area" attribute (or column) from the left, and update this same column every time you complete a phase/process. However, this does not preclude you from adding additional fields to indicate Area.

For example, one AREA field may contain the original area of each municipality in the province. Another field (say, Area1) may contain the actual area of features (polygon) within the municipality. Retaining the original area of each municipality in AREA is useful in estimating the proportion of a quantity with respect to a municipality when the data is available only for a municipality, e.g., quantity for small area = quantity for entire municipality x AREA of small area / AREA of entire municipality.

To illustrate, rice area is reported per municipality and contained in the field RICEAREA. Therefore, the estimate of rice area for smaller features with AREA1 will be RICEAREASMALL = RICEAREA*AREA1/AREA

The reference tables for this operation are Tables 4.21 to 4.25 of Chapter 4. For rain-induced landslide, Table 4.23 is presented anew for the factors for fatality.

Table 4.23 Factors for Fatality for Rain-induced Landslide

Hazard Event	Affected Area	Factors for fatality (FTLFAC)		
		< 250 (persons/ sq km)	250 – 500 (persons/ sq km)	>500 (persons/ sq km)
Frequent (CONSEQH)	HSA	3.30×10^{-5}	6.60×10^{-5}	1.00×10^{-4}
Likely (CONSEQM)	HSA MSA	6.60×10^{-5}	1.33×10^{-4}	2.00×10^{-4}
Rare (CONSEQL)	HSA MSA LSA	1.00×10^{-4}	2.00×10^{-4}	3.00×10^{-4}

e. Determine the probability of fatality for barangays with population density of less than 250 people per square kilometer and with return periods less than or equal to five years (third column, first row of Table 4.23 above). The probability of fatality for this combination is 0.000033.

To select areas with this combination, go to **ArcView main menu → Table → Query**. In the Query dialog box, type:

([FTLFAC]=1) AND ([RETURN] <=5).

Click **New Set**. Those that match the criteria should be highlighted.

f. To compute the consequence for this combination, right-click on the CONSEQH field, **ArcView main menu →Field →Calculate**. Select the CONSEQH field. In the dialog box, type the following formula:

0.000033*([Area])*([Pop_den])

g. Repeat steps e and f to compute for probability of fatality for barangays with population density of 250-500 (FTLAC = 2) and 500 above (FTLFAC = 3). The factors for fatality to be used are 0.000066 and 0.0001, respectively.

To select level: ([FTLFAC]=2 AND ([RETURN]=5).
To compute the consequence: 0.000066*([Area])*([Pop_den])
To select: ([FTLFAC]=3 AND ([RETURN]=5).
To compute the consequence: 0.0001*([Area])*([Pop_den])

Selection syntax: CONSEQH (GIS Command: Query)	Factors for fatality	Value for CONSEQH (GIS Command: Calculate)
([FTLFAC]=1) AND (([RETURN]=5)	0.000033	0.000033*([Area])*([Pop_den])
([FTLFAC]=2) AND (([RETURN]=5)	0.000066	0.000066*([Area])*([Pop_den])
([FTLFAC]=3) AND (([RETURN]=5)	0.0001	0.0001*([Area])*([Pop_den])

h. For the next level/return period, create another field called CONSEQM (Width: 18, Decimal places: 8)

Both the moderate susceptibility (MSA) and high susceptibility areas (HSA) are selected. The selection syntax and factors are shown below:

Selection syntax: CONSEQM (GIS Command: Query)	Factors for fatality	Value for CONSEQM (GIS Command: Calculate)
([FTLFAC]=1) AND (([RETURN]=5) OR ([FTLFAC]=1) AND ([RETURN]=25))	0.000066	0.000066*([Area])*([Pop_den])
([FTLFAC]=2) AND (([RETURN]=5) OR ([FTLFAC]=1) AND ([RETURN]=25))	0.000133	0.000133*([Area])*([Pop_den])
([FTLFAC]=3) AND (([RETURN]=5) OR ([FTLFAC]=3) AND ([RETURN]=25))	0.0002	0.0002*([Area])*([Pop_den])

i. For the next consequence level:

Do previous steps for next return period (CONSEQL) until finished with the low, moderately and highly susceptible area. The selection syntax and factors are shown below:

Selection syntax: CONSEQL (GIS Command: Query)	Factors for fatality	Value for CONSEQL (GIS Command: Calculate)
([FTLFAC]=1) AND (([RETURN]=5) OR ([FTLFAC]=1) AND ([RETURN]=25) OR ([FTLFAC]=1) AND ([RETURN]=100))	0.0001	0.0001*([Area])*([Pop_den])
([FTLFAC]=2) AND (([RETURN]=5) OR ([FTLFAC]=2) AND ([RETURN]=25) OR ([FTLFAC]=2) AND ([RETURN]=100))	0.0002	0.0002*([Area])*([Pop_den])
([FTLFAC]=3) AND (([RETURN]=5) OR ([FTLFAC]=3) AND ([RETURN]=25) OR ([FTLFAC]=3) AND ([RETURN]=100))	0.0003	0.0003*([Area])*([Pop_den])

By this time the CONSEQH, CONSEQM and CONSEQL fields, although not all, contain values. Save edits.

2.3. Estimating Risk of Fatality

This step refers to Chapter 4 Section C3.3.1

The calculation of risk of fatality can be operationalized in ArcView as follows:

a. Open the popu_risk_hazard.shp file and start editing.

b. Update the AREA field, click on the AREA field and Calculate

(([Shape].ReturnArea)/1000000)

c. Add another field called POPU_RISK (Number, Width=18, Decimal places=8)

d. Click on the POPU_RISK field heading, right-click and select Field Calculator.

e. Select those areas where there is consequence from a high frequency. Go to **ArcView main menu→Table→ Query**. In the Query dialog box, type:

[CONSEQH]>0

f. In the Field Calculator fields list, select the POPU_RISK and enter the following expression:

[CONSEQM]*((1/5)-(1/25))+ [CONSEQL]*((1/25)-(1/100))

Click **OK**.

g. Select those areas where there is consequence from a moderate frequency event but none from high frequency event. Go to **ArcView main menu→ Table→Query**. In the Query dialog box, type:

[CONSEQH]=0 AND [CONSEQM]>0.

In the Field Calculator fields list, select the POPU_RISK and enter the following expression:

[CONSEQM]*((1/25)-(1/100))+[CONSEQL]*((1/25)-(1/100))

h. Finally, select those areas where there is consequence from a low frequency event but none from high and moderate frequency events. Go to **ArcView main menu→Table→Query**. In the Query dialog box, type:

[CONSEQH] = 0 OR ([CONSEQM] = 0 AND [CONSEQL] > 0)

i. In the Field Calculator fields list, select the POPU_RISK and enter the following expression:

[CONSEQL]*(1/100)

3. ESTIMATING RISK OF PROPERTY DAMAGE

3.1 Determining Potentially Affected Property for Each Type of Hazard

As indicated in Chapter 4 Section B2.2.2, the potentially affected property is estimated by assigning an indicative value to each land use category that represents the cost of replacing the lost asset or property within that land. This is done in ArcView through the following steps:

a. Open the land use shape file. Open the attribute table and start editing.

b. **Add Field** for the unit costing. Go to **Edit→Add Field**. Name this field "UNIT_COST" (Number, Width=18, Decimal places=2).

c. Select the built-up areas and assign unit costing based on Table 4.13 of Chapter 4. Select the land use feature by **ArcView main menu→Table →Query**. In the query dialog box, type: ([Lu_name])="Built Up Areas"

d. Using the property value for built-up area (residential and nonresidential urban area) in Table 4.13 of Chapter 4 (PhP7,509.00/sq m), change the value of the UNIT_COST for built-up areas by going to **Assign Fields→Calculate**. In the Value dialog box, type 7509*10000 (without any comma).

The value was multiplied by ten thousand (10000) to convert the value in hectares (10,000 sq m = 1 hectare).

e. Using the property value for agricultural areas (based on value of crops planted) in Table 4.14 of Chapter 4 (PhP31,597.27/hectare), change the value of the

UNIT_COST for agricultural areas by going to **Assign Fields→Calculate**. In the Value dialog box, type 31597.27 (no comma). No need to multiply the value by ten thousand as the value is already per hectare.

f. Repeat the two previous steps for the other land use types. (Note that Chapter 4 only showed examples for Built-Up and Agricultural Land Use. Unit Cost for other types of land use should be generated by the region/province).

