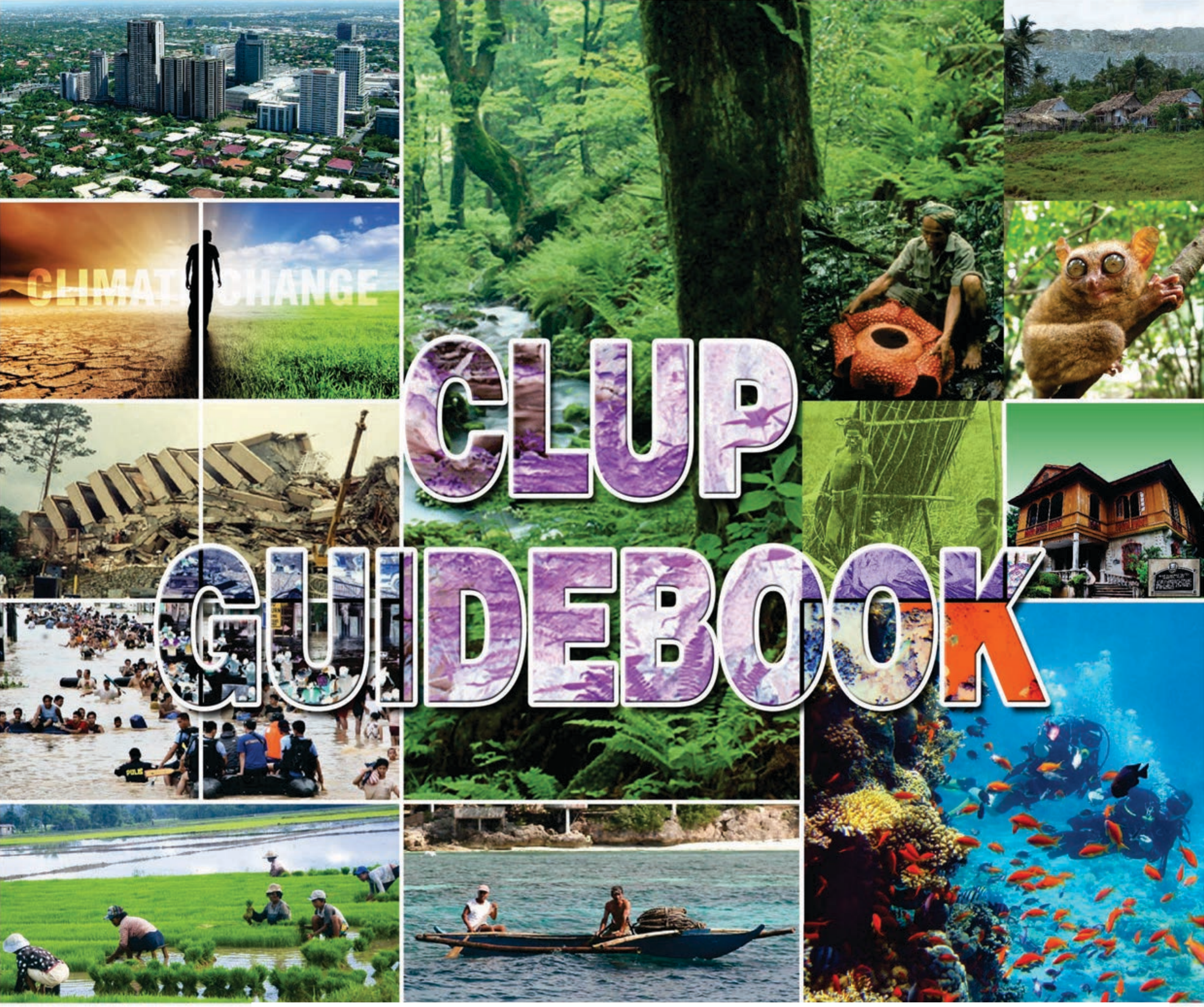
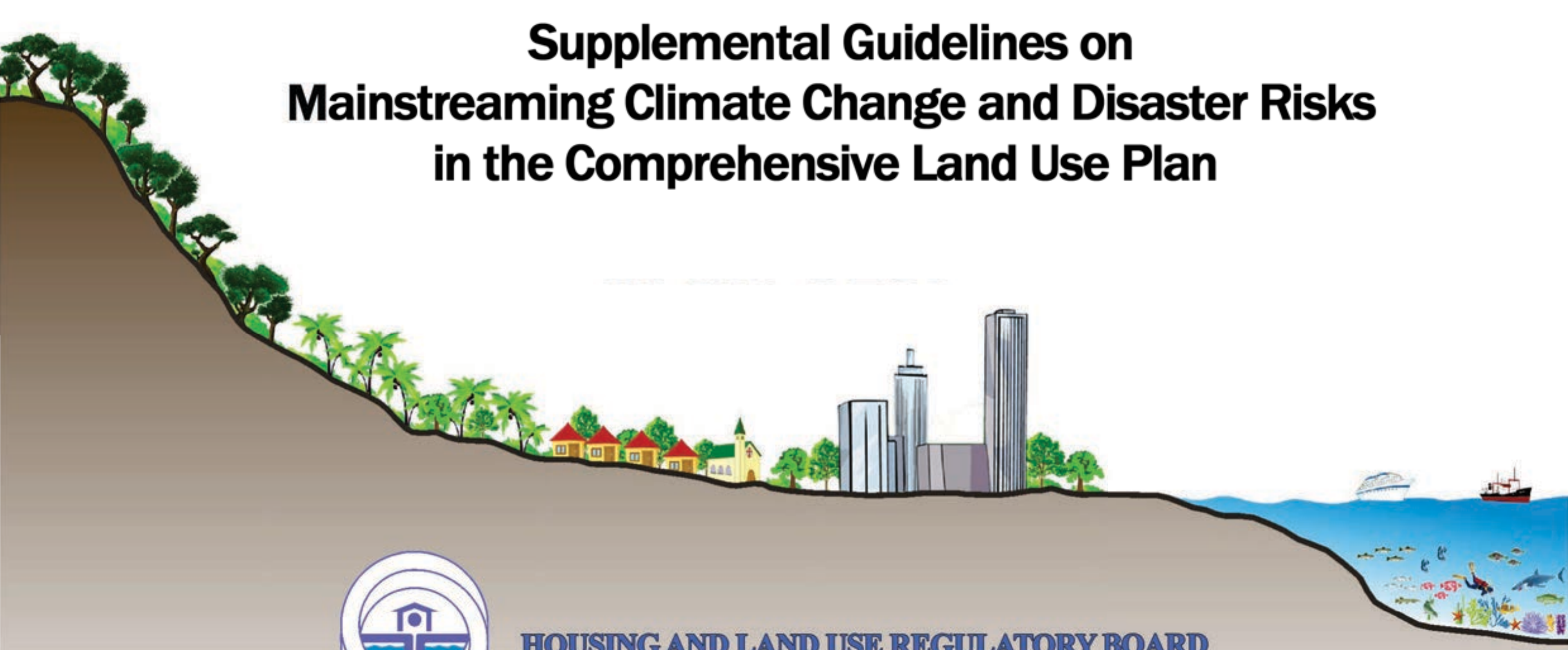


CLUP GUIDEBOOK

Supplemental Guidelines on Mainstreaming Climate Change and Disaster Risks in the Comprehensive Land Use Plan



HOUSING AND LAND USE REGULATORY BOARD

Supplemental Guidelines on Mainstreaming Climate Change and Disaster Risks in the Comprehensive Land Use Plan

Published by the Housing and Land Use Regulatory Board
Climate Change Commission
United Nations Development Programme
Australian Government

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Supplemental Guidelines

Mainstreaming Climate Change and Disaster Risks
in the Comprehensive Land Use Plan

2014

FOREWORD

The Philippines ranks third among most countries at risk in the world because of vulnerability and susceptibility to natural hazards of its exposed population. This situation is further aggravated by threats like climate change. Meteorological and meteorologically-induced hazards have intensified within the last decade, resulting in increased deaths and economic devastation, especially in areas that are unprepared for such phenomena.

A more focused intervention prioritizing climate change adaptation and disaster risk reduction in the country's cities and municipalities needs to be put in place, noting that our LGU's vulnerabilities are becoming more pronounced.

This Supplemental Guideline was developed in compliance with two (2) landmark national laws, the *Climate Change Act of 2009* and the *Disaster Risk Reduction and Management Act of 2010.* This is also HLURB's response to address and support for our local government units to mainstream Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) into the Comprehensive Land Use Plans and Zoning Ordinances.

The *Supplemental Guideline on Mainstreaming Climate Change and Disaster Risks in the Comprehensive Land Use Plan* is a complementary tool to the three volume enhanced HLURB CLUP Guidebooks (2013-2014) to assist our city and municipal planners in the assessment of risks and vulnerability in their respective cities and municipalities.

We highly appreciate the successful partnership of the HLURB, the Climate Change Commission (CCC), the United Nations Development Program (UNDP) and the Australian Aid (AusAid) in the preparation of this supplemental guideline.

Everyone is enjoined to utilize this guideline to mainstream climate and disaster risks in the CLUP to ensure that appropriate policies, strategies and interventions are put in place to increase adaptive capacities and resilience of our communities from a rapidly changing environment.

ANTONIO M. BERNARDO
Chief Executive Officer and Commissioner
Housing and Land Use Regulatory Board

Republic of the Philippines
Office of the President
Housing and Urban Development Coordinating Council
HOUSING AND LAND USE REGULATORY BOARD

BOARD OF COMMISSIONERS

RESOLUTION NO. 915
Series of 2014

APPROVING THE SUPPLEMENTAL GUIDELINES FOR MAINSTREAMING CLIMATE CHANGE ADAPTATION AND DISASTER RISK REDUCTION IN THE COMPREHENSIVE LAND USE PLAN

WHEREAS, Executive Order 648 provided that it is the policy of the state to implement an integrated program of land use control that aims to foster growth and development of our urban and rural communities in an integrated manner that promotes optimum land use, adequate and safe settlements' development and environmental protection towards the promotion of general welfare;

WHEREAS, the Housing and Land Use Regulatory Board is empowered under Section 4 (a) of Executive Order 648 to "promulgate zoning and other land use control standards and guidelines that shall govern land use plans and zoning ordinances of local governments;

WHEREAS, the enhanced Comprehensive Land Use Plan guidebooks mainstreamed climate change adaptation and disaster risk reduction in land use planning to increase preparedness and adaptation measures by local communities;

WHEREAS, it is likewise imperative that local government units formulate climate and disaster risk-sensitive CLUPs/ZOs that regulate allocation of land use so that exposure and vulnerability of population, infrastructure, economic activities and the environment to natural hazards and climate change can be minimized or even prevented;

WHEREAS, there is a need for a supplemental guidelines that will provide a process of understanding risks and making them part of land use allocation and zoning decisions ;

WHEREFORE, be it **RESOLVED** as it is hereby **RESOLVED** that the **"SUPPLEMENTAL GUIDELINES ON MAINSTREAMING CLIMATE AND DISASTER RISKS IN THE COMPREHENSIVE LAND USE PLAN"**, an integral

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component of the land use planning processes as outlined in the CLUP Guidebooks, Volumes 1 to 5 be **APPROVED** as the same is hereby **APPROVED.**

APPROVED, 24 February 2014, Coconut Palace, Pasay City.

HON. JEJOMAR C. BINAY
Vice-President of the Philippines
and HLURB Chairman

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Contents

Message
Board Resolution No. 915, 2014
Acronyms
Executive Summary

Introduction 1

Policy Context 1
Rationale 2
Benefits of Mainstreaming 3
Features of the Guidelines 4
Structure of the Guidelines 8

Mainstreaming Framework 11

Climate and Disaster Risk Assessment (CDRA) Process 14
Integrating Climate Change and Disaster Risks in the Comprehensive Land Use Plan 49

Climate and Disaster Risk Assessment 55

Step 1. Collect and analyze climate and hazard information 55
Step 2. Scoping the potential impacts of disasters and climate change 72
Step 3. Exposure Database Development 79
Step 4. Conduct a Climate Change Vulnerability Assessment (CCVA) 93
Step 5. Disaster Risk Assessment (DRA) 141
Step 6. Summarize Findings 192

Formulating a Risk Sensitive Land Use Plan 197

Set the Vision 199
Situational Analysis 201
Set the Goals and Objectives 228
Selection of the Preferred Development Thrust 234
Selection of the Preferred Spatial Strategy 236
Climate and Disaster Risk Sensitive Land Use Planning 241
Climate Risk Sensitive Zoning Ordinance 255
Implementation of the CLUP and ZO 266
Monitoring and evaluation 268

Glossary of Terms 271
Annex 277
References 291
Project Core Team 295

List of Tables

Table	2.1	Climate Change Projections for Misamis Oriental, Region 10	17
Table	2.2	Summary of Climate Change Variables	20
Table	2.3	Summary of Climate Change Effects and Impacts	21
Table	2.4	Recommended Population Exposure, Sensitivity/Vulnerability and Adaptive Capacity Indicators	24
Table	2.5	Recommended Urban Use Area Exposure, Sensitivity/Vulnerability and Adaptive Capacity Indicators	25
Table	2.6	Natural Resource based Production Areas Exposure, Sensitivity/Vulnerability and Adaptive Capacity Parameters	27
Table	2.7	Critical point facilities Exposure, Sensitivity/Vulnerability and Adaptive Capacity Parameters	28
Table	2.8	Lifeline Utilities Exposure, Sensitivity/Vulnerability and Adaptive Capacity Parameters	29
Table	2.9	Degree of Impact Score	33
Table	2.10	Adaptive capacity score and description	34
Table	2.11	Vulnerability Index Scores	35
Table	2.12	Indicative Likelihood of Occurrence Scores	39
Table	2.13	Severity of Consequence Score Matrix	42
Table	2.14	Risk Score Matrix for Prioritization	43
Table	2.15	Sample Issues Matrix Urban Use Areas	48
Table	3.1.1	Projected seasonal temperature changes (in °C) in 2020 and 2050 under the medium-range emission scenario, Provinces in Region 10	56
Table	3.1.2	Projected seasonal temperature changes for 2020 and 2050 under the medium-range emission scenario, Province of Misamis Oriental	57
Table	3.1.3	Seasonal rainfall change (in %) in 2020 and 2050 under the medium-range emission scenario, Provinces in Region 10	58
Table	3.1.4	Medium emission range projected seasonal rainfall scenarios for 2020 and 2050, Province of Misamis Oriental	58
Table	3.1.5	Frequency of extreme events in 2020 and 2050 under medium-range emission scenario, Province of Misamis Oriental	59
Table	3.1.6	Summary of Projected Changes in Climate Variables, Municipality of Opol, Misamis Oriental	61
Table	3.1.7	Hazard maps and data sources	63
Table	3.1.8	Sample Inventory of Hazards and their description	68
Table	3.1.9	Records of Previous Disasters, Municipality of Opol (2009-2012)	70
Table	3.1.10	Sample Hazard Susceptibility Inventory Matrix	71
Table	3.2.1	Summary of Projected Changes in Climate Variables and potential affected exposure unit/s, Municipality of Opol	74
Table	3.2.2	Summary of Climate Change Impacts, Municipality of Opol	77
Table	3.3.1	Sample Existing Population Exposure Attribute Table, Municipality of Opol	81
Table	3.3.2	Sample Existing Urban Use Areas Exposure Attribute Table, Municipality of Opol	83
Table	3.3.3	Sample Existing Natural Resource Production Area Exposure Attribute Table, Municipality of Opol	86
Table	3.3.4	Sample Critical Point Facilities Exposure Attribute Table, Municipality of Opol	89
Table	3.3.5	Sample Lifeline Utilities Exposure Attribute Table, Municipality of Opol	92
Table	3.4.1	Sample Impact Area and Climate Stimuli	94
Table	3.4.2a	Sample Population Exposure to Sea Level Rise, Municipality of Opol	98
Table	3.4.2b	Sample Natural Resource Production Area Exposure to Sea Level Rise, Municipality of Opol	101
Table	3.4.2c	Sample Urban Use Area Exposure to Seal Level Rise, Municipality of Opol	104
Table	3.4.2d	Sample Critical Point Facilities Exposure to Sea Level Rise, Municipality of Opol	106
Table	3.4.2e	Sample Lifeline Utilities Exposure to Sea Level Rise, Municipality of Opol	108
Table	3.4.3	Degree of Impact Score	110
Table	3.4.4a	Population Degree of Impact Rating, to Sea Level Rise, Municipality of Opol	111
Table	3.4.4b	Natural Resource based Production Areas, Degree of Impact Rating to Sea Level Rise, Municipality of Opol	112

Table	3.4.4c	Urban Use Area, Degree of Impact Rating to Sea Level Rise, Municipality of Opol	113
Table	3.4.4d	Critical Point Facilities, Degree of Impact Rating to Sea Level Rise, Municipality of Opol	114
Table	3.4.4e	Lifeline Utilities, Degree of Impact Rating to Sea Level Rise, Municipality of Opol	115
Table	3.4.5	Adaptive Capacity Scores and Descriptions	116
Table	3.4.5a	Population, Adaptive Capacity to Sea Level Rise, Municipality of Opol	117
Table	3.4.5b	Natural Resource based Production Areas, Adaptive Capacity to Sea Level Rise, Municipality of Opol	118
Table	3.4.5c	Urban Use Areas, Adaptive Capacity to Sea Level Rise, Municipality of Opol	119
Table	3.4.5d	Critical Point Facilities, Adaptive Capacity to Sea Level Rise, Municipality of Opol	120
Table	3.4.5e	Lifeline Utilities, Adaptive Capacity to Sea Level Rise, Municipality of Opol	121
Table	3.4.6	Vulnerability Index Scores	122
Table	3.4.6a	Population Vulnerability to Sea Level Rise, Municipality of Opol	124
Table	3.4.6b	Natural Resource based Production Areas Vulnerability to Sea Level Rise, Municipality of Opol	126
Table	3.4.6c	Urban Use Areas Vulnerability to Sea Level Rise, Municipality of Opol	128
Table	3.4.6d	Critical Points Facilities Vulnerability Coastal Impact Areas	130
Table	3.4.6e	Lifeline Utilities Vulnerability to Sea Level Rise, Municipality of Opol	132
Table	3.4.7	Sample Climate Change Vulnerability Assessment Summary Matrix	133
Table	3.4.8	Disaster Thresholds and acceptability rating per exposure type	135
Table	3.4.9a	Sample Climate Change Vulnerability Assessment Summary Matrix for Population, Sea Level Rise	136
Table	3.4.9b	Sample Climate Change Vulnerability Assessment Summary Matrix for Natural Resource Production Areas, Sea Level Rise	137
Table	3.4.9c	Sample Climate Change Vulnerability Assessment Summary Matrix for Urban Use Areas, Sea Level Rise	138
Table	3.4.9d	Sample Climate Change Vulnerability Assessment Summary Matrix for Critical Point Facilities, Sea Level Rise	139
Table	3.4.9e	Sample Climate Change Vulnerability Assessment Summary Matrix for Lifeline Utilities, Sea Level Rise	140
Table	3.5.1a	Indicative Likelihood of Occurrence Scores	142
Table	3.5.1b	Sample Flood Hazard Inventory, Municipality of Opol	142
Table	3.5.2a	Sample Population Flood Exposure Estimation, Municipality of Opol	145
Table	3.5.2b	Sample Natural Resource-based Production Area Flood Exposure Estimation, Municipality of Opol	148
Table	3.5.2c	Sample Urban Use Areas Flood Exposure Estimation, Barangay Barra, Municipality of Opol	151
Table	3.5.2d	Sample Critical Point Facilities Flood Exposure, Municipality of Opol	153
Table	3.5.2e	Sample Lifeline Utilities Flood Exposure Estimation, Municipality of Opol	156
Table	3.5.3	Severity of Consequence Score Matrix	158
Table	3.5.3a	Sample Population Severity of Consequence Estimation for Floods	161
Table	3.5.3b	Sample Natural Resource-based Production Area Severity of Consequence Estimation for Floods	162
Table	3.5.3c	Sample Urban Use Area Severity of Consequence Estimation for Floods	164
Table	3.5.3d	Sample Critical Point Facilities Severity of Consequence Estimation for Floods	165
Table	3.5.3e	Sample Lifeline Utilities Severity of Consequence Estimation for Floods	167
Table	3.5.4	Risk Score Matrix	169
Table	3.5.4a	Sample Population Risk to Floods	171
Table	3.5.4b	Sample Flood Risk to Natural Resource Production-based areas	173
Table	3.5.4c	Sample Flood Risk to Urban Use Areas	175
Table	3.5.4d	Sample Flood Risk to Critical Point Facilities	177
Table	3.5.4e	Sample Flood Risk to Lifeline Utilities	179

Table	3.5.5a	Sample Risk Disaster Risk Assessment Summary Matrix for Population, Flood	181
Table	3.5.5b	Sample Disaster Risk Assessment Summary Matrix Natural Resource Production Areas, Floods	182
Table	3.5.5c	Sample Disaster Risk Assessment Summary Matrix Urban Use Area, Floods	182
Table	3.5.5d	Sample Disaster Risk Assessment Summary Matrix Critical Point Facilities, Floods	183
Table	3.5.5e	Sample Disaster Risk Assessment Summary Matrix Lifeline Utilities	183
Table	3.5.6a	Sample Issues Matrix for Population for Flood Hazard	185
Table	3.5.6b	Sample Issues Matrix Natural Resource Production Areas for Flood Hazard	187
Table	3.5.6c	Sample Issues Matrix Urban Use Areas for Flood Hazard	189
Table	3.5.6d	Sample Issues Matrix Critical Point Facilities for Flood Hazard	190
Table	3.5.6e	Sample Issues Matrix Lifeline Utilities for Flood Hazard	191
Table	3.6.1	Sample Issues Matrix Urban Use Areas	194
Table	4.1	Sample Vision Element Descriptors and Success Indicators for Disaster Risk Reduction and Climate Change Adaptation	199
Table	4.2	Steps and expected outputs of the Climate and Disaster Risk Assessment	202
Table	4.3	Adjustments in housing requirements for 2022	205
Table	4.4	Area requirements for educational facilities for 2020	206
Table	4.5	Area requirements for Day Care Centers, 2022	207
Table	4.6	Adjustments in area requirements for Health related facilities	208
Table	4.7	Adjustments in area requirements for Urban Use Areas	209
Table	4.8	Sample summary of Risk Management Options for Natural Resource Production Areas	211
Table	4.9	Sample Risk Management Options for Priority Bridges	213
Table	4.10	Summary Risk Management Options for Road Network	214
Table	4.11	Suitability score and description	220
Table	4.12	Recommended suitability score and description	221
Table	4.13	Risk and Vulnerability Information in the Sectoral and Cross-sectoral Analysis	225
Table	4.14	Risk and Vulnerability considerations in the Sectoral and Cross-sectoral Analysis, Social Sector Housing Sub-sector	226
Table	4.15	Risk and Vulnerability considerations in the Sectoral and Cross-sectoral Analysis, Social Sector-Health Sub-sector	227
Table	4.16	Sample Goals and Objectives	230
Table	4.17	Sample Development Thrust Evaluation	235
Table	4.18	Sample Spatial Strategy evaluation	239
Table	4.19	Sample Land Use Planning Options for Flood hazard areas	249
Table	4.20	Sample Priority Programs-Projects-Legislation	252
Table	4.21	Sample Zone Boundary Description, Flood Hazard Overlay Zone Map	258
Table	4.22	Sample Monitoring and Evaluation Indicators	268
Table	A1	The four SRES scenarios developed by the Intergovernmental Panel on Climate Change (IPCC)	279
Table	A2	Comparative Matrix of Application of Concept of Risk	282
Table	A3	Thresholds for declaring a state of calamity	283

List of Figures

Figure	**1.1**	Identified Decision Areas, CDRA, Municipality of Opol, Misamis Oriental	5
Figure	**1.2**	Existing and Proposed Land Use Maps, Municipality of Opol, Misamis Oriental	7
Figure	**2.1a**	Integrated Climate and Disaster Risk Assessment Model	12
Figure	**2.1b**	Framework for Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan	13
Figure	**2.2**	Climate adjusted flood hazard maps of the Cagayan de Oro River System	19
Figure	**2.2a**	Sample Population Exposure to Sea Level Rise, Municipality of Opol	31
Figure	**2.2b**	Land cover (2009) and projected temperature increase (2020) of Silago, Southern, Leyte	32
Figure	**2.3**	Sample Urban use area flood exposure mapping	41
Figure	**2.4a**	Detailing of decision areas	47
Figure	**2.4b**	Entry-points for Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan	51
Figure	**3.1.1**	Sample Flood and Rain-Induced Landslide Hazard Map, MGB-Region 10, 2011	66
Figure	**3.1.2**	Flood Susceptibility Map of the Municipality of Opol, Misamis Oriental	67
Figure	**3.2.1**	Sample Climate Change Impact Chain Multiple Sectors	75
Figure	**3.2.2**	Sample Agriculture Sector Impact Chain	76
Figure	**3.3.1**	Sample Existing Population Exposure Map, Municipality of Opol	80
Figure	**3.3.2**	Sample Existing Urban Use Areas Exposure Map, Municipality of Opol	82
Figure	**3.3.3**	Sample Existing Natural Resource-based Exposure Map, Municipality of Opol	85
Figure	**3.3.4**	Sample Existing Critical Point Facilities Exposure Map, Municipality of Opol	88
Figure	**3.3.5**	Sample Existing Lifeline Utilities Exposure Map, Municipality of Opol	91
Figure	**3.4.1**	Sample Impact Area Map for Sea Level Rise, Municipality of Opol	95
Figure	**3.4.2a**	Sample Population Exposure to Sea Level Rise, Municipality of Opol	97
Figure	**3.4.2b**	Sample Natural Resource-based Production Area Exposure Map to Sea Level Rise, Municipality of Opol	100
Figure	**3.4.2c**	Sample Urban Use Areas Exposure Map to Sea Level Rise, Municipality of Opol	103
Figure	**3.4.2d**	Sample Critical Point Facilities Exposure Map to Sea Level Rise, Municipality of Opol	105
Figure	**3.4.2e**	Sample Lifeline Utilities Exposure Map to Sea Level Rise, Municipality of Opol	107
Figure	**3.4.3a**	Sample Population Vulnerability Map to Sea Level Rise, Municipality of Opol	123
Figure	**3.4.3b**	Sample Natural Resource based Production Areas Vulnerability Map to Sea Level Rise, Municipality of Opol	125
Figure	**3.4.3c**	Sample Urban Use Areas Vulnerability Map to Sea Level Rise, Municipality of Opol	127
Figure	**3.4.3d**	Sample Critical Point Facilities Vulnerability Map to Sea Level Rise, Municipality of Opol	129
Figure	**3.4.3e**	Sample Lifeline Utilities Vulnerability Map to Sea Level Rise, Municipality of Opol	131
Figure	**3.5.1a**	Sample Population Flood Exposure Mapping	144
Figure	**3.5.1b**	Sample Natural Resource-based Production Area Flood Exposure Mapping	147
Figure	**3.5.1c**	Sample Urban Use Areas Flood Exposure Mapping	150
Figure	**3.5.1d**	Sample Critical Point Facilities Flood Exposure Mapping	152
Figure	**3.5.1e**	Sample Lifeline Utilities Flood Exposure Mapping	155
Figure	**3.5.2a**	Flood Risk to Population Map	170
Figure	**3.5.2b**	Flood Risk to Natural Resource-based Production Areas Map	172
Figure	**3.5.2c**	Flood Risk to Urban Use Areas Map	174
Figure	**3.5.2d**	Flood Risk to Critical Point Facilities Map	176
Figure	**3.5.2e**	Flood Risk to Lifeline Utilities Map	178
Figure	**3.6.1**	Detailing of Major Decision Areas	193

List of Figures

Figure	**4.1**	Mainstreaming Climate and Disaster Risks in the CLUP (Steps 3-5)	201
Figure	**4.2**	Land Demand and Supply Analysis, incorporating results of the Climate and Disaster Risk Assessment	218
Figure	**4.2a**	Sample Sieve Mapping and Suitability Analysis	222
Figure	**4.2b**	Sample Suitability Analysis Map	224
Figure	**4.3**	Mainstreaming Climate and Disaster Risks in the CLUP (Steps 3-5)	228
Figure	**4.4**	Sample Spatial Strategy Option	240
Figure	**4.5**	Sample Flood Hazard Overlay Map, Barangay Barra, Municipality of Opol, Misamis Oriental	257
Figure	**A1**	Scenarios for GHG emissions from 2000 to 2100 and projections of surface temperatures	279
Figure	**A2**	Correspondence of the IPCC Vulnerability and UN Risk Frameworks	286

Acronyms

AIP	Annual Investment Plan
APAs	Areas for Priority Action
BAS	Bureau of Agricultural Statistics
C/MPDC	City/Municipal Planning and Development Council
C/MPDO	City/Municipal Planning and Development Office
CCA	Climate Change Adaptation
CCC	Climate Change Commission
CCVA	Climate Change Vulnerability Assessment
CDP	Comprehensive Development Plan
CDRA	Climate and Disaster Risk Assessment
CLUP	Comprehensive Land Use Plan
DA	Department of Agriculture
DEM	Digital Elevation Model
DENR	Department of Environmental and Natural Resource
DFAT	Department of Foreign Affairs and Trade
DILG	Department of Interior and Local Government
DPWH	Department of Public Works and Highways
DRA	Disaster Risk Assessment
DRR	Disaster Risk Reduction
DRRM	Disaster Risk Reduction and Management
ECC	Environmental Compliance Certificate
ECHO	European Commission Humanitarian Office
EIS	Environmental Impact Statement
EWS	Early Warning System
FAR	Floor Area Ratio
GHG	Greenhouse Gases
GIS	Geographic Information System
GPS	Global Positioning System
HLURB	Housing and Land Use Regulatory Board
IPCC	Intergovernmental Panel on Climate Change

LCCAP	Local Climate Change Action Plan
LDIP	Local Development Investment Program
LDRRMP	Local Disaster Risk Reduction and Management Plan
LGU	Local Government Unit
MAPSO	Maximum Allowable Percentage of Site Occupancy
MGB	Mines and Geosciences Bureau
NBCP	National Building Code of the Philippines
NDCC	National Disaster Coordinating Council
NDRRMC	National Disaster Risk Reduction and Management Council
NEDA	National Economic Development Authority
NSCP	National Structural Code of the Philippines
OCD	Office of Civil Defense
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PDPFP	Provincial Development and Physical Framework Plan
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PRECIS	Providing Regional Climates for Impact Studies
RAP	Risk Analysis Project
RCPs	Representative Concentration Pathways
READY	Hazards Mapping and Assessment for Effective Community-Based Disaster Risk Management Project
REDAS	Rapid Earthquake Damage Assessment System
RIDF	Rainfall Intensity Duration Frequency
RPFP	Regional Physical Framework Plan
TWG	Technical Working Group
UNDP	United Nations Development Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UTM	Universal Transverse Mercator
WGS84	World Geodetic System of 1984
ZO	Zoning Ordinance

Executive Summary

The Supplemental Guidelines on Mainstreaming Climate and Disaster Risks in the Comprehensive land use plan will help local governments formulate climate and disaster risk-sensitive comprehensive land use plans and zoning ordinances that would guide the allocation and regulation of land use so that exposure and vulnerability of population, infrastructure, economic activities and the environment to natural hazards and climate change can be minimized or even prevented. The resulting improvements in land use planning and zoning processes will strengthen the ability of local governments to achieve their sustainable development objectives given the challenges posed by climate change and natural hazards.

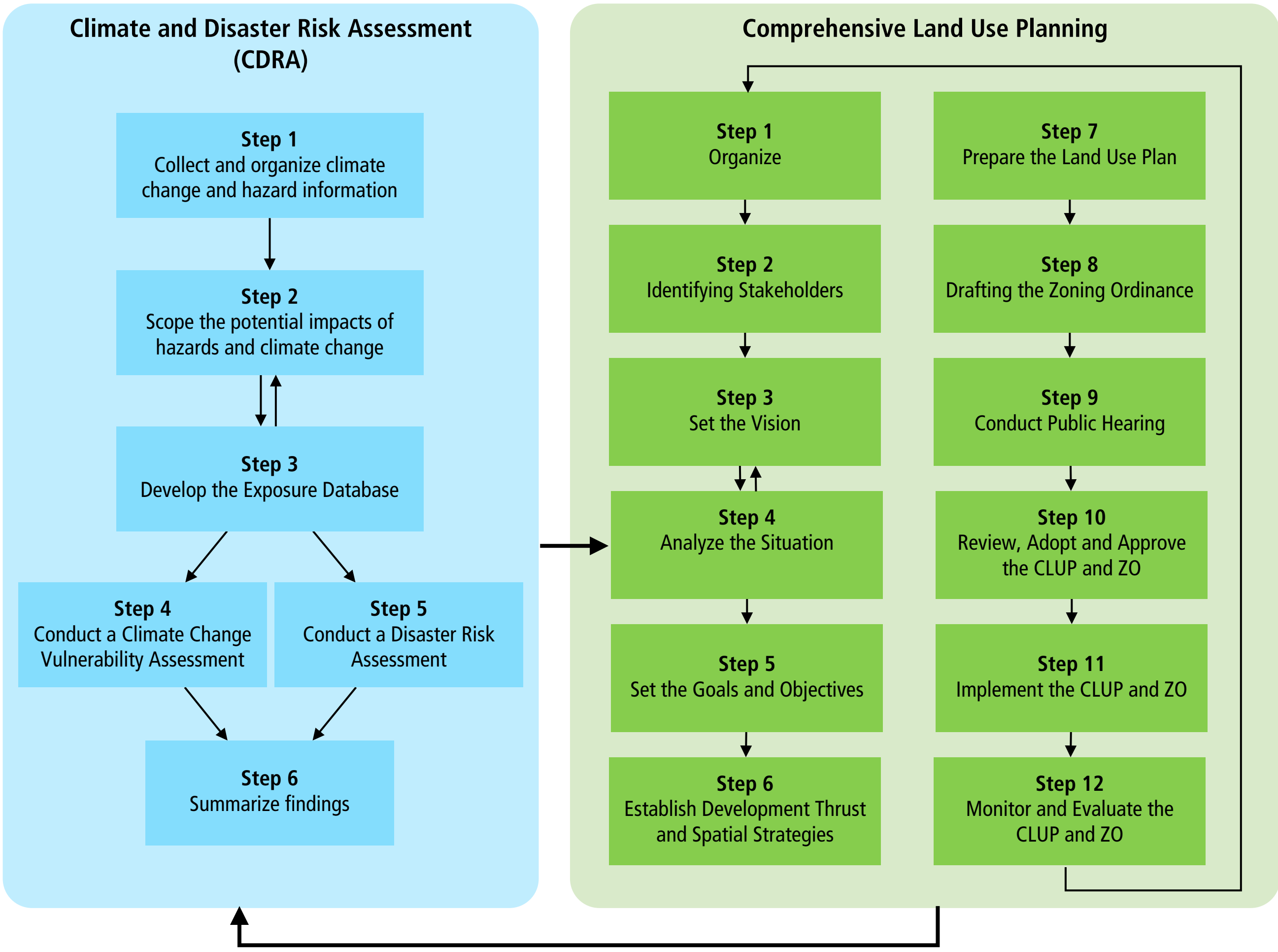
The Housing and Land Use Regulatory Board (HLURB) partnered with the Climate Change Commission (CCC), United Nations Development Program (UNDP) and the Australian Government, under Project Climate Twin Phoenix in the formulation of the Supplemental Guidelines on Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan. The supplemental guidelines is a product of consultations with HLURB and other National Government Agencies (NGAs); and the piloting in the Municipality of Opol, Misamis Oriental.

The Comprehensive Land Use Plan is an effective disaster risk reduction instrument which may at the same time result in climate change adaptation. It seeks to rationalize the allocation of land uses to reduce exposure of people, assets and economic activities; address vulnerabilities by providing safer places to live, sustain livelihood and ensure optimum productivity of natural resources through ecosystem-based management. Also, land use planning is a cost-effective and proactive approach in managing current and future risks considering the high costs of structural measures to address unplanned spatial development. Land use planning can also reduce hazard magnitudes by including ecosystem management approaches, such as rehabilitation of watersheds to minimize lowland flooding. Lastly, it serves as a framework to guide in the preparation of local level plans (CDP, LDIP, AIP, LDRRMP) to implement its DRR-CCA development agenda.

The Climate and Disaster Risk Assessment (CDRA) is the process of studying risks and vulnerabilities of exposed elements namely, the people, urban areas, agriculture, forestry and fishery production areas, critical point facilities, and lifeline infrastructure associated with natural hazards and climate change. It seeks to establish risk and vulnerable areas by analyzing the hazard, exposure, vulnerability/sensitivity and adaptive capacities of the various exposed

elements. The CDRA identifies the priority decision areas that needs to be addressed given the acceptable or tolerable levels of risks and allow the identification of various disaster risk and climate change adaptation and mitigation measures and spatial policy interventions.

The CDRA generates planning information to provide a better understanding of the existing situation on risks and vulnerabilities to natural hazards and climate change to enable planners and decision makers to come up with informed decisions during the CLUP formulation process as shown in the mainstreaming framework.



Introduction 1

The Climate Change Commission (CCC) and the Housing and Land Use Regulatory Board (HLURB) formulated the Supplemental Guidelines as an annex to the 2014 Comprehensive Land Use Plan (CLUP) Guidebooks of HLURB. Local governments shall refer to the Supplemental Guidelines in the preparation of their risk-sensitive land use plans.

The Supplemental Guidelines provides a step-by-step process on assessing the climate and disaster risks of a locality. Risk information coming from this analysis will form part of the basis for the optimum allocation of land for various uses, taking into account the locational and sectoral constraints posed by natural hazards and the potential impacts of climate change.

This introductory chapter provides the rationale for mainstreaming climate and disaster risks in comprehensive land use planning. It discusses the enabling environment for mainstreaming Disaster Risk Reduction-Climate Change Adaptation (DRR-CCA) in local level planning and provides the benefits of a risk-sensitive CLUP as an instrument in promoting sustainable development.

Policy Context

The 2009 Climate Change Act and the 2010 National Disaster Risk Reduction and Management Law provide the fundamental frameworks for key actions toward improving governance and participation, financing, capacity and development as well as addressing critical hazard challenges, specifically those which are becoming more frequent and intense due to climate change.