3.2. Computing Consequence of Property Damage Per Hazard Event

a. Estimate the consequence of damage to property

a.1. Computing for the total floor area (TFA) and the total residential area (RFA) for each municipality in the GIS.

a.1.1. Prepare a list of the latest TFA and RFA for each municipality as in Table 4.15 of Chapter 4.

a.1.2. Open the municipal boundary data, muni_boundry.shp and make it available for editing (**ArcView main menu →Table →Start Editing**).

a.1.3. Add a field called TFA and enter the total floor area values that were computed for each municipality.

a.1.4. Add a field called RFA, and enter the residential floor areas that were computed for each municipality.

a.2. Entering the crop area per municipality in the GIS

a.2.1. Prepare a list of total agricultural area per crop for each municipality as in Table 4.14 of Chapter 4.

a.2.2. Open the municipal boundary data, muni_boundry.shp and start editing it.

Add a field called <CROP>AREA, select the particular municipality and enter the total agricultural area values that were computed for each municipality. For example if the crop area is for palay, the field should be called PALAYAREA; for corn, CORNAREA; and so on.

a.3. Combining the land use and municipal boundary data and updating the area value

a.3.1. Open the land use data and the municipal boundary data.

a.3.2. Combine the land use and municipal boundary data using the UNION command. This step is necessary so that the land use values are disaggregated according to municipality. It is suggested that the output filename be expo_property.shp.

a.3.3. Open the expo_property.shp. attribute table and create a field called AREA_1. This is where the area of each municipality is transferred. The field AREA_1 shall be used later. Click on the AREA_1 field heading and equate it to the current AREA values. Using Field Calculator, type:

AREA

a.3.4 Update the AREA field by using the Field Calculator. Use sq km as unit. The syntax is:

([Shape].ReturnArea)/1000000

b. Determine the urban area per municipality

b.1. Open the expo_property.shp. attribute table and create a field called URBANAREA. This is where the urban area of each municipality is stored. Here it is assumed that your built-up area is equivalent to your urban area.

b.2. Select all the built-up areas for a particular municipality. For example to find the built-up area for municipality named Bayan1, go to **ArcView main menu →Table →Query** and in the Query dialog box, type:

([Lu_name])= “Built-up area” and ([Muni_name]) = “Bayan1”

In some cases, none is selected when you do this operation. This only means that the particular municipality has no built-up area.

b.3. Click on the field heading AREA, and go to **ArcView main menu→Field→ Statistics**. Copy the values for the Sum. This is the total built-up area for Bayan1.

b.4. Update the field URBANAREA with the number copied from the previous step. You can do this by going to **ArcView main menu→Field→Calculate** and in the Calculate box, paste the number copied.

b.5. Do the three previous steps for all other municipalities and cities.

c. Combine the property map and the hazard map.

c.1. Combine the exposure map expo_property.shp and the rain-induced landslide hazard map, hazard.shp using UNION command. Name the output risk map file as risk_property_hazard.shp.

c.2. In the risk_property_hazard.shp, add a field called VALUE (Number, Width=20, Decimal Numbers=2). This is where the values of the land use "parcels" are entered.

c.3. Update the AREA field, click on the AREA field and Calculate

(([Shape].ReturnArea)/1000000)

From hereon all GIS operations will be done on the risk to property map, risk_property_hazard.shp.

d. Estimate the values of the affected property and agricultural areas

d.1. Open the table for risk_property_hazard.shp and using Query, select the agricultural areas which lie in the hazard zone. A series of queries should be done to select the right areas. The syntax to the select agricultural areas is:

"LU_NAME"= 'Agricultural lands'

From the above selection, select those that are within the hazard zones. This time, NOTE: instead of Query New Set, use **Select from Set**.

"RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility'

From the above selection, those that are either palay or corn

("PALAYAREA">0 OR "CORNAREA">0 OR "AREA_1">0)

d.2. Select the VALUE field heading and using the Field Calculator, calculate the value of the agricultural area using the unit costs for each municipality found in Tables 4.13 and 4.14 of Chapter 4. Note that the unit costs per municipality are only available for palay and corn. The expression is:

[AREA] * 100 * (30486 * [PALAYAREA] + 17112 * [CORNAREA] + (61670 * 558 + 25228 * 108 + 98367 * 521) * ([AREA_1] / 2017)) / ([PALAYAREA] + [CORNAREA] + (558 + 108 + 521) * ([AREA_1] / 2017))

This step estimates the value of agricultural area for a portion of the municipality. Usually from agricultural census, the data on crop area are available per municipality only. Therefore, in order to estimate agricultural area for a portion of a municipality, a ratio-and-proportion method is employed. The method assumes that the proportion of each type of crop in one portion of the municipality is the same with that of the entire municipality.

For example, if area per municipality is available for palay and corn, a simple expression to get the unit cost would be:

Area x (Palay unit cost x Palay area per municipality + Corn unit cost x Corn area per municipality) / (Palay area per municipality + Corn area per municipality)

If area for other crops is available at the province level only, a ratio and proportion approach where each municipality is assumed to have agricultural areas proportional to the size of the province. For two types of crops, the expression to estimate value of agricultural land is:

(Area x Area per municipality / Area of entire province) x (Crop1 unit cost x Crop1 area per province + Crop2 unit cost x Crop2 area per province)

(Crop1 area per province + Crop2 area per province)

Therefore, the two previous expressions can be combined for cases where municipal and provincial level agricultural data are used:

Area x (Palay unit cost x (Palay area per municipality + Corn unit cost x Corn area per municipality) + (Crop1 unit cost x Crop1 area per province + Crop2 unit cost x Crop2 area per province) x Area per municipality / Area of entire province)) / ((Palay area per municipality + Corn Area per municipality) + (Crop1 area per province + Crop2 area per province) x (Area per municipality / Area of entire province))

"AREA*100" converts square kilometers into hectares (1km^2=100 hectares). The area field is given in hectares. 2017 is the total area of the province in square kilometers.

d.3. Select the built-up areas lying on the hazard zone. The syntax for the selection is:

("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility') AND "LU_NAME" = 'Built-up areas' AND "URBANAREA">0

d.4. Select the VALUE field heading and using the Field Calculator, calculate the value of the built-up area using the unit cost. The expression is:

[UNIT_COST]* [AREA]* [TFA2007] /([URBANAREA]*1000000)

d.5. Compute the consequence of property damage for each intensity level following the equation in Chapter 4 Section B2.2.2

d.6. Add three fields CONSEQH, CONSEQM, CONSEQL (All Number, Width=18, Decimal places = 8) to contain the consequence for high, moderate and low intensity events respectively.

d.7. Compute for the Consequence to Property for Frequent Events. To do this, first, select highly susceptible areas (HSAs) and areas with potentially damage to property that is less than ten million pesos (PhP <10 Million). Go to **ArcView main menu → Table → Query.** In the Query dialog box, type:

("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility') AND ("VALUE"<10000000)

d.8. When the areas meeting the criteria are selected, compute for consequence to property by multiplying the corresponding factor for damage and the computed value of property. In the case of rain-induced landslides, the factor for damage for this combination is 3.3 x 10^{-3}, or 0.0033

To do this, right-click on the CONSEQH field, and go to **ArcView main menu → Field →Calculate**. Select the CONSEQH field. In the dialog box, type the following formula:

0.003333*([VALUE])

d.9 Repeat the last 3 steps above, this time, using the other combinations of HSA and value of 10-100 million, and HSA and value of over 100 million. Refer to Tables 4.27 to 4.33 in Chapter 4 (factor tables).

Repeat the process for Likely and Rare Events (CONSEQM, CONSEQL). Since there are three hazard intensity levels, there will be nine combinations, three for each frequency level.

Similar to the procedure for consequence of fatality, the consequence of property damage for a 25-year return period includes the Moderate and High Susceptibility Areas (MSA and HSA) while the consequence of property damage for a 100-year return period includes the Low, Moderate and High Susceptibility Areas (LSA, MSA and HSA).