The National Climate Change Action Plan and the National Disaster Risk Reduction and Management Plan have been adopted to define priority areas for interventions toward achieving reduction in climate and disaster risks and adaptation to climate change.At the subnational level, Local Disaster Risk Reduction and Management Plans (LDRRMPs) are prepared to define the local agenda for preparedness, prevention and mitigation, response, and recovery and rehabilitation. The Local Climate Change Action Plans (LCAAPs) defines the local agenda for anticipating potential impacts of climate change to important vulnerable sectors, and local initiatives that will contribute to the global efforts to mitigate atmospheric green house gases levels.

These plans recognize the need for a more balanced and systematic approach that puts forward the importance and value of properly assessing and managing climate and disaster risk before disasters happen. Thus, a lot of effort is now being put into understanding hazards, risks, and vulnerabilities of population, assets and the environment; and in factoring in climate and disaster risk assessment information into national planning, investment and development decisions.

The convergence of disaster risk reduction and climate change adaptation are likewise being pursued given their similar goal of sustainable development. These Supplemental Guidelines is meant to mainstream both disaster risk reduction and climate change adaptation into the comprehensive land use plan to ensure policy coherence and effective use of resources.

Rationale

The Philippines is among the most hazard-prone countries in the world. Millions of individuals are affected annually by disasters caused by natural hazards. Economic losses are high, eroding growth prospects of the country.

Climate change will increase the vulnerability of communities due to potential impacts on agricultural productivity, food supply, water availability, health, and coastal and forest ecosystem degradation. These environmental impacts lead to loss of income and livelihood, increased poverty, and reduced quality of life. These impacts will significantly delay development processes.

Comprehensive land use planning puts into practice the essence of local autonomy among Local Government Units[1](LGUs), enabling them to formulate development goals, objectives, and spatial design alternatives, and arrive at sound and socially acceptable spatial-based policies, strategies, programs, and projects. The process rationalizes the location, allocation, and use of land based on social, economic, physical, and political/ institutional requirements and physical/environmental constraints and opportunities. It provides the basis for the effective regulation of land and its resources and rationalized allocation of public and private investments.

The CLUP is therefore an integral instrument for local government units to effectively address existing risks, and avoid the creation of new risks to people, assets, and economic activities by rationalizing distribution and development of settlements, and the utilization and management of natural resources. In the context of disaster risk reduction and management, land use planning is a proactive approach, which emphasizes predisaster prevention and mitigation. Through anticipatory interventions, it is expected that the population would be safer, the economy more resilient, and basic services and infrastructure robust.

[1] HLURB, CLUP Guidebook, Volume 1 ,p.2, 2006

In the process, substantially reducing resources for disaster response and post disaster recovery and rehabilitation.

Through the CLUP, risks and vulnerabilities can be assessed in detail at the city/municipal and barangay levels; national and sub-national DRR-CCA strategic priorities can be localized and integrated into the land use plan; development and use of properties, structures, and resources at the parcel level can be regulated through zoning; local governments can identify and implement local legislations to support land use policies related to the reduction of risks and vulnerabilities; and local stakeholders can be engaged to identify socially acceptable policy and program interventions to address DRR-CCA related concerns and issues.

Benefits of Mainstreaming

Climate and disaster risk assessment provides LGUs the necessary planning information to supplement the CLUP process. The climate and disaster risk assessment seeks to establish a deeper understanding of natural hazards (frequency of occurrence and magnitude) and climate change impacts that may affect the local territory; the vulnerabilities of the various exposed elements; and the magnitude of risks involved in order to identify the pressing development challenges, problems, issues, and concerns so the proper interventions for mitigation and adaption can be translated into the various aspects of the CLUP. Understanding the potential risks and the vulnerabilities allow decision-makers and stakeholders to make informed and meaningful decisions in goal formulation, strategy generation, and land use policy formulation and development. The integration of climate and disaster risks in the CLUP and Zoning Ordinance (ZO) formulation will allow local government units to:

- Better understand natural hazards and climate change and how these would likely alter the development path of the locality;
- Understand risks posed by natural hazards and climate change on exposed areas, sectors and communities by analyzing exposure, vulnerabilities, and adaptive capacities;
- Identify priority decision areas and development challenges posed by climate change and natural hazards;
- Determine realistic projections on demand and supply of land for settlements, production, protection, and infrastructure development given the impacts of climate change and natural hazards, and existing risks and vulnerabilities;
- Incorporate spatial development goals, objectives and targets to reduce risks and vulnerabilities;

- Make informed decisions to effectively address risks and vulnerabilities by weighing alternative spatial strategies, land use allocation, and zoning regulations;

- Identify appropriate risk reduction and climate change adaptation and mitigation measures as inputs to the comprehensive development planning and investment programming.

Interventions, done without the consideration of the potential threats of natural hazards and climate change, may lead to the creation of new risks and maladaptation. Increasing population and demand for land, coupled with the improper location and development of settlement zones and the unsustainable utilization and management of natural resources, may generate new risks by exposing vulnerable elements in hazard-prone areas. Interventions that address historical frequencies and intensities of hazards may inadequately address current risks and provide a false sense of security to its inhabitants.

Features of the Guidelines

1. Supports the updated CLUP Guidebook

The HLURB, in collaboration with the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, updated and approved the three volume CLUP guidebooks in 2014 to provide support to local government units in formulating their comprehensive land use plans to address new planning challenges. The said guidebooks integrated additional thematic planning concerns such as biodiversity, heritage, ancestral domain, green growth, and disaster risk reduction and climate change adaptation in the land use planning process. The Supplemental Guidelines serves as companion resource book to the three volume guidebooks and provides added concepts and tools on climate and disaster risk assessment to generate additional planning information and recommendations on how to integrate the results in the 12-step CLUP formulation process which covers situational analysis; goal and objective setting; development thrust and spatial strategy generation; and use policy development and zoning. Risk information from the Supplemental Guidelines shall be useful for deepening the thematic analysis of the Guidebooks.

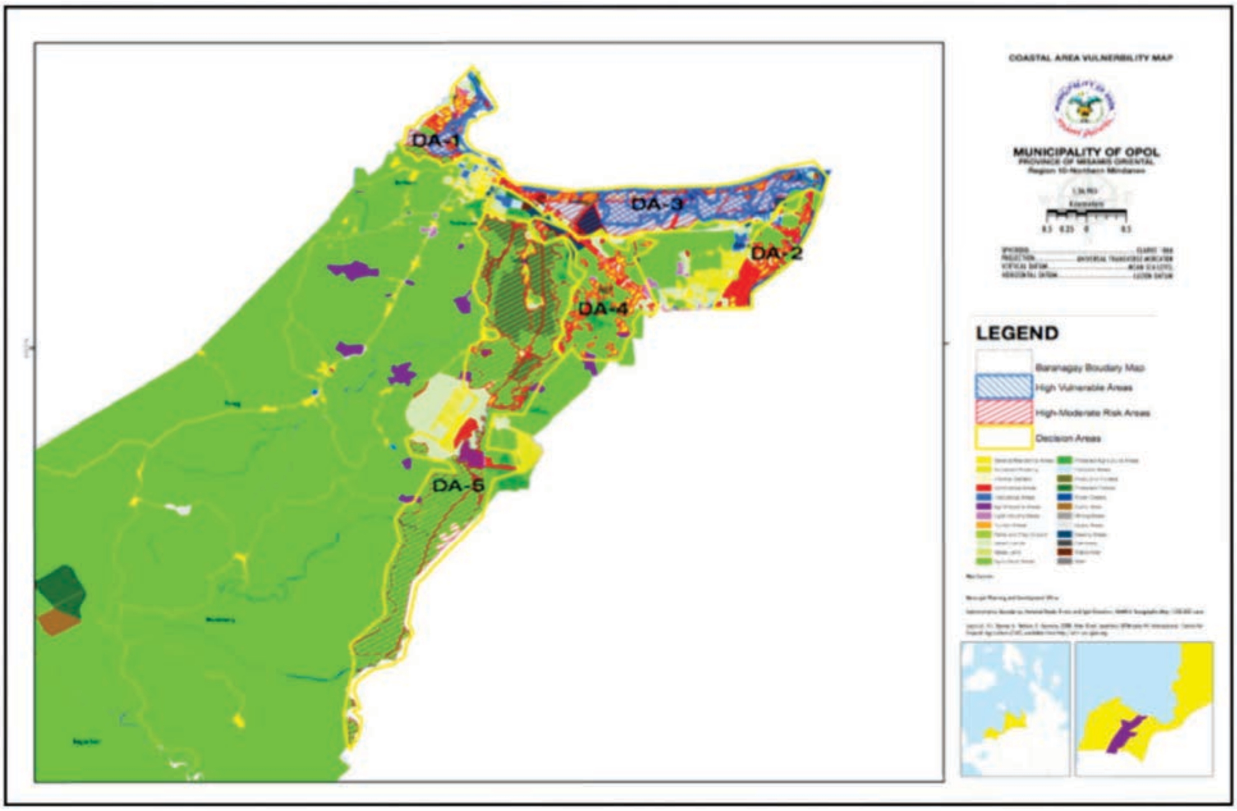
2. Introduces a conceptual Climate and Disaster Risk Assessment (CDRA) process

The Supplemental Guidelines introduces a six-step CDRA process to analyze risks and vulnerabilities of exposed elements namely: people, urban areas, agriculture, forestry and fishery production areas, critical point facilities, lifelines, and other infrastructure that are associated with natural hazards and climate change. It seeks to establish risk and vulnerable areas by analyzing the underlying factors on hazard, exposure, vulnerability/sensitivity, and adaptive capacities. The CDRA facilitates the identification of priority decision areas and allow the identification of various disaster risk reduction and climate change adaptation measures in the form of land use policy interventions (i.e. land use policies, zoning provisions, support legislation, programs and projects) to address current risks and vulnerabilities and prevent future ones.

3. Operationalizes the CDRA process and integration of the results in the CLUP

The preparation of the Supplemental Guidelines benefited from the pilot-testing in the Municipality of Opol, Misamis Oriental where the CDRA and the integration of the results were demonstrated. This will provide LGUs a guide on how to conduct a CDRA and how the results can be integrated in CLUP formulation. The combined assessments on disaster risks and climate change vulnerability done in the said municipality revealed priority decision areas which shall be the focus of land use and sectoral planning and analysis. Figure 1.1 below shows the five decision areas in Opol which have been sieved from the analysis of the geographic extent of flood and the exposed population, structures, and economic activities as well as from the assessment of vulnerability to sea level rise and other climate change stimuli (i.e. changes in rainfall patterns, temperature and extreme weather events).

Figure 1.1 Identified Decision Areas, CDRA, Municipality of Opol, Misamis Oriental

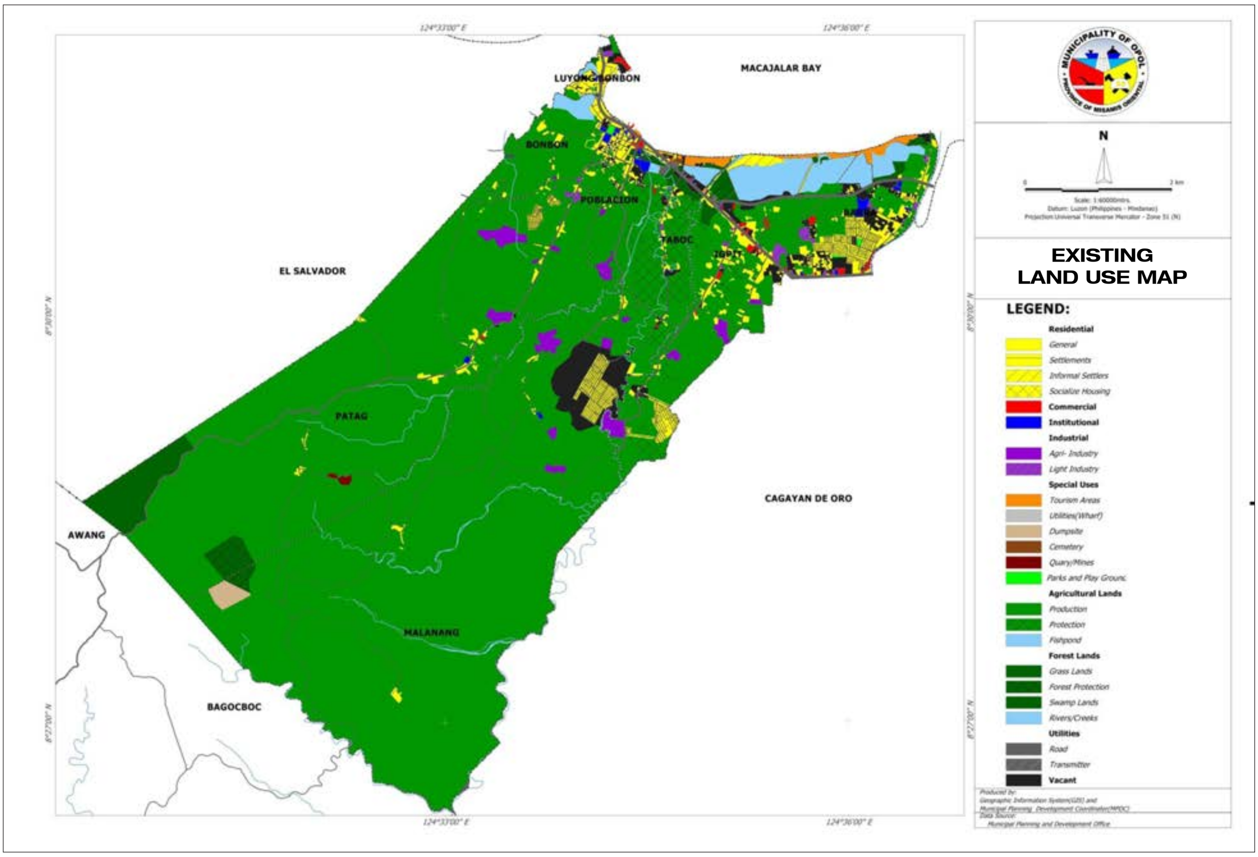


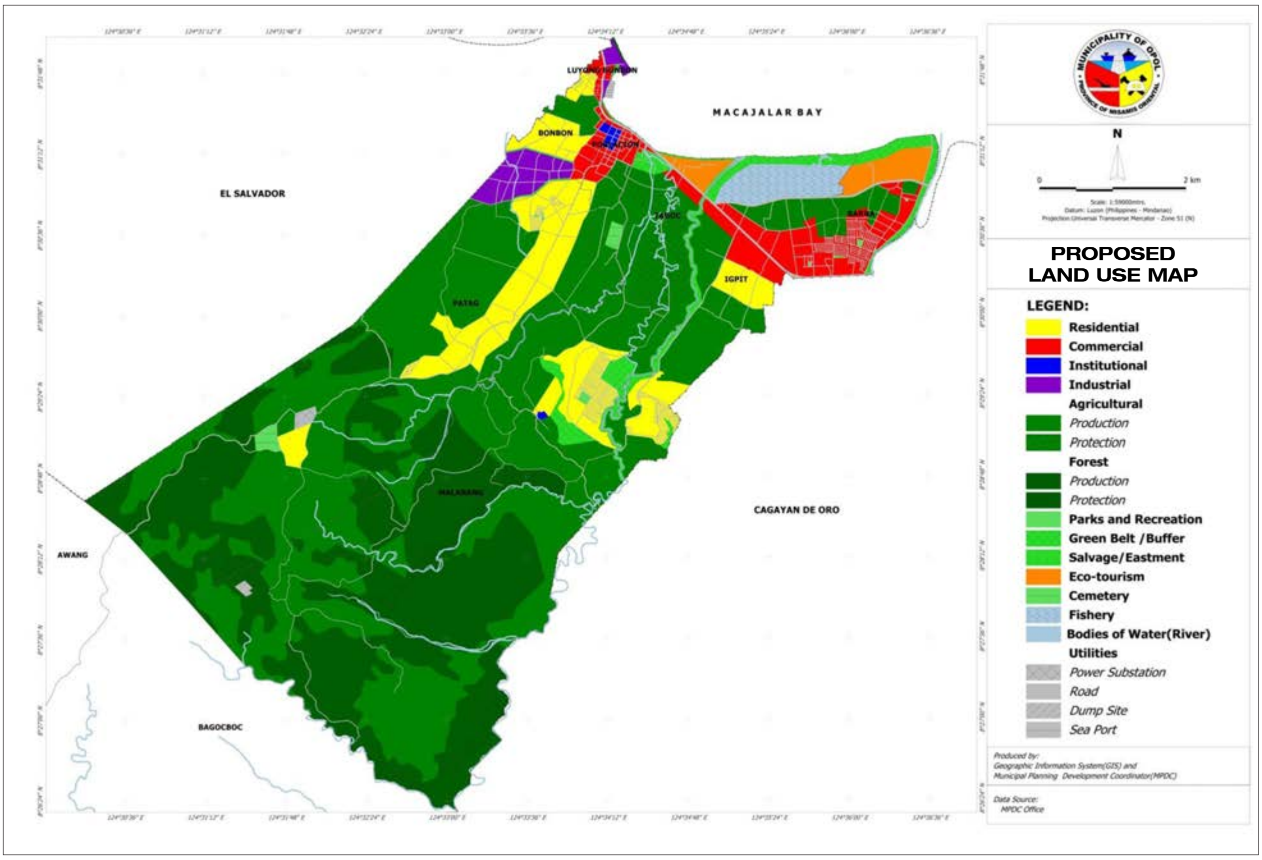
Major highlights include the identification of coastal and riverine settlements considered highly at risk to flooding due to the poor quality of structures, and fishpond areas which are moderately at risk given their location, fish cage design and current production practices. Also, transport or circulation systems are also considered at risk and may cause a significant disruption on the flow of people and goods in the event of floods. Some portions of the coastal areas of Brgys. Bonbon, Poblacion, and Igpit areas are projected to be permanently inundated due to changes in sea levels and most of the structures in the area are not designed to withstand coastal flooding and storm surges. A significant portion of the low-income population relies on tourism for their means of livelihood, which is expected to be disrupted by coastal flooding. If left unaddressed, damage to structures and possible deaths and injuries may be expected during floods and storm surges.

Considering the five priority decision areas identified in the climate and disaster risk assessment, the Municipality of Opol identified the following general land use policy directions (refer to Figure 1.2):

- Redirecting residential type uses to higher grounds to manage property and population exposure to sea-level rise, coastal, and riverine flooding;
- Limiting land use in the coastal areas to non-residential uses: tourism, commercial, and industrial type uses where regulations on hazard-resistant design shall be imposed on property developers;
- Establishing two commercial growth nodes (Brgy. Barra and Brgy. Poblacion) to ensure redundancies in the provision of commercial-based services;
- Establishing easements, green belts, and parks and open spaces along the coast, and rivers;
- Establishing crop production areas and support infrastructure such as irrigation and water impoundment, and changing crop production practices to adapt to projected changes in rainfall patterns;
- Rehabilitation and protection of upland forests and watersheds to manage local surface and potable water supplies, and control surface water run-off that would contribute to low-land flooding along the Iponan and Bungcalalan Rivers; and
- Establishing redundant transportation systems further upland that would run parallel to the existing coastal national roads to ensure continued access to major growth nodes;

Figure 1.2 Existing and Proposed Land Use Maps, Municipality of Opol, Misamis Oriental





4. Covers the formulation of zoning parameters to operationalize the land use plan

The Supplemental Guidelines illustrates how LGUs can translate land use policies on disaster risk reduction and climate change adaptation into zoning parameters to effectively address risks through managing exposure and encouraging resilient structures to ensure the safety of the population and limit structural damages caused by hazards. These include:

- Hazard resistant building design provisions – hazard-specific building design regulations to minimize structural damage, damage to building contents and minimize potential casualties using important referral codes such as the National Building Code of the Philippines (NBCP) and National Structural Code of the Philippines (NSCP);

- Bulk and Density Control – density control measures/regulations as an exposure management approach to control the number of elements exposed to the hazard by controlling the gross floor area, building height, and minimum lot sizes.

- Permitted Uses – list of uses allowed within the hazard overlay zone and identifying critical facilities (i.e. schools, hospitals, government buildings, power/ water distribution support facilities) which will be allowed usage depending on the intensity of the hazard to ensure minimal disruption on vital facilities, during and after a hazard occurrence;

- Added regulations – covering incentives/disincentives (i.e. real property tax discounts, required property insurance, or period given to property owners to employ structural retrofitting) to encourage property owners to implement risk mitigation measures.

Structure of the Guidelines

After this introductory chapter, Chapter 2 discusses the two major components of the mainstreaming framework: the climate and disaster risk assessment (CDRA) and integration of results into the CLUP. The theoretical aspects are discussed to gain a better understanding on the how to's of the six-step climate and disaster risk assessment process and to identify the entry points for integrating the results of the assessment in the 12-step CLUP formulation process.

Chapter 3 operationalizes the CDRA approach by demonstrating how each step is done using the pilot testing results in the Municipality of Opol. It outlines the procedures for: gathering climate and hazard information; scoping of impacts of climate change and hazards on areas, sectors or human and natural systems; enumerating various indicators for establishing exposure, sensitivity/vulnerability, and adaptive capacity for population, urban use areas, natural-resource-based production areas, and critical point and lifeline facilities; assessing and mapping vulnerability and risks; establishing priority decision areas; identifying sectoral development issues and concerns in terms of climate change and natural hazards;

and enumerating policy options/interventions with emphasis on the identification of risk management options.

Chapter 4 illustrates how the results of the CDRA are integrated in the various steps of the CLUP formulation. Analytical results of the CDRA are used in risk-sensitive development thrust and spatial strategy evaluation and selection, land use policy formulation, zoning regulations, program and project identification, and monitoring and evaluation. The annex presents the fundamental concepts of climate change in the Philippine context and the concept of risk and vulnerability in the context of Disaster Risk Reduction and Climate Change Adaptation.

Mainstreaming Framework 2

Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan

There is increasing recognition on the need to 'mainstream' disaster risk reduction into development – that is, to consider and address risks emanating from natural hazards in medium-term strategic development frameworks, in legislation and institutional structures, in sectoral strategies and policies, in budgetary processes, in the design and implementation of individual projects and in monitoring and evaluating all of the above (Benson and Twigg, 2007).

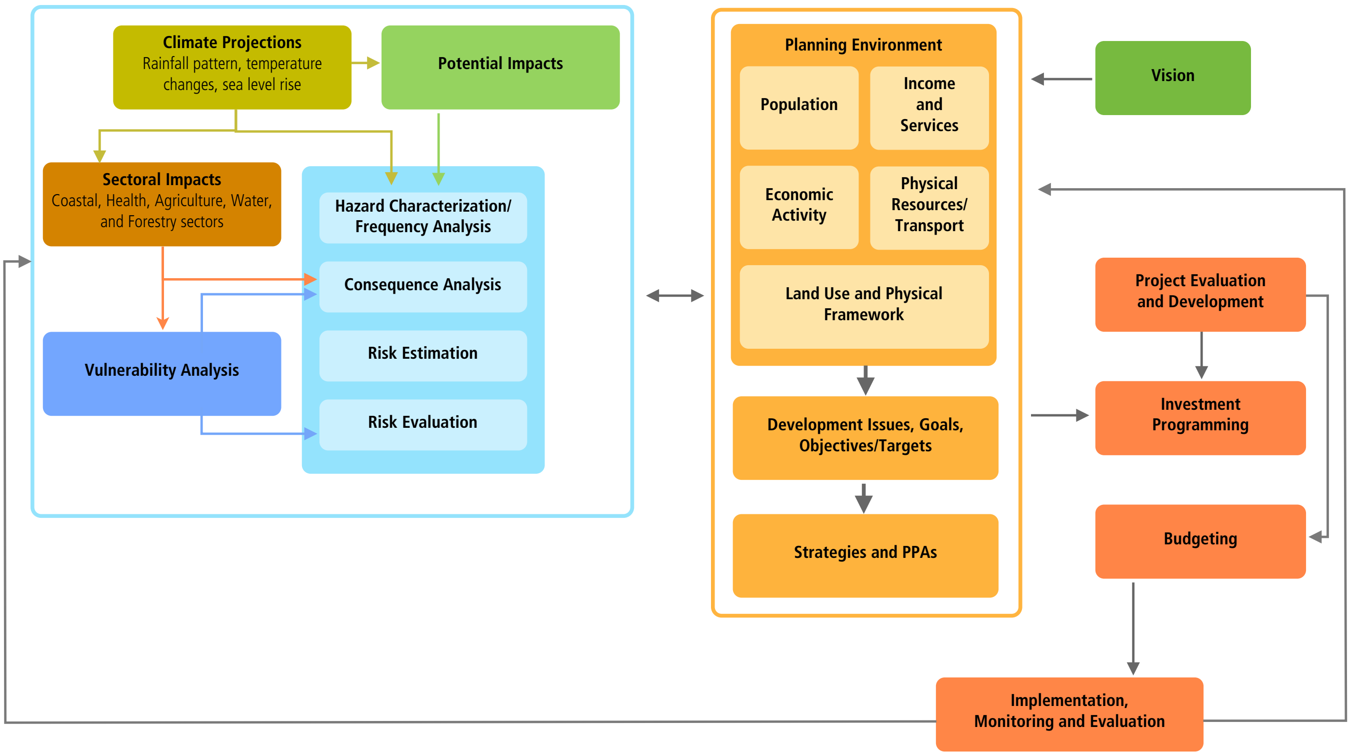
The framework of these Guidelines provides structure for mainstreaming climate and disaster risks in the comprehensive land use plan (CLUP). In local governance, the CLUP is the long-term physical plan that allocates land to specific uses taking into account best use of land after analysis of competing uses, locational strengths, and environmental constraints. It is the main entry point for mainstreaming as it serves as the basis for comprehensive socioeconomic development planning, project prioritization and design, budgetary allocation, implementation and monitoring and evaluation of outcomes.

The framework does not alter the comprehensive land use planning process. Instead, it shows how risk information from an analysis of the hazards and the vulnerability of elements exposed to these hazards are derived through a climate and disaster risk assessment (CDRA) process. These information are then integrated into the CLUP resulting in a rationalized allocation of use of land based on limitations posed by the impacts of natural hazards which can be exacerbated by climate change.

The CDRA covers both disaster risk assessment (DRA) and climate change vulnerability assessments (CCVA). The commonalities of these two processes have been established in the National Climate Change Action Plan. While the disaster risk assessment uses historical patterns in describing climate-related hazards, climate change adaptation establishes how a changing climate may influence the frequency and severity of these hazards so actions for mitigation can be designed to accommodate predicted changes. Pursuing a single approach will be beneficial to local government units since both DRA and CCVA look at the same geographical area. It will result in the identification of projects that address risks with an added level of safety to accommodate predicted changes in the climate.

The DRA process takes off from the NEDA-UNDP-EU Guidelines on Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning in the Philippines. The process outlines a quantitative and probabilistic approach to assessing disaster risks. The methodology adopted in these Guidelines will be qualitative due to the unavailability of probabilistic hazard maps, complete catalogue of hazard events and characteristics, georeferenced data of exposed elements, and assessed values of structures and facilities. It takes off from the approach used by NEDA and HLURB in the Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans in 2012.

Figure 2.1a Integrated Climate and Disaster Risk Assessment Model

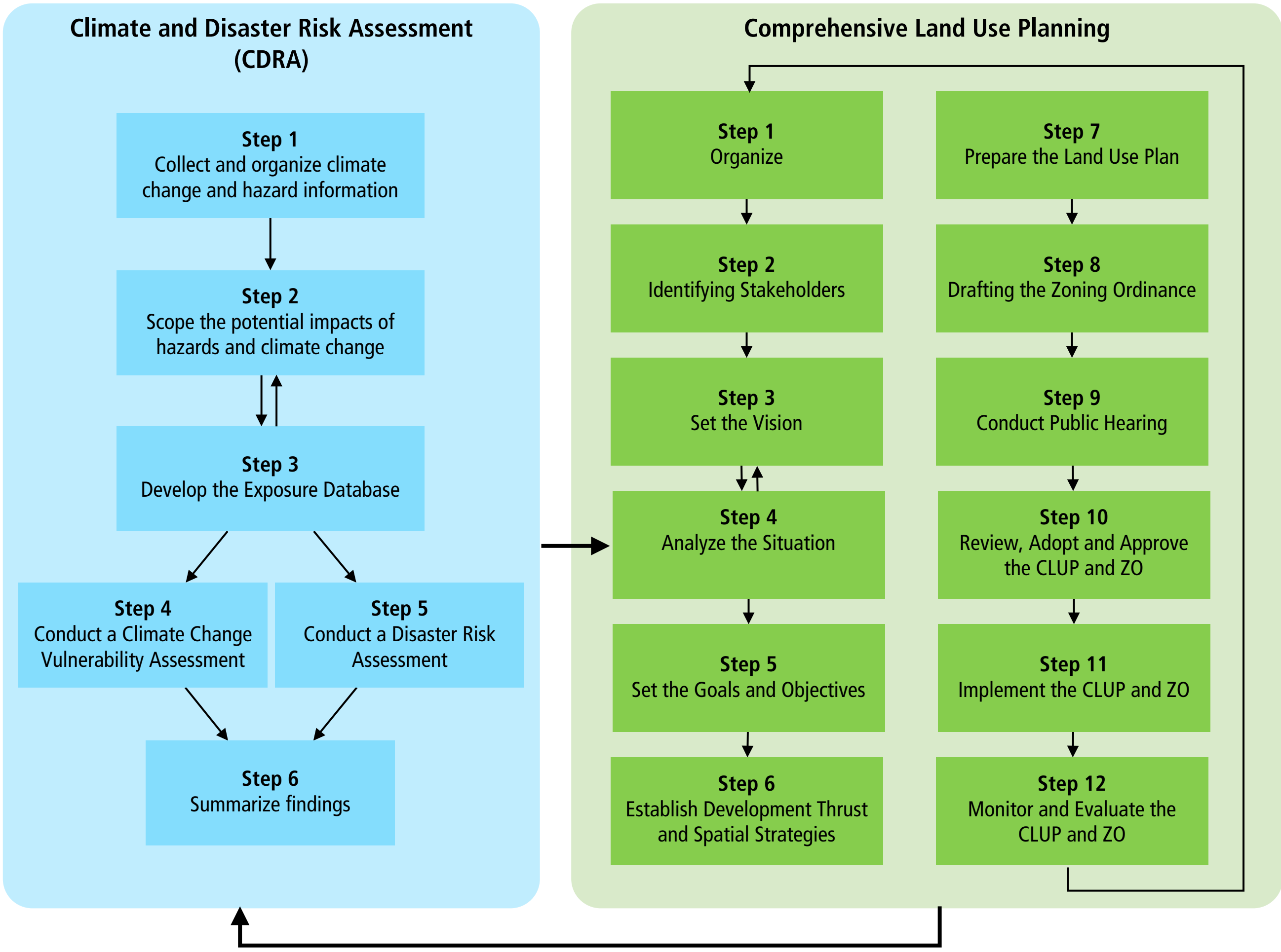


Source: A Practical Guide on Climate/Disaster Risk and Vulnerability Assessment, Mainstreaming CCA and DRR in Local Development Planning, CCC-UNDP-Australian Government

The mainstreaming framework involves two processes: first, the conduct of climate and disaster risk assessment (CDRA); and second, the mainstreaming of results of the CDRA in the various steps of the CLUP formulation process. The outputs derived from the climate and disaster risk assessment help in identifying major decision areas that are characterized as areas at risk to natural hazards and can be exacerbated by vulnerabilities to climate change impacts, including the necessary interventions to address them in the form of disaster risk reduction (DRR) and climate change adaptation (CCA) options.

The formulation of a risk-sensitive comprehensive land use plan shall be guided by the results of the CDRA in order to create safer and resilient human settlements through rationalized location of people, assets, economic activities, and sustainable management of resources to effectively reduce and manage climate and disaster risks (Figure 2.1b Framework for Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan).

Figure 2.1b Framework for Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan



Climate and Disaster Risk Assessment (CDRA) Process

The climate and disaster risk assessment (CDRA) intends to determine the level of risks and vulnerabilities of areas and sectors in the municipality/city to climate related hazards and potential impacts of climate change and facilitate the identification of priority decision areas where the various interventions can be implemented. The CDRA involves six steps namely:

1. Collect and organize climate change and hazard information - involves the gathering of climate change information and characterizing hazards that may affect the locality.

2. Scope the potential impacts of hazards and climate change - identifying key areas or sectors that may be affected by climate change and natural hazards and determining likely impacts (direct and indirect);

3. Develop the exposure database - gathering baseline map and attribute data on exposure, vulnerability/ sensitivity and adaptive capacity as basis for the Climate Change Vulnerability Assessment (CCVA) and Disaster Risk Assessment (DRA).

4. Conduct a CCVA - identification of vulnerable areas and sectors by analysing exposure, sensitivity and adaptive capacity to the various climate stimuli.

5. Conduct a DRA - identification of risk areas by analyzing hazard, exposure and vulnerability.

6. Summarize findings - identification of priority decision areas/sectors based on the combined level of risks and vulnerabilities, identification of risk management options, climate change adaptation and mitigation options.

Step 1. Collect and organize climate change and hazard information

Climate Change Information

The book, Climate Change in the Philippines, published by PAGASA in February 2011 is the basic source of climate change information for local government units. The said report contains the projections for 2020 and 2050 under the high, medium, and low emission scenarios. Boxes 1 and 2 show the methodology and trends of these projections, respectively. These projections are guided by scenarios developed under the IPCC fourth assessment report. PAGASA is expected to update these projections as new scenarios are developed and better data sets are gathered.

Box 1. Climate Change Projections in the Philippines: Methodology

PAGASA used three climate scenarios (high, medium and low range scenarios). The medium-range emission scenario which indicates "a future world of very rapid economic growth, with the global population peaking in mid-century and declining thereafter and there is rapid introduction of new and more efficient technologies with energy generation balanced across all sources" (PAGASA: 2011) is proposed to be used for the climate and disaster risk assessment since it considers past emissions.

The projected changes are relative to the baseline (1971-2000) climate, the years where actual observed data has been established for the Philippines. Two time slices centered on 2020 (2006-2035) and 2050 (2036-2065) were used in the climate simulations.

The main outputs of the simulations are: (a) projected changes in seasonal and annual mean temperatures; (b) projected changes in minimum and maximum temperatures; (c) projected changes in seasonal rainfall; and (d) projected frequency of extreme events.

The seasonal variations are as follows: (a) the DJF (December, January, February or northeast monsoon locally known as "amihan") season; (b) the MAM (March, April, May or summer) season; (c) JJA (June, July, August or southwest monsoon locally known as "habagat") season; and (d) SON (September, October, November or transition from southwest to northeast monsoon) season.

On the other hand, the extreme events are defined as follows:

- Extreme temperature (assessed as number of days with maximum temperature greater than 350C, following the threshold values used in other countries in the Asia-Pacific region);
- Dry days (assessed as number of dry days or days with rainfall equal to or less than 2.5 mm/day), following the World Meteorological Organization standard definition of dry days used in a number of countries); and
- Extreme rainfall (assessed as number of days with daily rainfall greater than 300 mm, which for wet tropical areas like the Philippines is considerably intense and could trigger disastrous events).

Source: PAGASA. 2011. In partnership with UN-GOP-MDGF Project. Climate Change in the Philippines. Quezon City, Philippines

The PAGASA report (2011) includes climate change projections in the provincial level. It contains climate variables on the baseline period from 1971-2000 and the projected changes from the baseline values for two time frames—2020 and 2050, covering seasonal rainfall change, seasonal temperature change, frequency of extreme rainfall events, frequency of days with temperatures exceeding 35^{o}C, and frequency of dry days or days with rainfall less than 2.5mm (refer to Table 2.1)

Table 2.1 Climate Change Projections for Misamis Oriental, Region 10

Climate Variables	Observed Baseline (1971-2000)				Change in 2020 (2006-2035)				Change in 2050 (2036-2065)			
Seasons	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
Seasonal temperature increases (^{0}C)	25.4	26.8	26.9	26.5	1.0	1.2	1.2	1.0	1.9	2.3	3.4	2.0
Seasonal rainfall change (%)	442.5	296.0	615.7	581.1	4.6	-10.4	-3.7	2.9	1.8	-17.8	-5.2	-0.1
No of days with Temp >35^{o}C	382				4,539				6,180			
No. of dry days (rainfall < 2.5mm)	8,251				6413				7,060			
No of days with Extreme Rainfall > 150mm	10				13				9			

Seasons: DJF - December, January and February; MAM- March, April, and May; JJA - June, July, and August; SON - September, October and November
Projections are based under medium-range emission scenario (A1B)
Source: DOST-PAGASA. Climate Change in the Philippines. 2011 (Under the UN-Philippine MDG F Project in partnership with Adaptayo).

This step will result in a summary of climate change information available to the local government units. The information covers climate type and projected changes in climate variables such as temperature, precipitation, and extreme events for specific future time horizon (e.g., 2020 or 2050). These information will be helpful in establishing the LGU that will be potentially affected by climate change, or if there are already indications that climate change is already happening. Apart from PAGASA, the local government unit may also look at other sources of climate change information such as special studies of universities and research institutes.

Hazard information covers the characterization of potential hazards affecting a locality and historical data on past disaster damage that show sectors/elements that are adversely affected by hazards. Information on hazards can be gathered from the various national and local level agencies. Hazards can be described in terms of frequency, spatial extent, magnitude/intensity, duration, predictability, and speed of onset.

Box 2. Potential Impacts of Climate Change on Existing Hazards

A changing climate may impact the frequency and severity of hazards such as floods, landslides (thru increases in frequency of extreme one-day rainfall events), and storm surges (thru rising sea levels). A demonstration of integrating climate change in flood hazard mapping was conducted in the cities of Iligan and Cagayan de Oro, incorporating the potential changes in the frequency of extreme one-day rainfall events, and changes in land cover of the watersheds resulting in changes in run-off in flood modeling, to compare historical and projected effects on flood depths and spatial extent (refer to Figure 2.2). Relative to flood maps which give indication of susceptibility or proneness to flooding, the climate-adjusted flood hazard maps provide greater detail in terms of varying flood depths. These firstever climate-adjusted flood hazard maps were prepared by the Climate Change Commission in partnership with the UNDP and Australian Government. The high resolution maps utilized elevation data from LiDAR.