Table A6.13 Expression Used in Selecting Hazard and Conditions and the Equivalent Consequence Value Computation for Built-Up Areas According to Table 4.31 of Chapter 4

Expression for selection	Consequence computation
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility') AND ("VALUE">10000000 AND "VALUE"<100000000)	[VALUE] *0.0067
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility') AND ("VALUE">100000000)	[VALUE]*0.010
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility') AND "VALUE"<10000000	[VALUE] *0.0067
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility') AND ("VALUE">10000000 AND "VALUE"<100000000)	[VALUE] *0.0133
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility') AND ("VALUE">100000000)	[VALUE] *0.02
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility') AND "VALUE"<10000000	[VALUE] *0.01
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility') AND ("VALUE">10000000 AND "VALUE"<100000000)	[VALUE] *0.02
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility') AND ("VALUE">100000000)	[VALUE]* 0.03

d.10. Since the factor of damage for agriculture for hydrometeorologic hazards is different from built-up areas, they need to be computed separately. First the affected agricultural areas are selected using the expression:

"LU_NAME" = 'Agricultural lands'

d.11. (Re)compute (using Calculate) the consequences for high, moderate and low frequency events as follows:

Expression for selection	Consequence computation
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility') AND ("VALUE">10000000 AND "VALUE"<100000000)	[VALUE] *0.1675
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility') AND ("VALUE">100000000)	[VALUE]*0.25
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility') AND "VALUE"<10000000	[VALUE] *0.1675
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility') AND ("VALUE">10000000 AND "VALUE"<100000000)	[VALUE] *0.3325
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility') AND ("VALUE">100000000)	[VALUE] *0.5
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility') AND "VALUE"<10000000	[VALUE] *0.01
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility') AND ("VALUE">10000000 AND "VALUE"<100000000)	[VALUE] *0.25
("RIL_TYPE" = 'Accumulation zone' OR "RIL_TYPE" = 'Flooded area' OR "RIL_TYPE" = 'High susceptibility' OR "RIL_TYPE" = 'Moderate susceptibility' OR "RIL_TYPE" = 'Low susceptibility') AND ("VALUE">100000000)	[VALUE]* 0.75

3.3 Estimating Risk of Property and Agricultural Damage

a. In the attribute table of risk_property_hazard.shp, add another field called RISK_PROP. This field will contain the incremental risk of property damage from the individual events.

b. Select the affected areas where consequence is present for high, moderate and low frequency events. The expression for selection is:

"CONSEQH">0 AND "CONSEQM">0 AND "CONSEQL">0 AND "LU_NAME" = 'Built-up areas'

c. Calculate the value of risk for the particular selection. Click on the RISK_PROP field which will represent the total incremental risk value for two return periods (50-year and 100-year). The formula as implemented in ArcView is:

[CONSEQM]*((1/5)-(1/25))+[CONSEQL]*((1/25)-(1/100))

Similar to the above step, select affected built-up areas and calculate the corresponding risk. The table below provides a summary of the expression used to select the appropriate features and the computation of the risk:

Expression for selection:	Risk computation
"CONSEQH"=0 AND "CONSEQM">0 AND "CONSEQL">0 AND "LU_NAME" = 'Built-up areas'	[CONSEQL] *(1/25-1/100)
"CONSEQH"=0 AND "CONSEQM"=0 AND "CONSEQL">0 AND "LU_NAME" = 'Built-up areas'	[CONSEQL] *(1/100)

d. These equations also apply for Agricultural Areas. Step b need to be modified to select affected Agricultural Areas

"CONSEQH">0 AND "CONSEQM">0 AND "CONSEQL">0 AND "LU_NAME" = 'Agricultural areas'

e. Repeat Step c above.

At this stage, the risk to property and agricultural damage are already computed. They should be found in RISKPROP field. The spatial distribution of risk is also determined.

3.4. Generalizing the risk estimates for life, property and agricultural damage

Sometimes it is useful to generalize the risk maps to the level of the administrative unit. The dissolve feature of ArcView enables the generalization of features to according to a spatial range.

a. For the risk to life map popu_risk_hazard.shp, it is necessary to weigh the values according to area covered. To calculate the weighted risk, a field is first added to accommodate this value. Let us call this field WRISK (Width:18, Decimal places: 10)

b. Select the WRISK field and do the weighted risk calculation. The expression is

[WRISK] = [RISK_PROP]*[AREA]

c. For properties, it is necessary to distinguish the risk according to the affected sector (e.g., property or agriculture) and later on sum up the risk value per municipality or city. In preparation, in the risk_prop_hazard.shp file, add fields according to the table below:

Field name	Meaning
AGRI VALUE	The total value of agricultural areas affected by hazard
AGRIRISK	The total risk value for agriculture in a particular area
VALUEURBN	The total value of the property in the area
RISKURBAN	The total property risk value for in a particular area

d. Select all affected agricultural areas. The syntax for the query is:

"LU_NAME" = 'Agricultural lands'

Note that it was not necessary to qualify the selection to include only those affected by the hazard since by this time, only those affected have been valuated and computed for risk.

Fill the values for the AGRIVALUE field for the selected agriculture areas. Select the AGRIVALUE field heading, go to **Field→Calculate** and in the dialog box, type [VALUE]

e. Fill in the values for the AGRIRISK field for the selected agriculture areas. Select the AGRIVALUE field heading, go to **Field→Calculate** and type [AGRIRISK]=[RISK_PROP].

f. Select all affected urban areas. The syntax for the query is:

"LU_NAME" = 'Built-up areas'

Fill up the values for the VALUEURBN field for the selected built-up areas. Select the VALUEURBN field heading, go to **Field→Calculate** and in the dialog box, type [VALUE]

g. Fill in the values for the RISKURBAN field for the selected urban areas. Select the RISKURBAN field heading, go to **Field→Calculate** and in the dialog box, type [RISK_PROP].

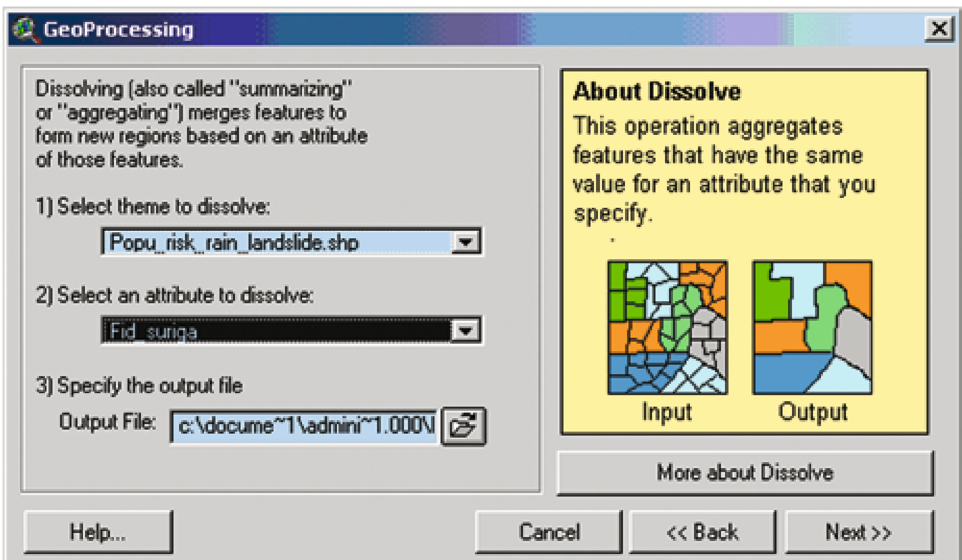
4. DETERMINING COMPOSITE PRIORITY SCORE PER MUNICIPALITY

Performing the Map Generalization Proper

a. Open Arcview and display the population risk map, popu_risk_hazard.shp in a new View window.

b. Load the Geoprocessing Extension (**ArcView main menu →File → Extensions**). Click on the popu_risk_hazard.shp Risk Map View window and go to Geoprocessing Wizard (**ArcView main menu → File → Extensions**). In the wizard, select "Dissolve feature based on attribute". Click Next.

Figure A6.7 Geoprocessing Wizard, Step 2 Dissolve Parameters



c. Generalize by municipal boundaries, so set the following:

Theme to dissolve: Risk_popu_hazard.shp
Attribute to dissolve: MUNI_NAME (The name of the municipalities)
Output file: Risk_popu_hazard_muni.shp

Click Next.

Include the following in the range of fields and corresponding operations in the output file (Press SHIFT while selecting).

AREA by Sum – this is the sum of the area by municipality
WRISK by Sum – this is the weighted risk value computed earlier

In the output file Risk_popu_hazard_muni.shp, add another field called (again) POPURISK. In this field, the risk to life value for each municipality is computed by (use Calculate function to do this):

[POPURISK]=[WRISK]/AREA

d. Do Steps a to c for the property damage risk maps.

e. Theme to dissolve: Risk_prop_hazard.shp

Attribute to dissolve: MUNI_NAME (The name of the municipality).
Output file: Risk_prop_hazard_muni.shp

Include the following in the range of fields and corresponding operations in the output file (Press SHIFT while selecting).