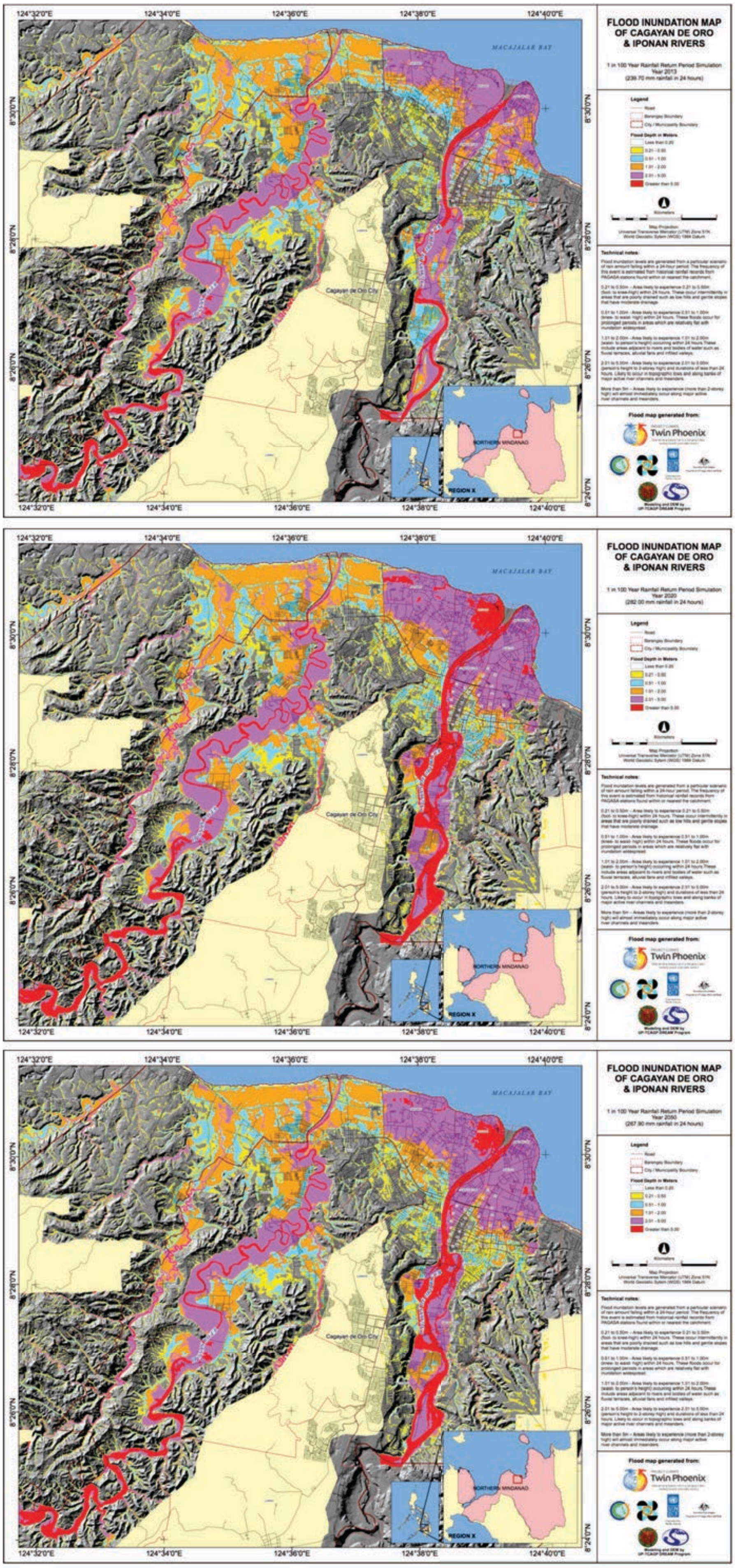


Figure 2.2
Climate-adjusted flood hazard maps of the Cagayan de Oro River System

A comparison of the estimated flood heights using a 1-in-100-year rainfall return period for 2013 (239.70mm) and climate change scenarios 2020 (282.00mm) and 2050 (267.00mm) for the Cagayan de Oro River System. It illustrates potential increase in flood heights and extent for projection years 2020 and 2050 compared to observed/ historical 100 year rainfall.

Step 2. Scope the potential impacts of climate hazards and climate change on the LGU

This step summarizes the initial scoping of potential hazards affecting the locality, including the associated impacts of climate change. These are based from findings from the initial scoping of climate trends, climate change, and compilation of hazard maps. This involves identifying various climate stimuli from climate trends, climate change projections, and hazards that will likely affect the municipality and the chain of direct and indirect impacts that may likely affect the various development sectors.

Table 2.2 Summary of Climate Change Variables

Climate change variables	Changes in variables	Climate Change Effects	Climate Change Impacts
Temperature	Increase	Longer period of droughts	Decline in crop production
		Warmer days and nights	Heat-related stresses on health
Seasonal Rainfall	Increase	Frequent flooding	Damage to agricultural crops
	Decrease	Drought	Decline in water supply, decline in crop production
Climate extremes	Increase in extreme one day rainfall events	Potential changes in frequency and severity of flooding events; Potential changes in frequency in rain-induced landslide events;	Property damage, deaths
Sea level	Increase	Permanent sea water inundation of inland areas Stronger storm surge resulting in coastal flooding	Loss of low lying/coastal land areas, Damaged property to low-lying coastal settlements

Table 2.3 Summary of Climate Change Effects and Impacts

Systems (1)	Climate Variable (2)	General Changes in Climate Variable (3)	Climate Change Effects (4)	Climate Change Impacts (5)
Coastal zone	Sea level rise	Increase	• Flooding • Storm surge	• Increased erosion or damage to coastal infrastructure, beaches, and other natural features • Loss of coastal wetlands and other coastal habitats such as mangroves • Coral bleaching • Pollution • Increased costs for maintenance and expansion of coastal erosion/flooding control (natural or manmade) • Saltwater intrusion into coastal aquifers • Submergence of low-lying lands • Loss of cultural and historical sites on coastline to sea level rise
Human Health	Temperature	Increase	• Hotter days	• More heat-related stress, particularly among the elderly, the poor, and vulnerable population
	Rainfall	Increase	• Flooding	• Increase in vector-borne diseases
Agriculture: crop production	Rainfall	Erratic rain patterns - Too little rainfall - Too much rains - Early onset of rainy season - Late onset of rainy season - Too little rainfall	• Drought • Flooding • Rain-induced landslides	• Crops submerged in water • Wilting of planted crops • Changes in crop yields • Diminishing harvest; reduction in farmers' income • Increase risk of pest outbreaks and weeds • Damaged road transportation network
	Temperature	Increase	• Drought	• Increased demand for irrigation due to longer and warmer growing season • Inability to plant especially in times when rains are too little • Poorer quality of agricultural products (e.g., less grain filling in rice, smaller coconut fruits)

Table 2.3 Summary of Climate Change Effects and Impacts

Systems (1)	Climate Variable (2)	General Changes in Climate Variable (3)	Climate Change Effects (4)	Climate Change Impacts (5)
	Sea level	Increase	• Flooding	• Intrusion of salt water into ricelands • Reduced areas for rice production • Reduction in farmer's income • Reduced food supply
Fishery production	Temperature	Increase (sea surface)		• Less fish catch; less fish variety in catch • Reduction in fishermen's income
	Sea level	Increase (sea level)	• Storm surge • Sea level rise	• Overflowing of fish cages resulting to less fish catch • Reduction in fishermen's income
Water Resources	Rainfall	Decrease	• Drought	• Increased competition for water (irrigation and hydropower) • Changes in water quality
	Extreme rainfall	More events	• Flooding	• Changes in water quality
Infrastructure: roads and bridges; flood control networks	Extreme rainfall	More events	• Flooding • Rain-induced landslide	• More travel disruptions associated with landslides and flooding • Damage to flood control facilities
Business	Extreme rainfall	More events	• Flooding	• Impacts on business infrastructure located in floodplains or coastal areas • Increased insurance premiums due to more extreme weather events
	Rainfall	Increase		

Step 3. Exposure Database Development

The Exposure Database provides baseline information pertaining to the elements at risk. Elements at risk refer to population, assets, structures, economic activities and environmental resources which are located in areas exposed to potential impacts of climate change and damaging hazard events.

The exposure data shall provide the location, vulnerability/sensitivity and adaptive capacity attributes of the exposed elements which are necessary information when conducting a climate change vulnerability and disaster risk assessments. Ideally, each element must be geo-referenced and accordingly reflected on a map. This will facilitate overlay with hazard maps and maps depicting impacts of climate change, such as sea level rise, which will be the basis in estimating the exposed elements expressed in terms of area, number and/or unit cost. Other area-/element-based information should also be gathered to establish the sensitivity/ vulnerability and adaptive capacity of the exposed elements which will be the basis for estimating the levels of risk and vulnerability.

Sample indicators can be gathered through primary field surveys or available secondary data such as the Community-Based Monitoring System (CBMS), Census of Population and Housing of the National Statistics Office (NSO), Barangay Profiles, and local Building Inventory. These information can be used to describe the extent of exposure (i.e. number of people, area, and unique structures), while the vulnerability/sensitivity and adaptive capacity indicators will be used in determining the severity of impacts. In these guidelines, exposure units will be limited to:

1. **Population Exposure -** shall indicate the spatial location and number of potentially-affected persons. Spatial location can be derived from existing residential area map. It shall also contain the demographic characteristics of local inhabitants which would be used to indicate whether they will be potentially affected by hazards or impacts of climate change by analyzing information on the sensitivityvulnerability and adaptive capacity. Suggested indicators for population exposure presented in Table 2.4.

2. **Urban use area Exposure -** pertain to the built environment currently utilized for residential, commercial, industrial, tourism, sanitary waste management facilities,cemeteries, and other land uses unique to the locality. These are often represented as area/zone in the existing/proposed general or urban land use maps. The exposure information can be expressed in terms of area (in hectares or square meters), type of use, and replacement/construction cost (estimated replacement cost per square meter).

   Sensitivity/vulnerability attributes can be expressed as proportion and will be limited to the general structural/design attributes of the various structures located in the area such as type of wall construction materials, structural condition, building age, property insurance coverage to indicate its resiliency to the potential impacts of hazards and climate change. Suggested indicators for Urban Use Area exposure presented in Table 2.5.

Table 2.4 Recommended Population Exposure, Sensitivity/Vulnerability and Adaptive Capacity Indicators

Indicator	Description
Exposure	
Residential area	Residential area allocation per baranagay in hectares
Barangay population	Barangay population
Barangay Population Density	Population density of the barangay derived by dividing the total barangay population with the estimated residential land area.
Sensitivity/Vulnerability	
Wall construction materials	Percentage of households living in dwelling units with walls made from predominantly light, salvaged and makeshift type materials.
Dependent population	Percentage of young (<5 years Old) and old (Above 65)
Persons with Disabilities	Number/Percentage of population with disabilities
Early Waring System	Absence of early warning systems
Informal settler households	Percentage of informal settler households
Local awareness	Percentage of households/property owners not aware of natural hazards and impacts of climate change.
Access to infrastructure-related mitigation measures	Percentage of areas with no access to infrastructure related mitigation measures (i.e. sea walls, flood control measures)
Employment	Percentage of the labor force who are unemployed
Income below poverty threshold	Households with income below the poverty threshold
Education/literacy rate	Proportion of population with primary level educational attainment and below / Proportion of the population who are illiterate
Adaptive Capacity	
Access to financial assistance	Percentage of individuals with access to financial assistance (i.e. Pag-Ibig, SSS, PhilHealth, credit cooperatives, micro-financing institutions, property and life insurance)
Access to information	Percentage of households with access to climate, climate change and hazards-related information affecting the area
Capacity and willingness to retrofit or relocate	Percentage of households willing and have existing capacities to retrofit or relocate
Government investments	Local government capacity to invest in risk management and climate change adaptation/ mitigation

Table 2.5 Recommended Urban Use Area Exposure, Sensitivity/Vulnerability and Adaptive Capacity Indicators

Indicator	Description
Exposure	
Category	The general classification or use of the area aggregated at the barangay level (residential, commercial, industrial)
Total Barangay Area Allocation per land use category	Total area allocation in hectares per land use category at the barangay level
Construction/replacement cost	Average construction/replacement cost per square meter per classification
Assessed value	Estimated assessed value of the property (if available)
Sensitivity/Vulnerability	
Building condition	Percentage of structures classified as dilapidated or condemned
Wall construction materials	Structure with walls made from predominantly light, salvaged and makeshift type materials.
Date of construction	Percentage of structures constructed before 1992
Area coverage to infrastructure related mitigation measures	Percentage of areas not covered by infrastructure-related mitigation measures (i.e. sea walls, flood control measures)
Structure employing hazard mitigation design	Percentage of structures employing site preparation, hazard resistant and/ or climate proofed design standards
Local awareness	Percentage of households/property owners aware of natural hazards associated with climate change.
Adaptive Capacity	
Government regulations	Presence and adherence to government regulations on hazard mitigation zoning and structural design standards
Capacity and willingness to retrofit or relocate	Percentage of property owners with capacities and willingness to retrofit or relocate
Insurance Coverage	Percentage of structures covered by property insurance
Available alternative sites	Available land supply/alternative sites
Government investments	Local government capacity to invest in risk management and climate change adaptation/mitigation

3. **Natural resource based production areas** - pertain to areas utilized for crop, fisheries, and forestrelated production. Exposure can be expressed in terms of type of resource (i.e. rice, corn, fish, timber or non-timber forest resource) or by area in terms of hectares and replacement cost (cost of replanting for crops or restocking for fisheries). Sensitivity/vulnerability and adaptive indicators pertain to current production practices (with emphasis on use of hazard resistant varieties and/or climate adapted production techniques), access to infrastructure (i.e. irrigation, water impoundment, flood control) and climate/hazard information, presence or use of risk transfer instruments and access to extension services. Suggested natural resource-based production area exposure presented in Table 2.6.

4. **Critical Point Facilities -** Special emphasis must be given in describing critical point facilities. These facilities provide key socio-economic support services such as schools, hospitals/rural health units, local government buildings, roads, bridges, air/ sea ports, communication towers, and power-related and waterrelated facilities. Exposure information can be supplemented by building/structure specific information generated during sectoral/structural inventories such as construction cost, floor area, number of storeys, number of rooms (class rooms), bed capacity for hospitals/health facilities and services offered. Suggested indicators presented in Table 2.7.

5. **Lifeline utilities -** cover the transportation, water distribution, drainage and power distribution networks. These are also important municipal/city assets which should be assessed to ensure the delivery of lifeline services. Exposure can be expressed in the linear kilometers exposed, the construction cost or replacement -values. At the minimum, LGUs limit the scope of establishing exposure for major access/ distribution networks. Suggested indicators presented in Table 2.8.

Box 3. Climate and Disaster Risk Exposure Database (ClimEx.db)

Developed under Project Climate Twin Phoenix of the CCC, UNDP, and Australian Government, the ClimEx.db is a tablet-based survey application designed to facilitate the gathering of geo-referenced data on population, buildings, infrastructure and economic activities in communities that are exposed to hazards and are predisposed to the impacts of climate change. Information gathered can be used as vital inputs to risk and vulnerability assessments, as well as, supplement socio-economic profiling in Comprehensive Land Use Planning.

Table 2.6 Natural Resource based Production Areas Exposure, Sensitivity/Vulnerability and Adaptive Capacity Parameters

Indicator	Description
Exposure	
Classification	The general classification or use of the area (fisheries, agriculture, livestock, production forest etc.)
Varieties produced	Existing crop and fish varieties and forest products being produced
Annual production output	Annual production output per hectare
Replacement cost	Replacement cost expressed as Philippine Pesos per hectare
Number of farming dependent households	Number of households dependent on agriculture, fisheries and forest-based production
Sensitivity/Vulnerability	
Access to early warning system	Percentage of production areas without access to production support early warning systems
Farmers/areas employing sustainable production techniques	Percentage of farmers not employing sustainable production techniques (i.e. climate proofing, use of hazard resistant crops varieties)
Local awareness/Access to information	Percentage of the population engaged in production who are aware of natural hazards associated with climate change
Access to hazard mitigation measures/structures	Percentage of production areas covered by hazard control measures (i.e. flood control, slope stabilization, sea walls, etc.
Irrigation Coverage	Percentage of production areas without access to irrigation
Water impoundment	Percentage of production areas without access to water impoundment infrastructures
Adaptive Capacity	
Access to financing	Percentage of production areas not covered by post disaster economic protection (insurance, micro-finance)
Alternative Livelihood	Percentage of population with access to alternative livelihood
Government Extension Programs	Institutional financial and technical capacity to provide local agriculture and forestry-based extension programs (technology and knowledge transfer related to climate change proofed production)
Government Infrastructure Programs	Institutional financial and technical capacity to implement hazard mitigation infrastructure projects

Table 2.7 Critical point facilities Exposure, Sensitivity/Vulnerability and Adaptive Capacity Parameters

Indicator	Description
Exposure	
Classification	The general classification or use of the structure (school, hospital, rural health unit evacuation center, water-related facility, airport, seaport, barangay hall, municipal/city hall)
Location	Location of the structure (i.e. baranagay, street address)
Floor Area	Estimated floor area in square meters
Construction cost	Estimated construction cost
Sensitivity/Vulnerability	
Wall construction materials	Structure/s with walls made from predominantly light, salvaged and makeshift type materials
Building condition	Structure/s classified as dilapidated or condemned
Structure employing hazard mitigation design	Structure/s employing site preparation, hazard resistant and/or climate proofed design standards
Date of construction	Structure/s constructed before 1992
Government regulations	Presence of government regulations on hazard mitigation zoning and structural design standards
Access to infrastructure related mitigation measures	Percentage of the site with no access to infrastructure-related mitigation measures (i.e. sea walls, flood control measures)
Adaptive Capacity	
Capacity and willingness to retrofit or relocate	Property owner/s with capacities and willingness to retrofit or relocate
Insurance Coverage	Structure/s covered by property insurance
Available alternative sites	Available land supply/alternative sites
Available alternative structures	Existing alternative structures to accommodate current demand
Government investments	Local government capacity to invest in social support infrastructure/facilities

Table 2.8 Lifeline Utilities Exposure, Sensitivity/Vulnerability and Adaptive Capacity Parameters

Indicator	Description
Exposure	
Classification	The general classification or use of the lifeline (road, water distribution network, power)
Length/Distance	Estimated linear meters/kilometers
Construction/replacement cost	Estimated construction cost per linear kilometers
Sensitivity/Vulnerability	
Construction materials used	Construction materials used (i.e. concrete, asphalt, gravel, dirt)
Condition	Qualitative assessment of the existing condition of the distribution/access network
Structure employing hazard mitigation design	Proportion of structures employing site preparation, hazard resistant and/or climate proofed design standards
Adaptive Capacity	
Insurance Coverage	Proportion of structures covered by insurance
Government infrastructure related investment	Local government capacity to invest in infrastructure related projects (mitigation and construction of redundant systems)
Available redundant systems	Existing alternative routes/distribution networks

Step 4. Conduct a Climate Change Vulnerability Assessment (CCVA)

The climate change vulnerability assessment (CCVA) assesses the locality's vulnerabilities to various climate related stimuli. As a tool, it uses a qualitative approach in establishing the level of vulnerability of identified areas or sectors of interest. Vulnerability shall be based on the extent of exposure, and an analysis of the sensitivities and adaptive capacities. This will inform the identification of decision areas and be the subject of further detailing for the identification of area specific planning implications and policy interventions.