1. AREA by Sum – this is area for each feature to be aggregated
2. RISK_PROP by Sum – this is where the total risk value for each municipality will be stored
3. VALUEAGRI by Sum - this is where the total value of agriculture for each municipality will be stored
4. AGRIRISK by Sum - this is where the total agricultural risk value for each municipality will be stored
5. RISKURBAN by Sum - this is where the total property risk value for each municipality will be stored
6. TRA2007 by Last or TRA2007 by First – this is where the total residential floor area will be stored.

f. Open the risk_prop_hazard_muni.shp. Include the fields MUNI_NAME, SUM_AREA, SUM_RISK_P, SUM_VALUEA, SUM_AGRIRI, SUM_RISKU, LAST_TRA20.

Preparing the Prioritization Maps from Risk Estimates

This step refers to the Chapter 4 Sections D1.1.1 and D1.1.2

To come up with a map showing the priority of the risk estimates for each municipality, the following can be done.

a. Open the risk to life estimate map risk_popu_hazard_muni.shp.

b. Add attribute fields called PRIORITY and ACTION. The PRIORITY field can be of type short integer with length 3. ACTION should be of type text with 20 characters length.

c. Select the categories of priority according to Table 4.41 of Chapter 4. For example, to find all municipalities with estimated risks greater than $>10^{-2}$, a query can be made on the attribute table where:

   “RISKPOPU” > 0.01
   “RISKPOPU” > 0.00001 AND “RISKPOPU” <= 0.01
   “RISKPOPU” 0 or “RISKPOPU” <= 0.00001

   After selecting the municipalities falling with the risk criteria, a risk priority score may be assigned. In the case of the municipalities with estimated risks greater than $1x10^{-2}$ per person per year, the field PRIORITY is selected and using **Field→Calculate,**

   [PRIORITY]=3

d. To put a description to the priority level, the ACTION field is assigned accordingly. For municipalities with estimated risks greater than $1x10^{-2}$ per person per year, the expression used in the calculation is

   [ACTION]=”Urgent”

e. Do Steps c to e, but this time, select the two remaining criteria. The table below shows the summary of the selection expression and the corresponding [PRIORITY] and [ACTION] assignments.

Expression used for selection	Value assigned to [PRIORITY] field	Value assigned to [ACTION] field
“RISKPOPU” < 1*10E-2 AND “RISKPOPU” > 1*10E-5	[PRIORITY]=2	”High”
“RISKPOPU” <= 1*10E-5	[PRIORITY]=1	”Low”

f. In the case of the risk to property and agriculture, certain thresholds need to be computed. For property damage, the threshold is that the risk cost should not exceed 20 percent of the cost of the total residential area. To operationalize this threshold, a field URBANTHRS is added to the generalized map risk_prop_hazard_muni.shp to represent the ratio between the risk and the threshold value for urban areas.

g. Likewise, another field called AGRITHRS should be added where the threshold ratio for agriculture may be added. The threshold for agriculture is that the risk cost should not exceed 40 percent of the cost of the affected agricultural area.

h. First the values for URBANTHRS and AGRITHRS are computed.

   [URBANTHRS]= [SUM_RISKU]/(0.20*[LAST_TRA20]*5534)

   The value 5534 represents the cost of construction per square meter of residential area (Table 4.13).

   For agricultural areas:

   [AGRITHRS]= [SUM_AGRIRI]/(0.40*[SUM_VALUEA])

i. Add fields where separate priority scores can be assigned for property and agriculture. These can be called URBNRISK and AGRIRISK respectively. Both are short integers with 3 lengths.

j. Apply the criteria set in Chapter 4, Section D-b to assign the risk priority scores for agriculture. For example, a query may be made to determine all municipalities that have values of URBANTHRS greater than 1.0.

   “URBANTHRS”>1

k. Those municipalities fulfilling the above selection should be assigned priority scores of 3 for URBNRISK

[URBNRISK]=3

l. The scoring can be done through a series of queries and value assignment as follows:

Expression used for selection	Value assigned to [URBNRISK] field	Value assigned to [AGRIRISK] field
"URBANTHRS">1	3	
"URBANTHRS"<1 AND "URBANTHRS">0	2	
"URBANTHRS"=0	0	
"AGRITHRS">1		3
"AGRITHRS"<1 AND "AGRITHRS">0		2
"AGRITHRS"=0		0

4.3. Preparing Composite Maps for Risk Estimates

The risk scores obtained from the risk to population, property and agriculture can be combined to create a composite risk map. The steps are as follows:

a. Open the generalized risk maps risk_popu_hazard_muni.shp and risk_prop_hazard_muni.shp containing the risk scores evaluated earlier.

b. Add a new field called RISKPRIOTY, with type integer, length 4 to the attribute table of any of the two themes.

c. Display the two risk tables. These two tables should be "joined". Overlay techniques like UNION is not necessary in this case. To be able to join, select the field content that is common to both themes and click on their field names. In this case, it is the MUNI_NAME, the field which contains the names of the municipalities are common to both. Make one attribute table active by making it editable, and add a field called RISKPRIOTY. In the main menu, go to **Table→Join**. The inactive table window should disappear. In the active theme table, the fields of the active and inactive should now be seen in one table.

d. The RISKPRIOTY should be the sum of all the risk priority scores evaluated earlier, that is:

[RISKPRIOTY]=[PRIORITY]+[URBNRISK]+[AGRIRISK]

e. To put a description to the priority level, an field called ACTNCMPST assigned accordingly (string, 12 char length)

Query the Theme Table where the RISKPRIORITY field is entered and assign the value for ACTNCMPST. Since the maximum value for RISKPRIOTY is 9, the prioritization can be done in 3 levels.

Range of values for RISKPRIOTY	Value assigned to ACTNCMPST
7 to 9	"Urgent"
4 to 6	"High"
2 to 3	"Low"

Thematic Mapping of Risk Estimates

a. As a new project. In a new View window, display the popu_risk.shp.

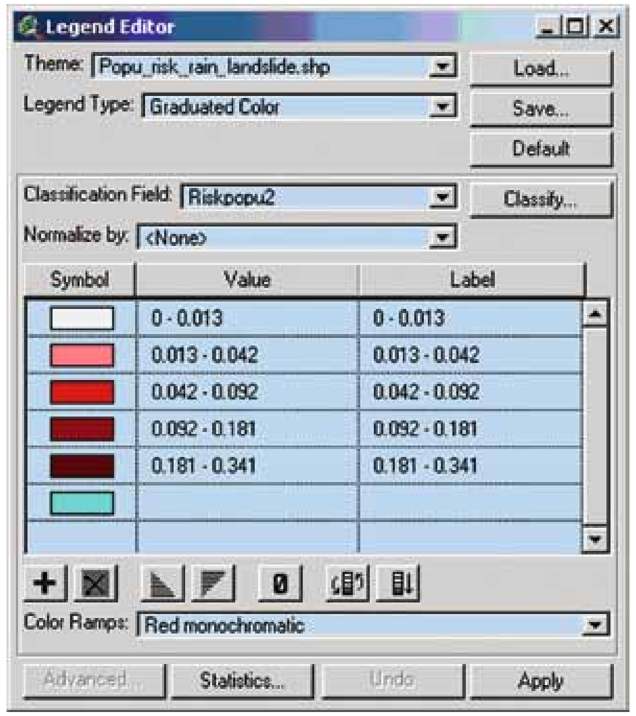
b. Create a thematic map. On the View window, double click on the theme name. The Legend Editor should appear and modify the values according to the following:

Theme: popu_risk.shp
Legend Type: Graduated color
Classification field: POPU_RISK
Normalized by: <blank>

c. Click on the Classify button. The Classification dialog box appears. Set the following:

Type: Natural Breaks
Number of classes: 5
Round values at: d.dddddd

Figure A6.8 Legend Editor



d. Modify the range on values for the colors by double-clicking on Value entries one by one. Set the following ranges:

Level	Value	Label
1	0.0 to 0.00001	Less than 1 in 100,000 per person per year
2	0.00001 to 0.0001	1 to 10 in 10,000 per person per year
3	0.0001 to 0.001	1 to 10 in 1,000 per person per year
4	0.001 to 0.01	1 to 10 fatalities in 100 per year
5	0.01 to <max>	1 to <max> fatalities in 10 per year

<max> is whatever the maximum value. See the Statistics for the RiskPopu column in the Attribute table. You can enter the upper value of the range only.

e. Save your legend setup as popu_risk.avi on your working directory. Open the municipal boundary map and overlay over the newly-created thematic map. Put a label for municipality.

f. Save your project as popu_risk_hazard.apr.

g. Close your population risk thematic map project (**ArcView Main → File → Close**).

h. Do Steps to but this time, use the property damage risk map, prop_risk_hazard.shp. Modify the range on values by setting the following recommended ranges.