In these guidelines, vulnerability of the system to the expected climate stimulus is the interplay of exposure, sensitivity and adaptive capacity. Vulnerability shall be operationalised using the following function:

$$f \text{ (Vulnerability)} = \text{Exposure, Sensitivity, Adaptive Capacity}$$

Where:

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes[2].

Exposure refers to people, property, systems, or other elements present in hazard zones that are thereby subject to potential losses[3]. It is expressed as the area and/or monetary unit, for social, economic and environmental related property. In terms of population exposure, it shall be expressed as the number of affected individuals or households exposed to a climate stimulus.

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise)[4]. Impact is the estimated direct and indirect impacts expressed in terms of damages, loss in productivity and quality of resources, and mortality, morbidity and impacts to the well-being of individuals based on the interplay of the extent of exposure and the sensitivity.

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences[5].

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[2] IPCC, Working Group II, Climate Change 2001: Impacts, Adaptation, and Vulnerability, 2001

[3] United Nations International Strategy for Disaster Reduction , UNISDR Terminology on Disaster Risk Reduction, 2009.

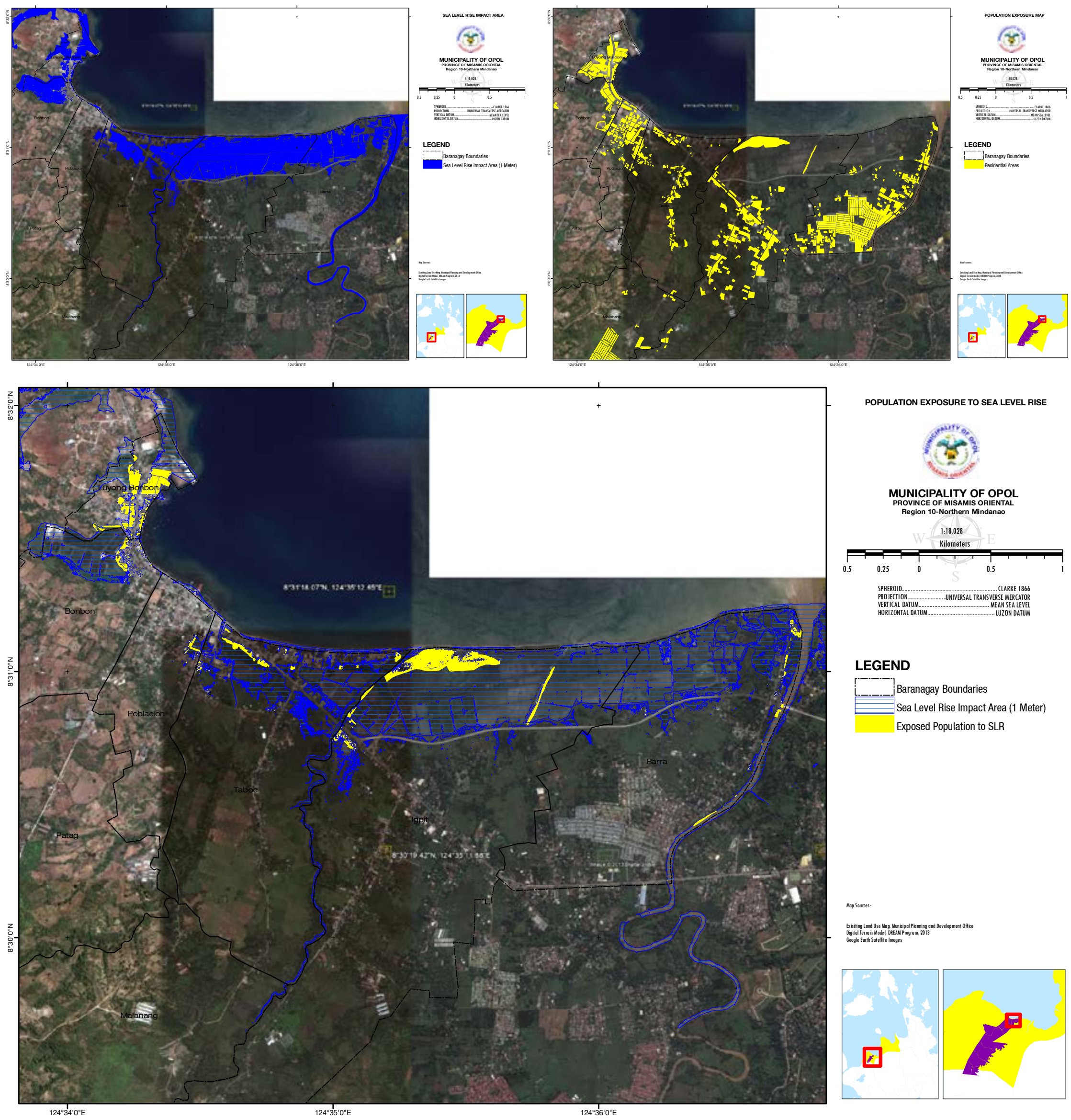
[4] IPCC, Working Group II, Climate Change 2001: Impacts, Adaptation, and Vulnerability, 2001

[5] Ibid

Determine Exposure

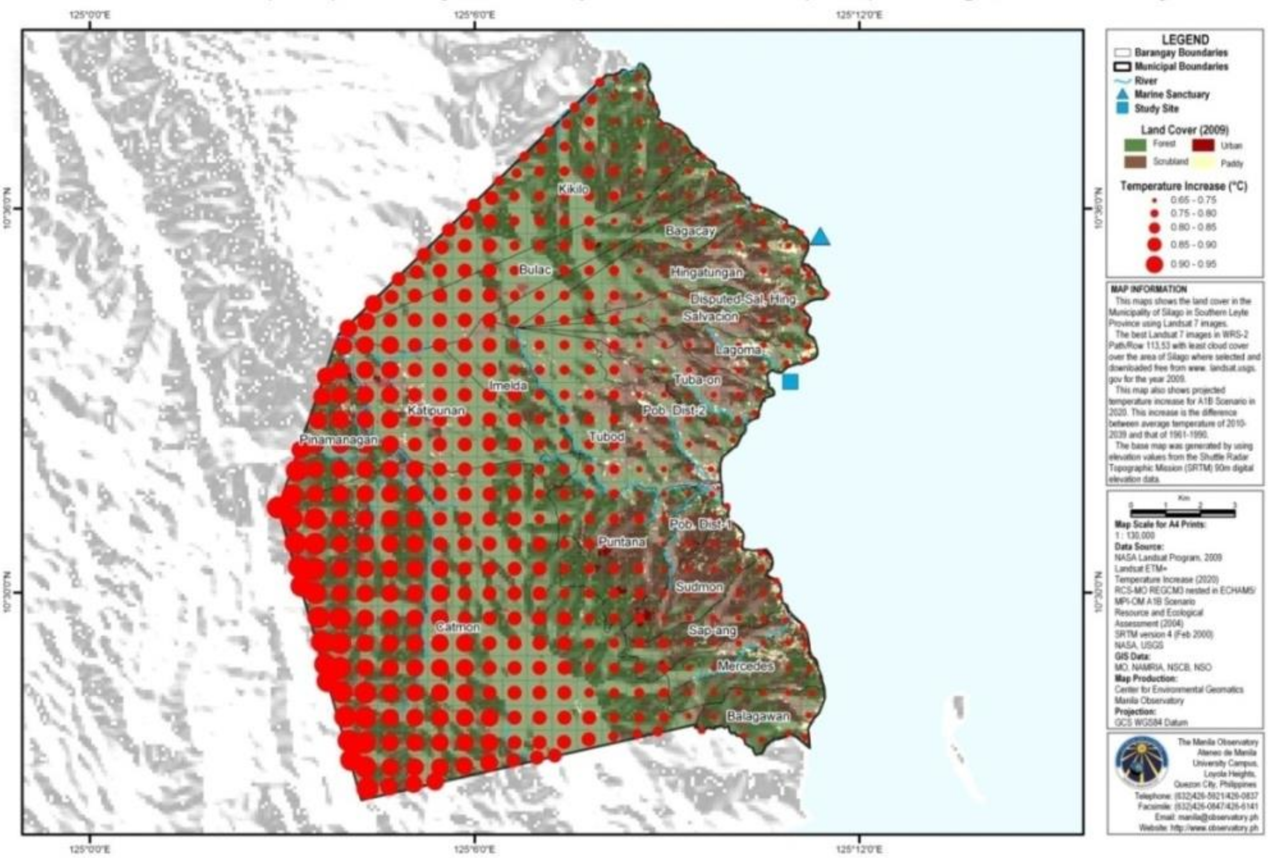
In these guidelines, the climate stimuli shall be represented as an impact area (similar to hazard maps) to indicate a location and extent of potentially affected area for a particular climate stimulus. Climate stimuli may range from changes in seasonal temperature and rainfall, number of dry days, and number of days with extreme temperatures and sea level rise. However, LGUs may work with experts, who could undertake special climate change mapping studies by down-scaling provincial level data at the municipal/city level, to establish site level variations of climate change variables. Establishing extent of exposure will be derived from the overlaying of the impact area map and the exposure database, as described in Step 3, for the various exposure units. Exposure shall be expressed in terms of area extent, number of affected persons and replacement cost depending on the exposure unit being analysed.

Figure 2.2a Sample Population Exposure to Sea Level Rise, Municipality of Opol



LGUs can pursue city/municipal level downscaling to provide site level disaggregation of climate change parameters (refer to Figure 2.2b), as demonstrated in the Municipality of Silago, Southern Leyte. This municipal level downscaling can support site level sectoral climate change vulnerability assessments for a better identification of priority areas/sites within the locality where interventions can be implemented.

Figure 2.2b Land cover (2009) and projected temperature increase (2020) of Silago, Southern, Leyte



Source: GIZ-MO-ICRAF, 2011: Patterns of vulnerability in the forestry, agriculture, water, and coastal sectors of Silago,Southern Leyte, Philippines, ISBN: 978-971-94565-1-3

Conduct a sensitivity analysis and determine the degree of impact

Sensitivity is the degree to which a built, natural or human, system is directly or indirectly affected by a particular climate stimuli (e.g., changes in seasonal temperature and precipitation, sea level rise). An analysis of the various sensitivity indicators of the exposed elements will give an indication of the degree of impact (the higher the sensitivity of the system, the higher the expected impacts). In the absence of quantitative information to measure direct or indirect damages, degree of impact may be assessed qualitatively as high, moderate or low (refer to table 2.9).

Table 2.9 Degree of Impact Score

Degree of Impact	Degree of Impact Score	Description
High	3	Estimated direct impacts in terms of number of fatalities, injuries and value of property damage will be disastrous given the extent of exposure and current sensitivity of the system. Medium- to long-term indirect impacts which may affect development processes will also be experienced. Significant costs needed to return to pre-impact levels.
Moderate	2	Moderate direct impacts in terms of number of fatalities, injuries and value of property damage are expected given the extent of exposure and current sensitivities of the system. Short- to medium-term indirect impacts which may affect development processes will also be experienced. Medium to low cost needed to return to pre-impact levels within a short to medium time period.
Low	1	Estimated direct and indirect impacts are low to negligible which can be felt within a short-term period. Minimal impacts to development processes and no significant cost needed to return to pre-impact levels.

Evaluate adaptive capacity

Information on the capacity of a system to accommodate the impacts of climate change are evaluated in this step. Information needed would be related to establishing the flexibility of a system measured by its current absorptive capacity, production practices, design standards, and remaining economic life, among others. It is also important to determine any barriers to the system's ability to accommodate changes. Covered here are the legal and regulatory frameworks under which the system operates, or the capability of government to finance necessary expansion works. Another dimension is the current situation of a system, whether it is already experiencing non-climatic stresses such as population growth, infrastructure decay, economic downturns, and damage from previous natural disasters.

An inventory of ongoing initiatives that are designed to address impacts and measure the capacities of private and public entities to finance future adaptation/mitigation-related interventions will further indicate the readiness of the system to absorb future impacts. A qualitative assessment (high, moderate or low) may be undertaken in the absence of quantitative studies (refer to Table 2.10).

Table 2.10 Adaptive capacity score and description

Degree of Adaptive Capacity	Adaptive Capacity Rating[1]	Description
Low	3	The system is not flexible to accommodate changes in the climate. Addressing the impacts will be costly. The LGU and property owners will require external assistance to address the impacts.
Moderate	2	Addressing the impacts will require significant cost but it is still within the capacity of a system to adapt to potential impacts. It can accommodate the cost for adapting and mitigating impacts using its resources.
High	1	The system is able to accommodate changes in climate. There are adaptation measures in place to address impacts.

[1]High adaptive capacity is given a low rating while low adaptive capacity is given a higher rating/score.

Determine level of vulnerability

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. In these guidelines, the expected degree of impact will be compared to the level of adaptive capacity to derive the level of vulnerability. A system that will potentially experience a high degree of impact (due to high exposure and sensitivity) and has a low adaptive capacity can be considered highly vulnerable to an expected climate stimulus. The vulnerability assessment will be qualitative (high, medium, low) in approach.

Table 2.11 Vulnerability Index Scores

Degree of Impact Score	Adaptive Capacity Score			Vulnerability	Vulnerability Index Range
	High (1)	Moderate (2)	Low (3)		
High (3)	**3**	**6**	**9**	**High**	**>6-9**
Moderate (2)	**2**	**4**	**6**	**Moderate**	**>3-6**
Low (1)	**1**	**2**	**3**	**Low**	**≤3**

Determine decision areas and interventions (adaptation and mitigation measures)

Priority decision areas and/or sectoral planning concerns can be identified based on the level of the vulnerability. Measures for climate change adaptation and mitigation can be identified to address underlying factors contributing to vulnerability such as reducing exposure, addressing sensitivities and enhancing adaptive capacities. There are eight broad categories of adaptation approaches/options (Burton et al., 1993)[6]:

- **Bear losses.** Implements the "do-nothing" approach and acceptance of possible impacts associated with expected impacts of climate stimuli.

- **Share losses.** Involves the sharing of potential losses through relief, rehabilitation, and reconstruction paid using public or private funds. This can also pertain to losses shared through risk transfer mechanisms (e.g. insurance).

[6] United Nations Environmental Programme-Institute for Environmental Studies, Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies, Chapter 5, pp 4-5. October 1998,

- **Modify the threat.** For certain hazards, establishing structural and non-structural measures can modify the severity of extreme hydro meteorological hazards (i.e. flood control, slope stabilization, sea walls, water impoundments, dams, levees). In the context of climate change, on a long-term scale, this can be achieved through the reduction of greenhouse gas atmospheric concentrations to minimize the effects of climate change and its impacts (i.e. rehabilitation of forests as carbon sinks, shifting to renewable sources of energy).

- **Prevent effects.** Refers to measures intended to increase a particular system's or element's resistance or resiliency to the expected effects/impacts. This may range from improving irrigation and water impoundment facilities to support crop production and improving building/construction regulations to address floods or storm surges.

- **Change use.** Where the threat of climate change makes the continuation of an economic activity impossible or extremely risky, consideration can be given to changing the use. For example, a farmer may choose to substitute a more drought-tolerant crop or switch to varieties with lower water requirements; changing built-up urban use areas into open spaces, parks, or greenbelt easements; and crop or inland fishery areas may be reverted back to forest type land uses such as watersheds, mangroves, and/or national parks.

- **Change location.** A more extreme response is to change the location of economic activities. There is considerable speculation, for example, in relocating major crops and farming regions away from areas of increased aridity and heat to areas that are currently cooler and which may become more attractive for some crops in the future. Another example will be the relocation of exposed, highly vulnerable communities/ settlements to areas where hazards can be sustainably managed.

- **Research.** The process of adaptation can also be advanced by research of new technologies and new methods of adaptation.

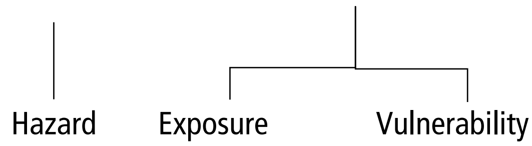
- **Encourage behavioral change through education, information and regulation.** Another type of adaptation is the dissemination of knowledge through education and public information campaigns, leading to behavioural change. Such activities have been slightly recognized and have received low priority in the past, but are likely to assume increased importance as the need to involve more communities, sectors and regions in adaptation becomes apparent.

Step 5. Conduct a Disaster Risk Assessment (DRA)

Disaster Risk Assessment (DRA) is a methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could potentially harm exposed people, property, services, livelihood and the environment on which the population depend. Risk assessments with associated risk mapping include: a review of the technical characteristics of hazards such as their location, intensity, frequency and probability; the analysis of exposure and vulnerability including the physical, social, health, economic and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities with respect to likely risk scenarios[7].

In the context of these guideline, risk shall be a function of likelihood of occurrence and the severity of consequence.

$$f(\text{Risk}) = \text{Likelihood of Occurrence, Severity of Consequence}$$



where:

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[8].

Likelihood of occurrence is the estimated period of time expressed in years, that a hazard of a certain magnitude is likely to repeat itself. When certainty is less determined from records, this is estimated by the likely occurrence of the event[9]. When empirical evidence are available, the recurrence of a hazard (in years) or return period is a measure of the average time a hazard of certain magnitude or intensity will be equaled or exceeded.

Severity of Consequence is a measure of the degree of impact, such as injury, death, damage, interruption brought to the sector of concern[10]. It is the function of exposure and vulnerability and measures the potential direct and indirect damages/impacts and the interplay of exposure and the vulnerability relative to the expected intensity of the hazard.

[7] Republic Act 10121, Philippine Disaster Risk Reduction and Management Act of 2010.

Assign the likelihood of occurrence

The use of probability to indicate recurrence requires a record of occurrences of a hazard and event descriptors such as amount of rainfall, wind speed, pressure in the case of weather-related events or magnitude, intensity and depth in the case of earthquakes in a specific location (e.g. instrumental records). Often times, records are lacking or are not readily available and require modeling and processing by the scientific community. In these guidelines, the likelihood of the hazard is an estimate of the period of time a hazard event is likely to repeat itself expressed in years. For simplification purposes, and when certainty is less determined from records, this may be estimated by the likely occurrence of the natural event. This broadly defines a return period of a hazard (ex. flood). Knowing the time interval for a hazard event to occur again is important because it gives an idea of how often a threat from a hazard may be expected.

Box 4. Recurrence Interval Determination

LGUs can gather historical instrumental data from mandated agencies and historical accounts on hazards from local stakeholders with emphasis on the tracking of the frequency (number of occurrences) for each hazard intensity/magnitude such as the number of occurrences that a certain flood height/s occurred (in meters) in a particular area, the frequency of locally generated large magnitude and shallow seated earthquakes (as basis for establishing the recurrence of liquefaction, high level of ground shaking, and earthquake triggered landslides), occurrences of rain triggered land slides for each identified susceptibility level, and occurrences of storm surges in terms of the wave height.

[8] National Economic Development Authority, Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/ Physical Planning in the Philippines, 2008
[9] Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans Report, NEDA-HLURB-UNDP,2012
[10] Ibid.

Due to lack of recorded instrumental data, Table 2.12 below suggests a scoring system for establishing likelihood of occurrence of certain events. Table 2.12 below provides the range of likelihood, their corresponding return period, and scores used in this guideline. The ranges describe an ordered but descriptive scale which can be assigned to real or assumed hydro-meteorological or geophysical events. The likelihood score ranges from 1-6. A score of 1 is given to very rare events (every 200-300 or more years and for example, volcanic eruptions, very strong ground shaking) while a score of 6 is given to frequently recurring or very likely recurring hazards (every 1 to 3 years and for example, recurring floods).