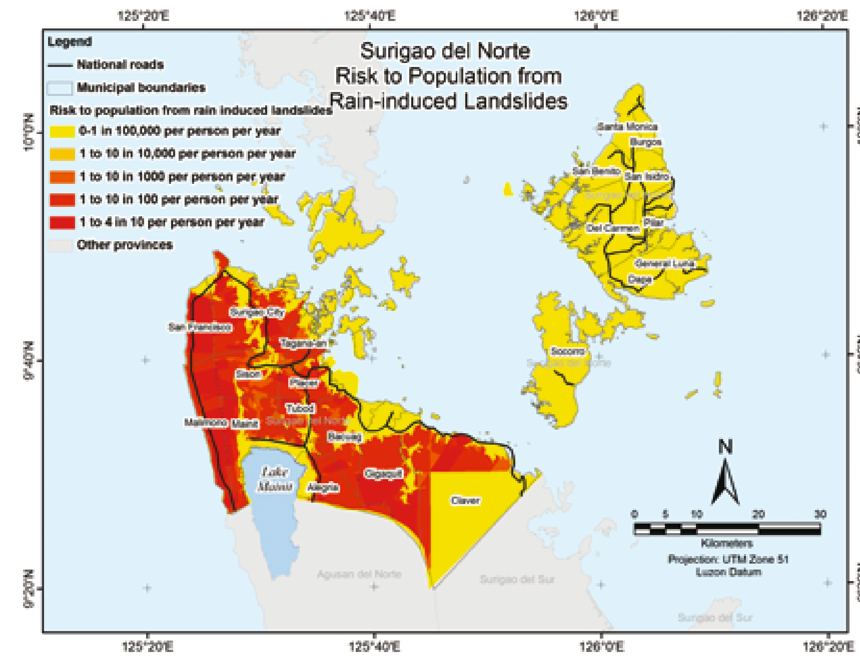
Level	Value	Label
1	0 to 1,000,000	Less than 1 Million a year
2	1,000,000 - 10,000,000	Between 1 to 10 Million in a year
3	10,000,000 - 50,000,000	Between 10 to 50 Million in a year
4	50,000,000 - 100,000,000	Between 50 to 100 Million in a year
5	100,000,000 - <max>	Above 100 Million in a year

Do not put a comma on the numbers. The comma is meant to facilitate reading.

Save your project. Name your risk of property damage thematic map as prop_risk_hazard.apr

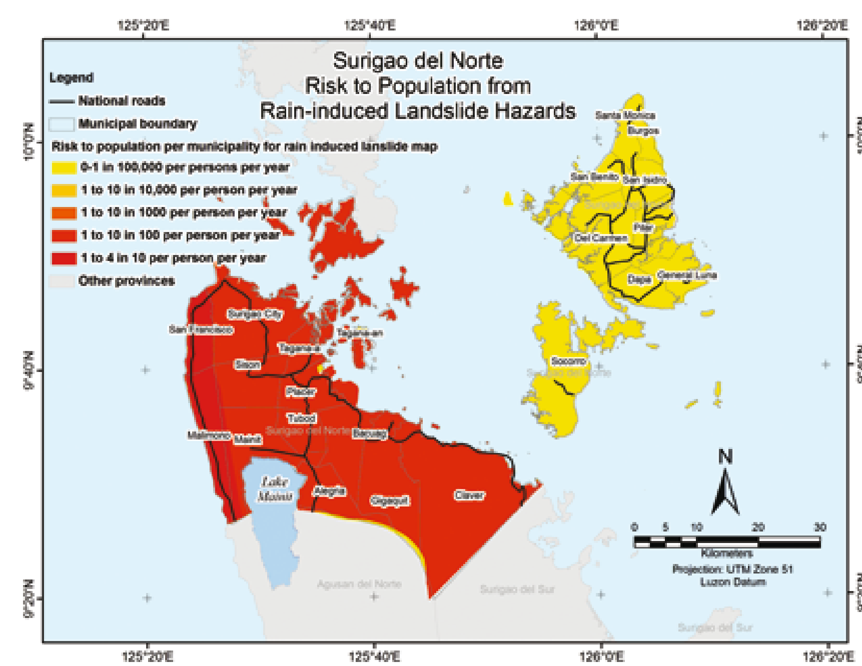
The final population risk map should look something like this:

Figure A6.9 Risk to Population from Rain-induced Landslides, Surigao del Norte



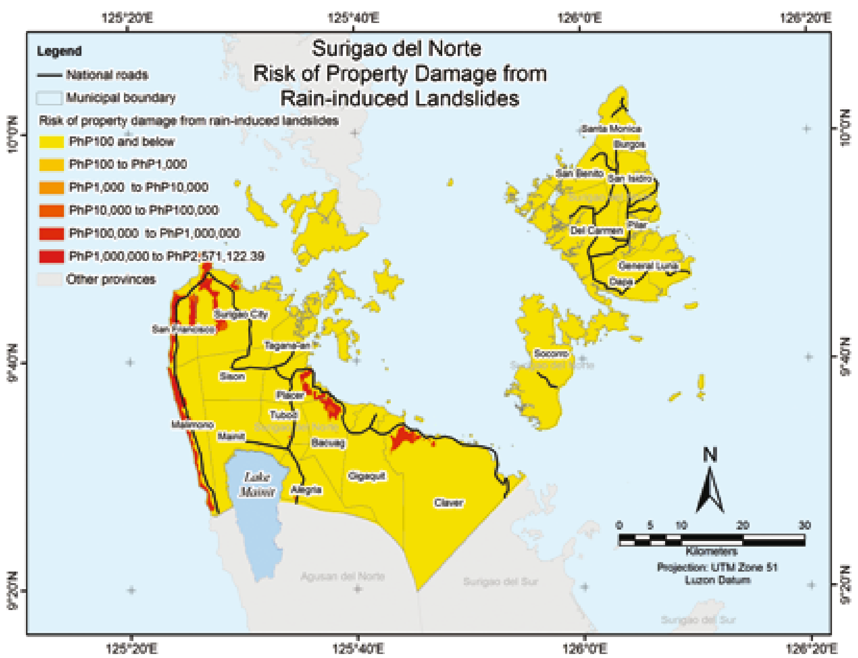
The generalized population risk map should look something like this:

Figure A6.10 Risk to Population from Rain-induced Landslide Hazards, Surigao del Norte



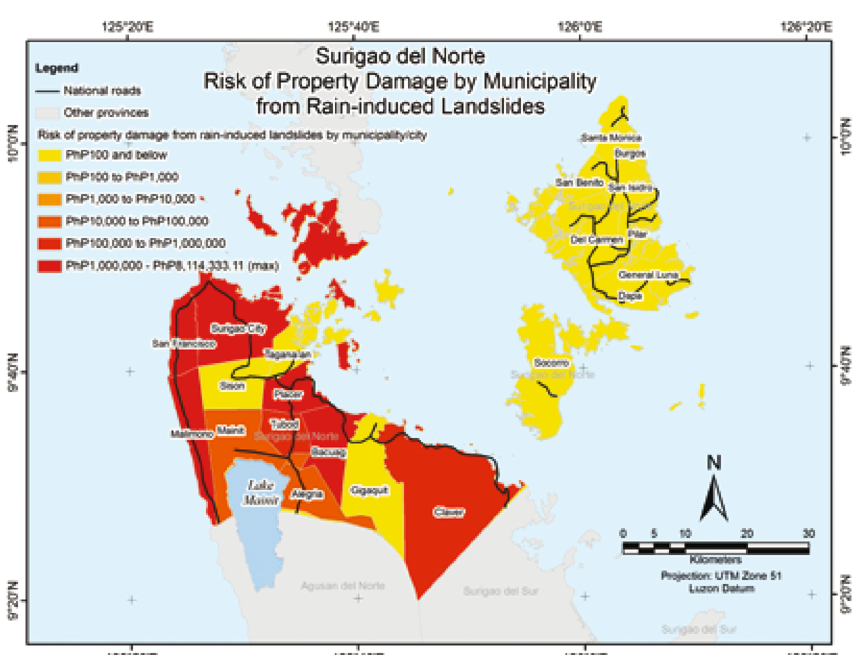
The final output property risk map should look something like this:

Figure A6.11 Risk of Property Damage by Municipality from Rain-induced Landslides, Surigao del Norte



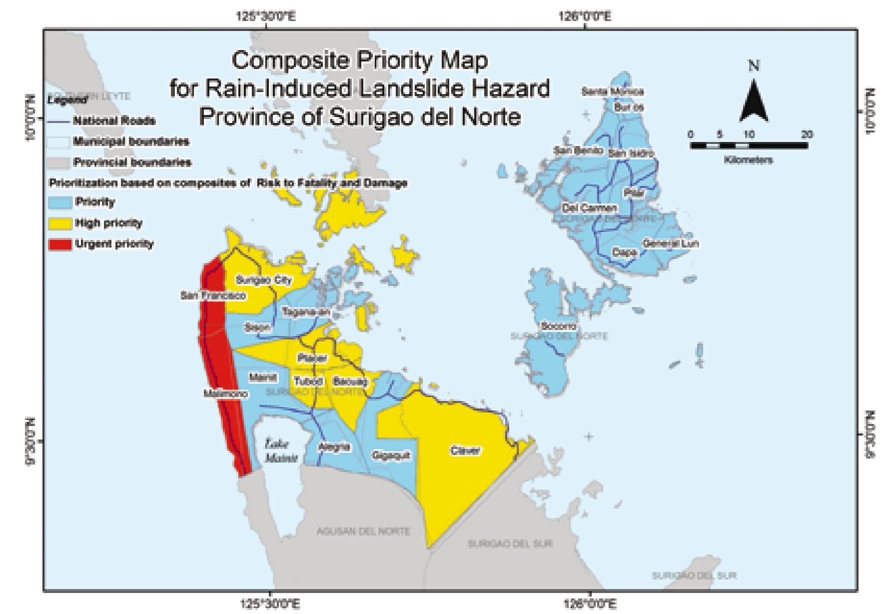
The final property risk map generalized per municipality should look something like this:

Figure A6.12 Risk of Property Damage by Municipality from Rain-induced Landslides, Surigao del Norte



The composite risk map should look something like this:

Figure A6.13 Composite Priority Map for Rain-induced Landslide Hazard, Surigao del Norte



ANNEX 7 CHARACTERISTICS OF RESILIENCE (ADOPTED FROM TWIGG, 2007)

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
Environmental and natural resource management (including natural capital and climate change adaptation)	1. Community understanding of characteristics and functioning of local natural environment and ecosystems (e.g., drainage, watersheds, slope and soil characteristics) and the potential risks associated with these natural features and human interventions that affect them (e.g., climate change) 2. Adoption of sustainable environmental management practices that reduce hazard risk[1] 3. Preservation of biodiversity (e.g., through community-managed seed banks, with equitable distribution system) 4. Preservation and application of indigenous knowledge and appropriate technologies relevant to environmental management 5. Access to community-managed common property resources that can support coping and livelihood strategies in normal times and during crises	1. Policy, legislative and institutional structure that supports sustainable ecosystems and environmental management, and maximizes environmental resource management practices that assist DRR 2. Effective official action to prevent unsustainable land uses and resource management approaches that increase disaster risk 3. Policy and operational interface between environmental management and risk reduction policies and planning 4. DRR policies and strategies integrated with adaptation to existing climate variability and future climate change 5. Local government experts and extension workers available to work with communities on long-term environmental management and renewal

[1] e.g., soil and water conservation, sustainable forestry, wetland management to reduce flood risk, conservation of mangroves as buffer against storm surges, maintenance of water supply and drainage systems

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
Health and well being (including human capital)	1. Physical ability to labor and good health maintained in normal times through adequate food and nutrition, hygiene and health care 2. High levels of personal security and freedom from physical and psychological threats 3. Food supplies and nutritional status secure (e.g., through reserve stocks of grain and other staple foods managed by communities, with equitable distribution system during food crises) 4. Access to sufficient quantity and quality of water for domestic needs during crises 5. Awareness of means of staying healthy (e.g., hygiene, sanitation, nutrition, water treatment) and of life-protecting/saving measures, and possession of appropriate skills 6. Community structures and culture support self confidence and can assist management of psychological consequences of disasters (trauma, PTSD) 7. Community health care facilities and health workers equipped and trained to respond to physical and mental health consequences of disasters and lesser hazard events, and supported by access to emergency health services, medicines, etc.	1. Public health structures integrated into disaster planning and prepared for emergencies 2. Community structures integrated into public health systems 3. Health education programmes include knowledge and skills relevant to crises (e.g., sanitation, hygiene, water treatment) 4. Policy, legislative and institutional commitment to ensuring food security through market and nonmarket interventions, with appropriate structures and systems 5. Engagement of government, private sector and civil society organizations in plans for mitigation and management of food and health crises 6. Emergency planning systems provide buffer stocks of food, medicines, etc.

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
Sustainable livelihoods	1. High level of local economic activity and employment (including among vulnerable groups); stability in economic activity and employment levels 2. Equitable distribution of wealth and livelihood assets in community 3. Livelihood diversification (household and community level), including on farm and off farm activities in rural areas 4. Fewer people engaged in unsafe livelihood activities (e.g., small-scale mining) or hazard-vulnerable activities (e.g., rainfed agriculture in drought-prone locations) 5. Adoption of hazard-resistant agricultural practices (e.g., soil and water conservation methods, cropping patterns geared to low or variable rainfall, hazard-tolerant crops) for food security 6. Small enterprises with business protection and continuity/ recovery plans 7. Local trade and transport links with markets for products, labor and services protected against hazards and other external shocks	1. Equitable economic development: strong economy wherein benefits are shared throughout society 2. Diversification of national and subnational economies to reduce risk 3. Poverty-reduction strategies target vulnerable groups 4. DRR seen as integral part of economic development, reflected in policy and implementation 5. Adequate and fair wages guaranteed by law 6. Legislative system supports secure land tenure, equitable tenancy agreements and access to common property resources 7. Financial and other incentives provided to reduce dependence on unsafe or hazard-vulnerable livelihood activities 8. Chambers of commerce and similar business associations support resilience efforts of small enterprises

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
Social protection (including social capital)	1. Mutual assistance systems, social networks and support mechanisms that support risk reduction directly through targeted DRR activities, indirectly through other socioeconomic development activities that reduce vulnerability, or by being capable of extending their activities to manage emergencies when these occur[2] 2. Mutual assistance systems that cooperate with community and other formal structures dedicated to disaster management 3. Community access to basic social services (including registration for social protection and safety net services) 4. Established social information and communication channels; vulnerable people not isolated 5. Collective knowledge and experience of management of previous events (hazards, crises)	1. Formal social protection schemes and social safety nets accessible to vulnerable groups at normal times and in response to crisis 2. Coherent policy, institutional and operational approach to social protection and safety nets, ensuring linkages with other disaster risk management structures and approaches 3. External agencies prepared to invest time and resources in building up comprehensive partnerships with local groups and organizations for social protection/security and DRR

[2] These comprise informal systems (individual, household, family, clan, caste, etc.) and more structured groups (CBOs: e.g. emergency preparedness committees, support groups/buddy systems to assist particularly vulnerable people, water management committees, burial societies, women's associations, faith groups).