Table 2.12 Indicative Likelihood of Occurrence Scores

Measure of Likelihood	Return Period in Years	Likelihood Score
Frequent	Every 1-3 years	6
Moderate	Every >3-10 years	5
Occasional	Every >10-30 years	4
Improbable	Every >30-100 years	3
Rare event	Every >100-200 years	2
Very rare event	Every >200 years	1

Source: Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans Report, NEDA-HLURB-UNDP,2012

LGUs should seek the assistance of mandated agencies and the scientific community to help explain the hazard likelihood for the event considered. Also, consultation with local communities can be pursued to establish the likelihood of occurrence based on past experiences.

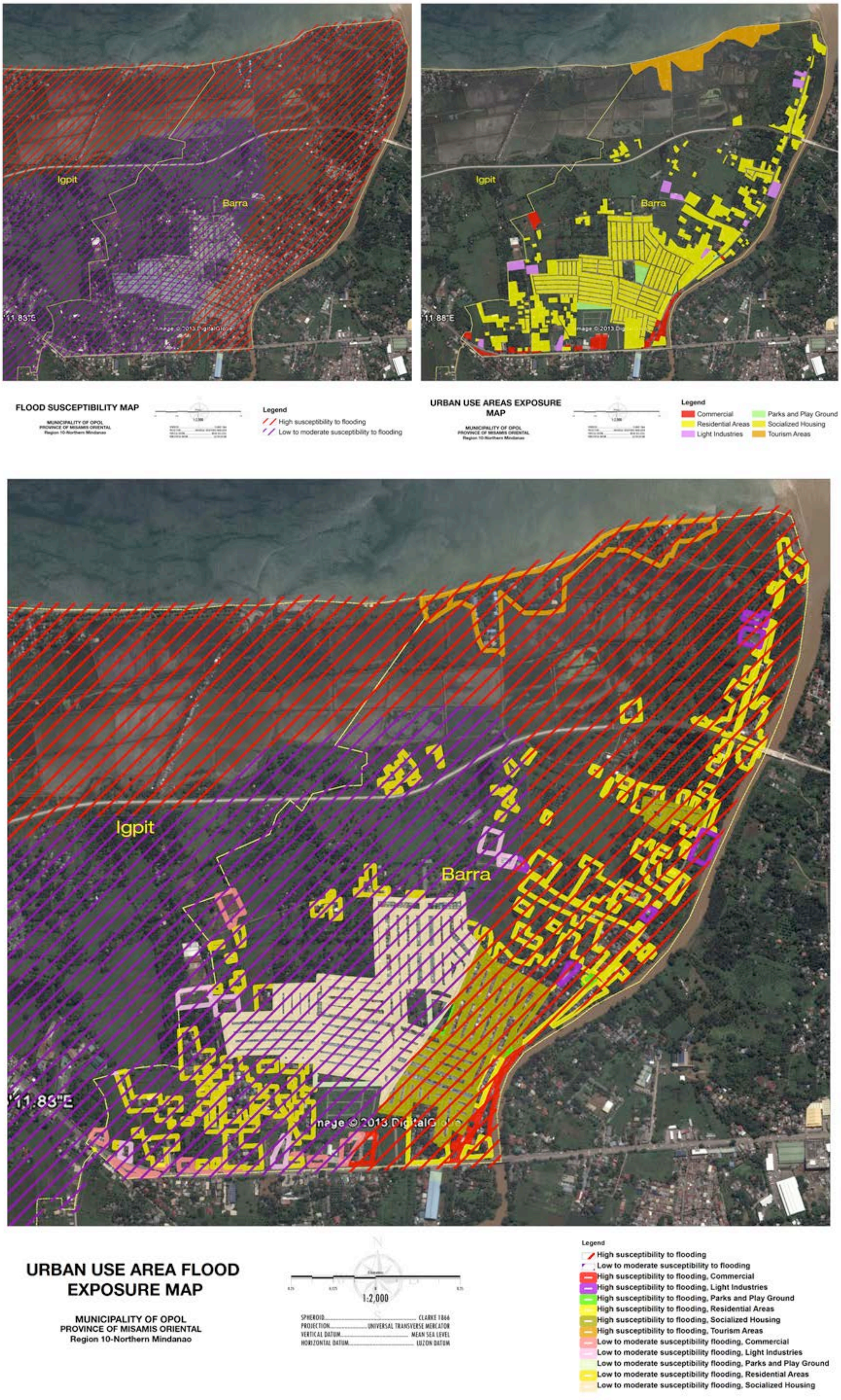
Determine Exposure

Determining exposure involves the estimation of the number of affected individuals, structures and extent of areas located within hazard susceptible areas. These can be done by overlaying hazard and the exposure maps (Refer them to Step 3, the step where exposure database is generated for population, urban use areas, natural resource production areas, critical point facilities and lifeline utilities). Based on the map overlaying, some exposed elements can be counted and summarized, including their attributes which make them predisposed to harm or damage. These vulnerability attributes will be the basis for estimating the severity of consequence in succeeding tasks.

Estimate the Severity of Consequence

The severity of consequence score shall be based on the expected magnitude of the hazard (hazard characterization), the extent of exposure (determined through hazard exposure mapping) and the vulnerabilities of the exposed elements (compiled in the exposure database), and the combination of which will be the basis for determining the severity of consequence rating. Although the indicators selected for the vulnerability analysis are likely to be interrelated, it has been assumed (for the purpose of this guideline) that each indicator can contribute dependently or independently to the vulnerability of an individual, community, structures and natural resource-based production areas.

Figure 2.3 Sample Urban use area flood exposure mapping



Severity of consequence shall be determined qualitatively using the suggested severity of consequence score matrix. The maximum damage ratios were based on the maximum thresholds/criteria set by the NDCC Memorandum Order No 4. series of 1998 for declaring a state of calamity (refer to table 2.13).

Table 2.13 Severity of Consequence Score Matrix

Category	Severity of Consequence Score	Description				
		Population	Urban Use Areas	Natural Resource based Production Areas	Critical Point Facilities	Lifeline Utilities
Very High	**4**	More than 20% of the population are affected and in need of immediate assistance	≥40% of non-residential structures are severely damaged or >20% of residential structures are severely damaged	≥ 40% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/ forest products are severely damaged;	Damages may lead to the disruption of services which may last one week or more	Disruption of service by lasting one week or more (for Municipalities) and one day for Highly Urbanized Areas
High	**3**	>10 - <20% of affected population in need of immediate assistance	>20 to <40% of non-residential structures are severely damaged or >10-20% of residential structures are severely damaged	20 to <40% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/ forest products are severely damaged;	Damages lead may to the disruption of services which may last three days to less than a week	Disruption of service by approximately five days for municipalities and less than 18 hour disruption for highly urbanized areas
Moderate	**2**	>5%-10% of affected population in need of immediate assistance	>10 to 20% of non-residential structures are severely damaged or >5 to10% of residential structures are severely damaged	10 to <20% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/ forest products are severely damaged;	Damages may lead to the disruption of service lasting for one day to less than three days	Disruption of service by approximately three days for municipalities and less than six hour disruption for highly urbanized areas
Low	**1**	≦5% of the affected population in need of immediate assistance.	≤10% of non-residential structures are severely damaged or ≤5% of residential structures are severely damaged	<10% and below of of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/ forest products are severely damaged;	Damages may lead to the disruption of service lasting less than one day	Disruption of service by approximately one day for municipalities and less than six hour disruption for highly urbanized areas

Estimate Risk

Risk is defined as the combination of the probability of an event and its negative consequences. This step deals with the estimation of the level of risk on the various exposed and vulnerable elements. Risk Estimation involves finding the intensity of risks formed by the product of the scores from the likelihood of the hazard and the severity of the consequence:

Risk = Likelihood of Occurrence x Severity of Consequence

The associated risk mapping should be able to depict/indicate high risk areas as the basis for identifying decision areas and prioritization

Table 2.14 Risk Score Matrix for Prioritization

Indicative Likelihood of Occurrence	Likelihood of Occurrence Score	Severity of Consequence Score			
		Very High	High	Moderate	Low
		4	3	2	1
Frequent (1-3 Years)	6	24	18	12	6
Moderate (4-10 Years)	5	20	15	10	5
Occasional Slight Chance (11-30 Years)	4	16	12	8	4
Improbable (31-100 Years)	3	12	9	6	3
Rare (101-200 Years)	2	8	6	4	2
Very rare (>200 years)	1	4	3	2	1

Source: Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans Report, NEDA-UNDP-HLURB,2012

The resulting risk score/categories and risk maps will provide a qualitative index of the various location of priority risk areas in the locality. Based on the computed risk score/s, reclassify into risk categories using the Risk Score Matrix (refer to table 2.16). Risk scores reflect three possible scenarios:

High Risk Areas - areas, zones or sectors may be considered High Risk if hazard events have Very High to moderate severity of consequence given the scale of exposure, vulnerability to the potential impacts of the hazards and the level adaptive capacity to endure the direct and indirect impacts of the hazard and likelihood of occurrence ranging from frequent to improbable events. The range of risk score for this scenario is 12-24.

Moderate Risk - areas, zones or sectors may be considered at Moderate Risk if the Likelihood of occurrence of a hazard event is either Improbable to Rare event with a very high to moderate severity of consequence. These may also pertain to areas where the severity of consequence is Moderate to Minor but with a likelihood of occurrence that is frequent. The range of risk score for this scenario is 5-<12.

Low Risk - areas, zones or sectors may be considered low risk due to the frequency of the hazard (very rare or >200 years) with very high to high severity of consequences. It may also pertain to moderate to low severity of consequence from an occasional to a very rare event. Risk scores for this scenario is < 5.

The suggested risk score matrix adopts the probabilistic risk estimation approach where the combination of the frequency (likelihood of occurrence) of the hazard and its resulting damage (severity of consequence) are used as basis for identifying and prioritizing risk areas for immediate implementation of risk management options under the notion that resources are often limited. Available resources can be initially allocated for addressing priority areas (or high risk areas) in need of immediate interventions characterized by areas where the estimated damage will be very high to high and the likelihood of occurrence of the hazard is within 10-100 years. However, in a land use planning perspective, areas considered as low risk areas where the expected damage is very high but are triggered by rare to extremely rare events (>100 years) can and should also be addressed within the short term to medium term when available resources permit.

5.5. Identify Decision Areas and Interventions (Risk Management Options)

Disaster Risk Reduction is the concept and practice of reducing disaster risks through systematic efforts to analyze 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[11]. Disaster risk reduction measures may be classified into four major categories and their subcategories as follows:

a. **Risk Avoidance/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[12];

b. **Risk 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[13]:

- Risk prevention - instituting measures to reduce the frequency of occurrence and magnitude of hazard's adverse impact through the establishment of structures such as levees, flood walls, ``dams, and sea walls;

- Risk or loss reduction through mitigation - modifying the characteristics of elements exposed to lessen the adverse impacts of hazards either through structural (e.g. hazard resistant structural design measures, flood and storm surge protection infrastructure), or non-structural `measures (e.g. such as watershed land cover management, density control and proper asset location through land use planning and zoning);

- Risk or loss reduction through preparedness - mechanisms to anticipate the onset of hazards, increase awareness, and improve capacities to respond and recover from the impact of hazards. This can be in form of establishing early warning systems, formulating contingency plans, and increase awareness through information, education and communication campaigns;

[11] United Nations International Strategy for Disaster Reduction , UNISDR Terminology on Disaster Risk Reduction, 2009.
[12] NEDA-UNDP-EU. 2009. Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning.
[13] Ibid

- Segregation of exposure by duplication or redundancy - increasing systemsustainability by providing back-up support for elements that may become non-functional or disrupted during and after the hazard impact. This may be in the form of alternative linkage/transportation systems, redundant water and power distribution systems, and construction of additional critical facilities (i.e. hospitals, schools, power plants, etc.);

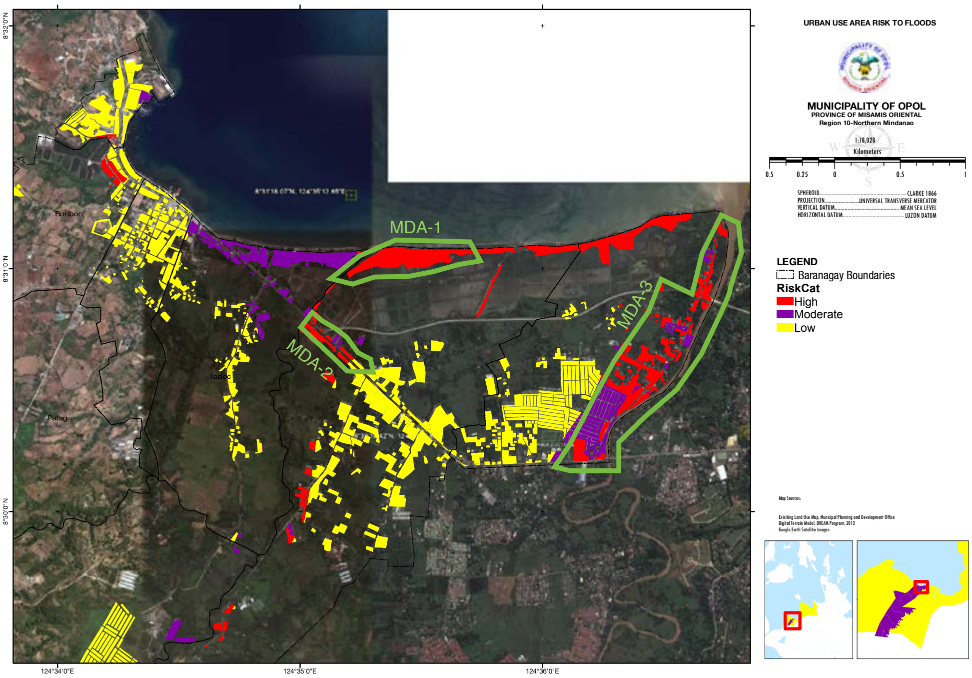
- Segregation of exposure by separation - increasing system capacity and robustness through geographic, physical and operational separation of facilities and functions.

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.

Step 6. Summarize Findings

Once the hazard-specific decision areas are identified in steps 4-5, LGUs will be tasked to overlay all identified decision areas to determine the major decision areas. It also entails the detailing of the various risk management options by consolidating and harmonizing the various DRR and CCA interventions. This will allow LGUs to analyze the spatial development issues and concerns, and enumerate the possible policy interventions to address it to reduce the risks at tolerable levels using a muti-hazard perspective (in the sample below, addressing both floods and SLR in a particular area).



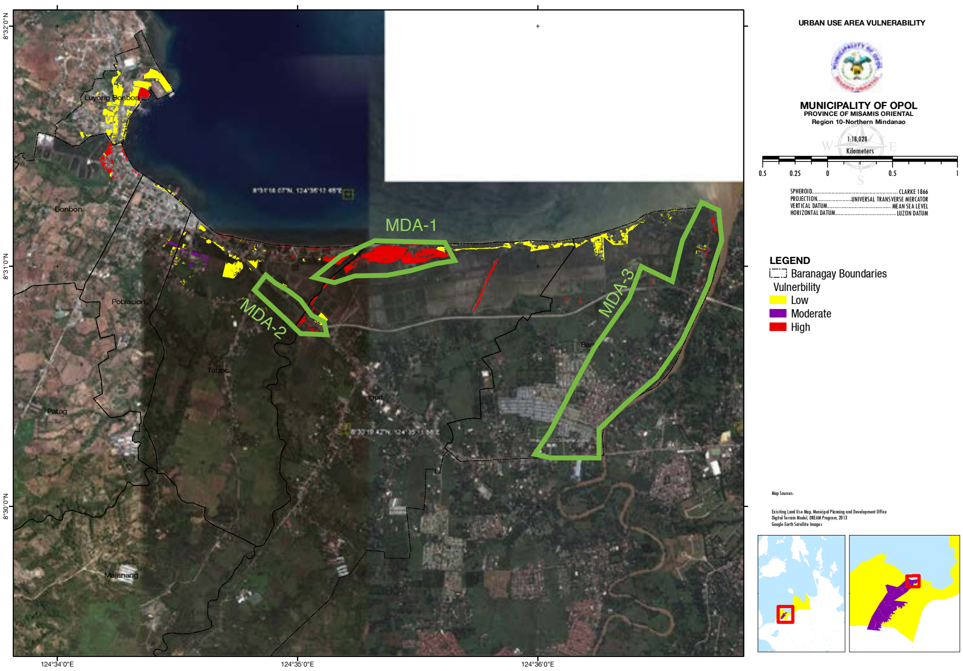


Figure 2.4a Detailing of decision areas

Identification of major decision areas (urban use areas) using the Identified flood risk decision areas (above) and Sea Level Rise vulnerability decision areas (below). In this example MDA-1 was considered a MDA due to risks associated with floods and vulnerability associated with sea level rise. Risk management options and interventions shall be identified to address both the risks to floods and SLR. Risk management options and interventions in MDA-3 will be focused mainly on reducing risks to floods.

Table 2.15 Sample Issues Matrix Urban Use Areas

A	B	C	D	E
Decision Area/s	**Description**	**Problems/Hazards**	**Impacts/Implications**	**Policy Interventions**
Igpit - Informal settler areas (MDA-1)	Area located at the mouth of the Bungcalalan River adjacent to the Macalajar Bay	Areas prone to riverine and coastal flooding, potential area submersion to due to sea level rise in the long term. Changes in tidal patterns may impact storm surge patterns specifically wave heights and inland inundation. Note: Risks to other hazards can be incorporated to describe the area for a more comprehensive and multi-hazard approach in identifying policy interventions/ recommendations	• Severe potential damages to residential structures due to floods. • Potential submersion of settlements due to sea level rise in the long term. • Potential isolation of communities, injuries and casualties during floods and, storm surges; • Establishment of sea walls and mitigation measures to retain current land uses will be costly, costs cannot be shouldered by affected families and the LGU; • Future uncontrolled growth of settlements may increase exposure and risks;	• Relocation of informal settler families, employ managed retreat or incremental relocation; • Establishment of early warning systems and formulation of flood contingency plans to minimize potential injuries and casualties during the implementation of relocation; • Identification of additional 9.29 hectares of residential to accommodate potentially affected families and provision of comprehensive housing program for affected families especially the informal settlers; • Designating areas for wetland and mangrove restoration and serve as part of the eco-tourism network; • New transportation systems will not be pursued in the area to discourage future settlement growth;
Barra Riverside Settlement areas (MDA-3)	Major growth area with mixed land uses located along the Iponan River	Mainly riverine flooding along the Iponan River with sea level rise near the river mouth	• Potential severe damage to settlement areas and possible deaths and injuries along the riverside areas due to floods; • Potential submersion of settlements due to sea level rise in the long term especially along the river mouth; • Riverbank erosion and possible failure of riverbank slopes affecting structures; • Future growth in the area may increase exposure and risks if no interventions are implemented;	• Establishment of expanded easements along the river side and changing these areas for open space development; • Mandatory relocation of structures within the expanded easements and sea-level rise impact area; • Low density development shall be employed within highly susceptible prone areas to minimize the level exposure; • Change the land use mix from residential to commercial or any land use mix where cost for effective mitigation can be shouldered by proponents/developers; • Development of settlement areas shall be subject to development restrictions with emphasis on the imposition of hazard resistant design regulations; • Mandatory retrofitting of structures within a period of 10 years; • All costs related to the establishment of mitigation measures such as riverbank protection structures shall be shouldered by the property owners through the imposition of special levy taxes; • Establishment of early warning systems and formulation of flood contingency plans to minimize potential injuries and casualties • Conduct of site specific flood modeling studies to inform development regulations;

Integrating Climate Change and Disaster Risks in the Comprehensive Land Use Plan

The second phase of the mainstreaming framework is the integration of the key findings in the climate and disaster risk assessment in the various steps of the CLUP formulation process. This will allow a better analysis of the situation to allow decision makers make informed decisions during visioning, goal formulation, strategy generation, land use policy formulation and zoning.