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
Financial instruments (including financial capital)	1. Household and community asset bases (income, savings, convertible property) sufficiently large and diverse to support crisis-coping strategies 2. Costs and risks of disasters shared through collective ownership of group/community assets 3. Existence of community/group savings and credit schemes, and/or access to microfinance services 4. Community access to affordable insurance (covering lives, homes and other property) thru insurance market, microfinance institutions 5. Community disaster fund to implement DRR, response and recovery activities 6. Access to money transfers and remittances from household and community members working in other regions or countries	1. Government and private sector supported financial mitigation measures[3] targeted at vulnerable and at-risk communities 2. Economic incentives for DRR actions (reduced insurance premiums for householders, tax holidays for businesses, etc.) 3. Microfinance, cash aid, credit (soft loans), loan guarantees, etc., available after disasters to restart livelihoods

[3] e.g., insurance/ reinsurance, risk spreading instruments for public infrastructure and private assets such as calamity funds and catastrophe bonds, microcredit and finance, revolving community funds, social funds

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
Physical protection; structural and technical measures (including physical capital)	1. Community decisions and planning regarding built environment take potential natural hazard risks into account (including potential for increasing risks thru interference with ecological, hydrological, geological systems) and vulnerabilities of different groups 2. Security of land ownership/ tenancy rights. Low/minimal level of homelessness and landlessness 3. Safe locations: community members and facilities (homes, workplaces, public and social facilities) not exposed to hazards in high-risk areas within locality and/or relocated away from unsafe sites 4. Structural mitigation measures (embankments, flood diversion channels, water harvesting tanks) in place to protect against major hazard threats, built using local labor, skills, materials, appropriate technologies as far as possible 5. Knowledge and take-up of building codes/regulations in community 6. Adoption of hazard-resilient construction and maintenance practices for homes and community facilities using local labor, skills, materials and appropriate technologies as far as possible	1. Compliance with international standards of building, design, planning, etc. Building codes and land use planning regulations take hazard and disaster risk into account 2. Compliance of all public buildings and infrastructure with codes and standards 3. Requirement for all public and private infrastructure system owners to carry out hazard and vulnerability assessments 4. Protection of critical public facilities and infrastructure through retrofitting and rebuilding, especially in areas of high risk 5. Security of access to public health and other emergency facilities (local and more distant) integrated into counter-disaster planning 6. Legal and regulatory systems protect land ownership and tenancy rights, and rights of public access 7. Regular maintenance of hazard control structures 8. 'Hardware' approach to disaster mitigation is accompanied by 'software' dimension of education, skills training, etc.

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
	7. Community capacities and skills to build, retrofit, maintain structures (technical and organizational) 8. Adoption of physical measures to protect items of domestic property (e.g., raised internal platforms and storage as flood mitigation measure, portable stoves) and productive assets (e.g., livestock shelters) 9. Adoption of short-term protective measures against impending events (e.g., emergency protection of doors, windows from cyclone winds) 10. Infrastructure and public facilities to support emergency management needs (e.g., shelter, secure evacuation, emergency supply routes) 11. Resilient and accessible critical facilities (e.g., health centers, hospitals, police, fire stations – in terms of structural resilience, back-up systems, etc.) 12. Resilient transport/service infrastructure and connections (roads, paths, bridges, water supplies, sanitation, power lines, communications, etc.) 13. Locally owned/available transport sufficient for emergency needs (e.g., evacuation, supplies), at least in the event of seasonal hazards; transport repair capacity within community	9. Legal, regulatory systems and economic policies recognise and respond to risks arising from patterns of population density and movement

RESILIENCE COMPONENTS	CHARACTERISTICS OF A DISASTER-RESILIENT COMMUNITY	CHARACTERISTICS OF AN ENABLING ENVIRONMENT
Planning regimes	1. Community decision making regarding land use and management, taking hazard risks and vulnerabilities into account. (includes microzonation applied to permit/restrict land uses) 2. Local (community) disaster plans feed into LGU development and land use planning	1. Compliance with international planning standards 2. Land use planning regulations take hazard and disaster risk into account 3. Effective inspection and enforcement régimes 4. Land use applications, urban and regional development plans and schemes based on hazard and risk assessment and incorporate appropriate DRR

ANNEX 8
SELECTED ODA DISASTER RISK REDUCTION PROGRAMS AND POLICIES AS OF OCTOBER 2008

Institution	Facility	Source(s) of Funding	Description	Remarks
Humanitarian Aid of the European Commission	Disaster Preparedness/ Disaster Risk Reduction in ECHO (DIPECHO)	European Commission	DIPECHO assistance is oriented towards ensuring preparedness for or prevention of risks of natural disasters. Its program covers: (a) strengthening capacity of local stakeholders and other potential beneficiaries to respond to natural disasters; and (b) improvement of decision making and reduction of vulnerabilities at a more global level in order to avoid the adverse impact of hazards within the broad context of sustainable development and to limit or minimize the adverse impacts of natural hazards by reducing the physical vulnerability of existing sites and infrastructures. DIPECHO covers six regions considered most vulnerable to natural disasters, one among which is Asia. Its global budget has been steadily increasing, i.e., from €6 million in 1998 to €15 million in 2007. Programming is on a biannual basis. Calls for proposals are issued to partner NGOs and international donors.	DIPECHO assistance to the Philippines for 2007-2008 include: a. Formulation of Guidelines on Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/ Physical Framework Planning, with UNDP and NEDA; b. Learning from Good Practices in Disaster Management, with Oxfam Great Britain Program; c. Strengthening Assets and Capacities of Communities and Local Governments for Resilience to Disasters, with CARE Netherlands; d. Formulation of a Strategic National Action Plan to implement DRR and DM priorities I within the context of the Hyogo Framework, with UNISDR, UNESCO, UNDP and the Asian Disaster Preparedness Center (ADPC); e. Partnerships for Disaster Reduction Southeast Asia with a component on Community-Based Disaster-Risk Management in the Philippines, with ADPC; and f. Disaster Preparedness in Eastern Visayas, with GTZ.

Institution	Facility	Source(s) of Funding	Description	Remarks
UNDP/UN	Millennium Development Goals Achievement Fund (MDG-F)	UN/Spain	The MDG-F aims to accelerate progress towards attainment of the MDGs by: (a) supporting policies and programs that promise significant and measurable impacts on selected MDGs; (b) financing the testing and/or scaling-up of successful models; (c) catalyzing innovations in development practices; and (d) adopting mechanisms that improve the quality of programs as foreseen in the Paris Declaration of Aid Effectiveness. The thematic areas of the MDG-F are the following: (a) democratic governance; (b) gender equality and women's empowerment; (c) basic social services; (d) economic and private sector development; (e) environment and climate change; (f) culture and development; and (g) conflict prevention and peace building. The MDG-F welcomes proposals that will implement adaptation measures in at-risk areas or sectors especially in climate change-related disaster risk management. The Spanish Government has committed €528 million to the MDG-F, programmed between 2007 and 2010.	

Institution	Facility	Source(s) of Funding	Description	Remarks
United Nations International Strategy for Disaster Reduction (UNISDR) System in partnership with World Bank	Global Facility for Disaster Reduction and Recovery (GFDRR)	Australia, Canada, Denmark, European Commission, Finland, France, Germany, Italy, Japan, Luxembourg, Norway, USAID/ OFDA, Spain, Sweden, Switzerland	Objective is to reduce disaster losses by mainstreaming disaster risk reduction in development. GFDRR grants support to disaster risk assessments, developing risk mitigation policies and strategies, preparation of disaster prevention projects, and additional financing for recovery if qualified. GFDRR has 3 financing tracks. Track I is intended to support disaster risk reduction. Track II directly supports disaster risk reduction through Technical Assistance (TA) to enhance investments in risk reduction and risk transfer mechanisms. Track III is intended to strengthen emergency and recovery assistance especially for low-income countries.	For 2008, the Philippines has been granted US$1 million grant for a two-year Technical Assistance (TA) on Supporting Local Government Capacity to Manage Natural Disaster Risks in the Philippines. The TA covers assessment of institutional issues and effectiveness of existing DRM-related infrastructures as well as review of financing sources, arrangements and funds flow. It also includes determination of gaps in knowledge tools and systems, livelihood restoration and social protection at the local level. The TA will draw experience from the Bicol region and support 20 most vulnerable provinces as identified by the National Disaster Coordinating Council.
World Bank in partnership with UNDP, UNEP, four regional banks, FAO, IFAD, and UNIDO	Global Environment Facility (GEF)		GEF finances projects to address six critical threats to the global environment: (a) loss of biodiversity; (b) climate change; (c) degradation of international waters; (d) ozone depletion; (e) land degradation; and (f) persistent organic pollutants. It serves as the financial mechanism for the Convention on Biological Diversity, the UN Framework Convention on Climate Change and the Stockholm Convention on Persistent Organic Pollutants. Since it began in 1991, the GEF has provided US$6.2 billion in grants and generated over US$20 billion in co-financing from other sources to support over 1,800 projects that produce global environment benefits in 140 developing countries and countries with economies in transition.	

Institution	Facility	Source(s) of Funding	Description	Remarks
World Bank	Rapid Disbursement Mechanism for Disaster Risk Management	World Bank	The Rapid Disbursement Mechanism for Disaster Risk Management is for investing in risk reduction as well as securing, allocating and disbursing external assistance in the event of major disaster-related losses beyond the financial capacity of the government. This mechanism, including related implementation and fiduciary arrangements, has been preappraised to permit fast-track approval of requests for emergency recovery assistance. The mechanism has five objectives: a. To facilitate rapid post-disaster rehabilitation and reconstruction, disbursing funding rapidly while maintaining flexibility to adjust the response according to need; b. To allow direct access to funds by all qualifying levels of government, from line agencies down to individual LGUs, speeding disbursement by eliminating layers of bureaucracy; c. To improve coordination, harmonization and overall efficiency in the use of combined GOP and international aid resources and to reduce any duplication of efforts by offering a transparent and efficient mechanism through which to channel post-disaster external assistance; d. To ensure that reconstructed infrastructure is adequately strengthened against future hazards; and e. To encourage increased investment in proactive risk reduction.	

Institution	Facility	Source(s) of Funding	Description	Remarks
	a. Disaster Recovery Facility (DRF) b. Risk Mitigation Facility (RMF)		The mechanism is designed specifically for use in response to 'natural' disasters. It cannot be used to provide assistance in response to war, insurrection or acts of terrorism, although epidemics such as the avian influenza which happened recently in other parts of East Asia could be eligible. Use of the mechanism is also limited to the funding of rehabilitation and reconstruction efforts. Humanitarian response and temporary emergency repairs are not eligible for support. DRF is targeted towards post-disaster reconstruction, and can be activated when the agreed triggers are met for specific disaster events. Reconstruction activities funded under this facility incorporate appropriate hazard-proofing measures. RMF is designed to encourage efforts to reduce natural hazard-related risks, both by ensuring that reconstruction incorporates hazard-proofing measures and by encouraging proactive risk reduction.	
Asian Development Bank (ADB)	Emergency Rehabilitation Assistance Loan for Small Development Member Countries (DMCs)	ADB's ordinary capital resources (OCR) or Asian Development Fund (ADF) resources, depending on the borrowing country's eligibility for and access to ADF at the time of loan negotiations.	Assists DMCs with prevention, preparation, and mitigation of the impact of future disasters	

Institution	Facility	Source(s) of Funding	Description	Remarks
Japan International Cooperation Agency (JICA)	Technical Cooperation: TA thru dispatch of experts and volunteers, acceptance of trainees, various surveys, etc. ODA Loans: concessionary loans provided to developing countries Grant Aid: financial assistance extended to developing countries without an obligation for repayment	Japanese Government	Thrusts of the Japanese Government are the following: (1) Poverty Reduction 1-1. Environmental protection and disaster prevention in order to preserve life from natural disasters and to mitigate the occurrence of natural disasters to prevent the loss of lives and properties a. Structural measures • O&M of existing flood ways and drainage system • Flood control measures and construction of drainage facility for the flood/sediment related disaster/lahar damage prone area b. Nonstructural measures • Preparation of hazard maps • Sediment related disaster measures like land stabilization for the warning area • Inclusion of disaster risk management in a development plan by each governmental agencies (2) Strengthening of reforestation and preservation of the major river basin • Prioritization of forestation in 140 river basins • Strengthening CBFM and coordination with other agencies for forest preservation (3) Response to disaster (at the time of disaster)	

Institution	Facility	Source(s) of Funding	Description	Remarks
Japan Bank for International Cooperation (JBIC)	a. Yen Loan Package (YLP) Loans b. Special Terms for Economic Partnership (STEP)	Japanese Government	For project formulation and implementation of environmental conservation and disaster management projects For project formulation and implementation of urban flood control projects	
Australia Agency for International Development (AusAID)	Disaster Response and Recovery Initiatives	Australian Government	In relation to natural disasters, AusAID's development strategy for year 2007-2011 focuses on the following: a. Provide technical advice, equipment and trainings for disaster management agencies, local governments and communities; b. Supply early warning equipment; and c. Initiatives to improve avian influenza preparedness.	Focus on Visayas and Mindanao regions The following are some of the financial commitment of AusAID in the Philippines for CY 2006 and 2007: a. UNDP Disaster Preparedness and Geo-Hazard Mapping; b. Strengthening the Disaster Capacities of Communities in the Philippines; and c. Additional emergency assistance for the rehabilitation/construction of classrooms/school building in Bicol affected by Typhoon Reming.
German Agency for Financial Cooperation Kreditanstalt fur Wiederaufbau (KFW)	Soft Loan Mixed Credit Facility Study Expert Fund (SEF) - facility for supporting conduct of project feasibility study	Federal Republic of Germany	One of the priorities of action is on disaster management.	Focus on Visayas and Mindanao

Institution	Facility	Source(s) of Funding	Description	Remarks
German Agency for Technical Cooperation (GTZ)	Technical Cooperation Program	Federal Republic of Germany	Mainstream disaster risk management into socioeconomic and land use/ physical planning to ensure that communities at risk are identified and purposive actions for resettlements, relocation, and appropriate technologies are put in place. Areas of assistance: 1. expert assignments 2. limited technical assistance 3. training and scholarship 4. preinvestment studies	From July 2005 to July 2009, GTZ has funded the following DRM-related activities: a. Hazard mapping, vulnerability and capacity assessments on disaster risk management (risk preparedness and management) in the following LGUs in Leyte: b. Establishment of six flood early warning systems in different barangays to warn communities of upcoming hazards brought about by floods; **Municipality** – **Barangay** Ormoc – Lao, Matica-a Palo – San Joaquin Pastrana – Tingib Dagami – San Benito Tanauan – Lapay c. Provision of equipment such as computers and rain gauges as well as flood maps to enable LGUs to respond to flood and other natural hazards; and d. Establishment of an operation center (OPCEN) in Palo, Leyte that will provide advance warnings to the at-risk communities and population. OPCEN is being operated and maintained by the Provincial Government of Leyte.

Institution	Facility	Source(s) of Funding	Description	Remarks
Swedish International Development Cooperation Agency (SIDA)	Concessionary Credit Grant (Contracts-Financed-Technical Cooperation)	Swedish Government	Areas of assistance are on: (a) environmental protection and energy conservation; (b) energy; (c) transportation and telecommunication; (d) governance; (e) environmental protection; and (f) human rights and democracy	One of the DRM-related projects of SIDA in the country is the Coastal Hazard Management Program. The objective of this project is to strengthen the capability of DENR and other related agencies to handle coastal hazards in the Philippines.
Korea	Korea International Cooperation Agency (KOICA)	Government of Korea	Areas of assistance include disaster relief and mitigation. Types of assistance are: (a) project aid; (b) development study; (c) dispatch of experts; (c) invitation of trainees; (d) dispatch of Korean overseas volunteers; (e) disaster relief, and (f) NGO support.	

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11. Office of Civil Defense: Admin. Glenn J. Rabonza, Dir. Josefina T. Timoteo, RD Ardiano D. Fuego, RD Vicente F. Tomazar, ARD Melchito M. Castro, Ms. Crispina B. Abat, Ms. Lenie D. Alegre, Mr. Fernando M. Cabarrubias, Ms. Ana C. Cañeda, Ms. Aireen L. Fuclan, Ms. Lita B. Enok, Mr. Rey M. Gozon, Mr. Welino S. Gubuan, Mr. Philip B. Labuguen, Ms. Carmelita A. Laverinto, Mr. Alexander S. Mandac, Ms. Liza R. Mazo, Ms. Celeste R. Milan, Ms. Ruth R. Rodriguez, Mr. Edgar B. Salanio, Mr. Jose V. Valera.
12. Department of Science and Technology-Philippine Institute of Volcanology and Seismology: Dir. Renato U. Solidum, Jr., Dr. Leonila P. Bautista, Mr. Ishmael C. Narag, Mr. Angelito G. Lanuza.
13. DOST-Philippine Atmospheric, Geophysical and Astronomical Services Administration: Dir. Prisco D. Nilo, Mr. Rolu P. Encarnacion, Ms. Maria Cecilia A. Monteverde, Dr. Rosa T. Perez.
14. Armed Forces of the Philippines: Mr. Julius A. Cabarloc, Mr. Jetmar A. Menchavez.

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2. BALAY Rehabilitation Center, Inc.: Exec. Dir. Auxilium Toling-Olayer.
3. Center for Disaster Preparedness: Vice-Pres. Lorna P. Victoria.
4. Christian Aid Partner- Marinduque Center for Environmental Concerns: Exec. Dir. Miguel Magalang.
5. Gawad Kalinga: Mr. Daniel R. Bercasio.
6. Manila Observatory: Exec. Dir. Antonia Yulo-Loyzaga.
7. Oxfam Great Britain: Ms. Donna Mitzi D. Lagdameo.
8. Philippine Rural Reconstruction Movement: Mr. Dante O. Bismonte.

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