Set the Vision (Step 3)

Mainstreaming climate and disaster risks in the CLUP starts with the enhancement of the vision statement by integrating climate change adaptation and disaster risk reduction and management principles in describing the ideal state of locality in terms of the people as individuals and society, local economy, built and natural environment, and local governance. Descriptors should put emphasis on the principles of adaptation and risk reduction such as safe, risk-resilient, and enhancing adaptive and coping capacities. The vision shall provide the overall guide to the succeeding steps of the CLUP planning process.

Situational Analysis (Step 4)

The climate and disaster risk assessment provides the climate and disaster risk perspectives for a deeper analysis of the planning environment. The emphasis is on the implications of climate change and hazards to the various development sectors/sub-sectors (i.e. demography/social, economic, infrastructure and utilities) and the land use framework. It allows climate and disaster risk concerns to be incorporated in the identification of issues, concerns and problems and ensure that identified policy interventions address both the potential impacts of climate change, hazards and risks.

The results of the CDRA along with other sectoral studies shall provide the opportunity for a more integrated approach in the practice of land use planning.

Set the Goals and Objectives (Step 5)

Recognizing risk reduction and management as prerequisite to sustainable development and informed of the development implications, issues, concerns, and problems brought about by climate and disaster risks, the municipality/city should be able to enhance its goals and objectives to guide physical growth of the locality and support and compliment sectoral/sub-sectoral development.

Establish Development Thrust and Spatial Strategies (Step 6)

Climate and disaster risk information allows decision makers and stakeholders to revisit the current development thrust, identify possible alternatives, evaluate and select the preferred development thrust that accounts for the current and potential implications of climate and disaster risks.

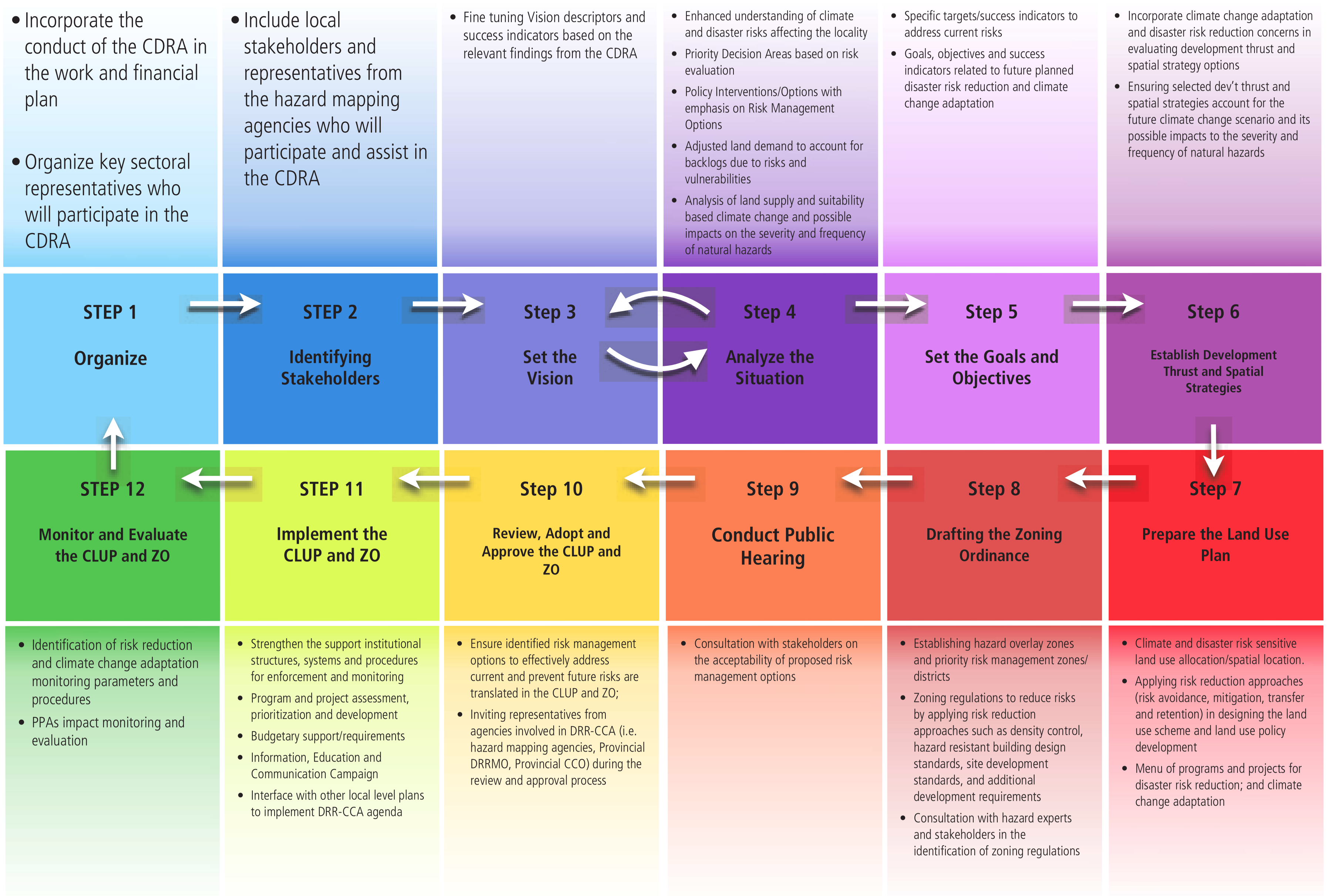
The extent of natural hazards, severity of consequence, degree of risks and the amount of required risk reduction and management measures are considerations for determining the best spatial development that promotes a safe built-environment, risk resilient production environment, balanced ecology, and efficient and functional linkages among the various development areas.

Prepare the land use plan (Step 7)

The land use design/scheme deals with the allocation and location of the various land use categories generally based on the projected service requirements, location standards, land suitability studies, costs, aesthetics, accessibility and other considerations. Land use policies refer to specific guidelines, methods, procedures, rules and forms that will guide the use of lands. In these guidelines, emphasis will be given to design approaches/ options to address current risks, prevention of future risks, and anticipating climate change impacts through proper siting and construction of the built environment and sustainable management of natural resources.

Urban use areas land use policies, in general, may include policies intended to ensure the safety and welfare of the population, minimize potential damages to buildings, and ensure adequate provision and access to important socio-economic support services. These can be achieved through proper location (i.e. prioritizing residential and critical point facilities in relatively safe areas or areas where mitigation is feasible); imposition of hazard resistant building design regulations for areas prone to hazards; density control measures (i.e minimizing density in hazard prone areas and increasing density in relatively safe areas); construction of risk mitigation structures to protect important urban use areas (i.e. flood control, sea wall, slope stabilization mitigation structures); and establishing redundancies or back-up systems for important socio-economic support facilities (i.e. hospitals, schools, commercial areas, government facilities).

Figure 2.4b Entry-points for Mainstreaming Climate and Disaster Risks in the Comprehensive Land Use Plan



For production land uses, recommended policies emphasize on the resiliency and sustainable utilization of natural resources given the challenges of climate and disaster risks. This may include economic protection or safety nets (i.e. crop insurance, building insurance), establishing resource production support infrastructure (i.e. irrigation and water impoundments), and promoting sustainable and/or climate resilient resource production techniques (i.e. use of hazard resistant varieties, climate sensitive production).

Protection land use policies emphasize on the conservation, preservation, and rehabilitation of significant natural resource areas because of their long-term strategic benefit and contributions to climate change adaption and mitigation. These may cover protection policies for critical watershed areas to manage potable and surface water resources; rehabilitation of upland forests as a strategy for managing low land flooding, enhance the quality of the natural environment, contribute to the mitigation of GHG; and preservation of coastal wetlands and mangrove areas. Furthermore, these recommended policies will also cover areas where the mitigation of risks are not feasible and impractical to pursue due to the frequency and magnitude of geologic and volcanic hazards, as well as, the projected impacts of climate change on the frequency, magnitude and spatial extent of hydro-meteorological hazards. Policies may include expanded easements, declaring areas as no settlement areas, and designating certain areas for open spaces.

For infrastructure and utilities, policies may include protection of critical point facilities through site selection (locating in relatively safe areas), applying the concept of service redundancy to ensure continued area access and provision of social and economic support services, strict imposition of hazard resistant building and structural design standards for critical emergency management services and government facilities.

Drafting the Zoning Ordinance (Step 8)

Zoning is concerned primarily with the use of land and the regulation of development through imposition of building heights, bulk, open space, and density provisions in a given area . In the context of DRR-CCA, zoning provisions may range from hazard resistant structural design regulations, prescribing allowed uses, and density control (i.e. building height, FAR, MAPSO, etc.) within identified hazard prone areas, intended to reduce property damage to acceptable levels and ensure the preservation of life and general welfare of property owners. It also include cross cutting provisions in support of CCA such as those related to water and energy efficiency, and green building design.

Implement the CLUP and ZO (Step 11)

Mainstreaming of climate and disaster risks in local development is further promoted in the implementation of the CLUP and enforcement of the ZO. This phase provides the opportunity for LGUs to review and enhance current institutional capacities, structures, systems and procedures for continuous/sustained risk reduction and management related planning; policy, program, and project development and management; resource generation/ fiscal management; investment programming; and regulation (enforcement of ZO). It also deals with the importance of interfacing the CLUP with other local level plans to implement priority DRR-CCA PPAs through the CDP and LDIP/AIP. [14]

Monitoring and evaluate the CLUP and ZO (Step 12)

Monitoring and evaluation serves as the feedback mechanism to ensure that DRR-CCA related interventions and its intended/desired results and benefits are achieved during the planning period. It will also serve as a basis for revising DRR-CCA related policy interventions so that alternative risk reduction and management measures and options can be identified and included in the CLUP and ZO revision.

[14] HLURB, CLUP Guidebook, Volume 3: Model Zoning Ordinance, 2014

Climate and Disaster Risk Assessment

3

Assessing risks and vulnerabilities, determining priority decision areas and risk management and adaptation options

Step 1. Collect and analyze climate and hazard information

Objectives

- Understand the various future climate scenario/s by analyzing climate change scenarios
- Characterize the natural hazards that may potentially affect the locality/barangay
- Understand previous disasters and severely affected elements

Outputs

- Local Climate Change Projections
- Inventory of natural hazards and their characteristics
- Tabular compilation of historical disaster damage/loss data
- Summary of barangay-level hazard inventory matrix

Process

Task 1.1 Collect and analyze climate change information
Task 1.2 Collect and organize hazard information
Sub-task 1.2.1 Gather hazard maps and characterize hazards
Sub-task 1.2.2 Prepare a summary hazard inventory matrix
Sub-task 1.2.3 Analyze previous disasters
Sub-Task 1.2.4 Prepare a Hazard Susceptibility Inventory Matrix

Climate Change Information

This step involves collecting and reviewing important climate change information relevant to the local government unit. Key climate variables to collect are temperature, precipitation, and extreme events (i.e. number of dry days, number of days with temperature exceeding 35OC, and number of extreme rainfall events). The basic source for climate information is the Climate Change in the Philippines publication of PAGASA. It includes the baseline climate trends from 1971-2000 where the projected changes in 2020 (2006-2035) and 2050 (2036-2065) can be compared. The climate projections are available for each region and province of the country. The municipality or city, at first pass, may consider the provincial data, and consult PAGASA on the applicability.

Seasonal Temperature. In the case of the Municipality of Opol, the provincial-level projections were used. In computing for the 2020 and 2050 projected seasonal temperature, the projected changes per season were added to the observed baseline (refer to table 3.1.1).

Table 3.1.1 Projected seasonal temperature changes (in °C) in 2020 and 2050 under the medium-range emission scenario in provinces in Region 10

Region/Province	OBSERVED BASELINE (1971-2000)				CHANGE in 2020 (2006 - 2035)				CHANGE in 2050 (2036 - 2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
REGION 10												
BUKIDNON	25.1	26.5	25.8	25.7	1.0	1.2	1.2	1.0	1.9	2.3	2.4	2.1
LANAO DEL NORTE	24.4	25.5	25.4	25.2	1.0	1.1	1.0	1.0	1.9	2.2	2.1	1.9
MISAMIS OCCIDENTAL	25.6	26.7	26.6	26.4	1.0	1.1	1.1	1.0	1.9	2.2	2.2	1.9
MISAMIS ORIENTAL	25.4	26.8	26.9	26.5	1.0	1.2	1.2	1.0	1.9	2.3	2.4	1.9

Projected seasonal temperature for DJF and MMA for Misamis Oriental (Medium Range Emission Scenario) can be computed as follows:

2020 Projected Seasonal Temperature^{DJF}= Baseline^{DJF}+ 2020 ^{DJF}
2020 Projected Seasonal Temperature^{DJF}= 25.4 + 1.0
2020 Projected Seasonal TemperatureDJF= 26.4

2020 Projected Seasonal Temperature^{MAM}= Baseline^{MAM} + 2020 ^{MAM}
2020 Projected Seasonal Temperature^{MAM}= 26.8 + 1.2
2020 Projected Seasonal Temperature^{MAM}= 28.0

Computation can be summarized and presented as follows:

Table 3.1.2 Projected seasonal temperature changes for 2020 and 2050 under the medium-range emission scenario, Province of Misamis Oriental

Period	Season			
	DJF	MAM	JJA	SON
Observed (1971-2000)	25.40	26.80	26.90	26.50
Change in 2020 (2006-2035)	26.40	28.00	28.10	27.50
Change in 2050 (2036-2065)	27.30	29.10	29.30	28.50

In this example, the data suggest that the area will experience relatively warmer conditions by 2020 and 2050 compared to the observed seasonal temperatures. There will be 1.2°C warming during the MAM and JJA while a 1.0°C warming during the DJF and SON seasons in 2020. In 2050, temperature may increase by as much as 2.3 to 2.4°C during the MAM and JJA seasons respectively while the projected increase during the DJF and SON season will be 1.9°C and 2.0°C respectively.

Seasonal Rainfall. For seasonal rainfall, projected data are expressed as percentage change from the baseline values. The percentage change are multiplied to the baseline values to get the rate of change in mm and added to the baseline values to derive the projected seasonal rainfall values (Table 3.1.3).

Table 3.1.3 Seasonal rainfall change (in %) in 2020 and 2050 under the medium-range emission scenario in provinces in Region 10

Region/Province	OBSERVED BASELINE (1971-2000)				CHANGE in 2020 (2006 - 2035)				CHANGE in 2050 (2036 - 2065)			
	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON	DJF	MAM	JJA	SON
REGION 10												
BUKIDNON	329.7	335.6	653.8	559.5	2.9	-10.3	-4.4	-0.3	-5.1	-13.0	-9.7	-5.8
LANAO DEL NORTE	337.5	350.3	662.5	621.1	9.6	-0.6	-2.2	6.9	2.5	-1.9	1.4	7.1
MISAMIS OCCIDENTAL	392.1	323.4	633.1	728.3	9.1	1.4	-6.1	6.1	5.2	0.3	-5.1	4.6
MISAMIS ORIENTAL	442.5	296.0	615.7	581.1	4.6	-10.4	-3.7	2.9	1.8	-17.8	-5.2	-0.1

Projected seasonal rainfall for 2020 DJF and MMA for Misamis Oriental (Medium Range Emission Scenario) can be computed as follows:

2020 Seasonal Rainfall^{DJF}= Baseline^{DJF}+ ((Baseline^{DJF})*(2020 ^{DJF}))
2020 Seasonal Rainfall^{DJF}= 442.5 + (442.5*4.6%)
2020 Seasonal Rainfall^{DJF}= 442.5 + 20.355
2020 Seasonal Rainfall^{DJF}= 462.85

2020 Seasonal Rainfall^{MAM}= Baseline^{MAM}+ ((Baseline^{MAM})*(2020^{MAM}))
2020 Seasonal Rainfall^{MAM}= 296.0 + ((296.0*(-10.4%))
2020 Seasonal Rainfall^{MAM} = 296.0 + (-30.78)
2020 Seasonal Rainfall^{MAM}= 265.22

Computation can be summarized and presented as follows:

Table 3.1.4. Medium emission range projected seasonal rainfall scenarios for 2020 and 2050, Province of Misamis Oriental

Period	Season			
	DJF	MAM	JJA	SON
Observed (1971-2000)	442.50	296.00	615.70	581.10
Change in 2020 (2006-2035)	462.86	265.22	592.92	597.95
Change in 2050 (2036-2065)	450.47	243.31	583.68	522.99

In this example, the data suggest that there will be a reduction in rainfall during the summer and Habagat seasons in 2020 and 2050. Also, there will be a slight increase in rainfall during Amihan season, but the amount of rain is expected to be lesser than the Habagat and transition seasons. Summer months are expected to be drier and Amihan months will be slightly wetter compared to observed trends.

Extreme events. Provincial-level projections provide three climate variables to cover extreme events namely: number of days with temperature exceeding 35°C; number of days (defined as days with rainfall less than 2.5mm); and the number of extreme daily rainfall. Projected data are expressed in frequency and can be compared to observed trends to establish the projected changes in 2020 and 2050.

Table 3.1.5 Frequency of extreme events in 2020 and 2050 under medium-range emission scenario, Province of Misamis Oriental

Climate Variable	Observed 1971-2000	2020 (2006-2035)	2050 (2036-2065)
No of days with Temp >35°C	382	4,539	6,180
No. of dry days (rainfall < 2.5mm)	8,251	6,413	7,060
No of days with Extreme Rainfall > 150mm	10	13	9

Source: Climate Change in the Philippines, PAGASA 2011, page 41.

Based on the data, there will be a significant increase in the number of days exceeding 35°C in 2020 and 2050 based on observed trends. In terms of extreme rainfall, the number of dry days will decrease in 2020 and 2050 but the number of extreme daily rainfall event will increase in 2020 and a slight decrease in 2050 compared to observed trends.

Sea Level Rise. Representative Concentration Pathways (RCPs) are scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). Four RCPs produced from Integrated Assessment Models were selected from the published literature and are used in the present IPCC Assessment as basis for the climate predictions and projections[15]. The Global mean sea level rise for 2081–2100 relative to 1986–2005 will likely be in the ranges of 0.26 to 0.55 m for RCP2.6, 0.32 to 0.63 m for RCP4.5, 0.33 to 0.63 m for RCP6.0, and 0.45 to 0.82 m for RCP8.5 (medium confidence)[16]. It is important to note that regional rates of sea level rise can vary. This is the result of regionally differing rates of thermal expansion of the oceans as well as regional differences in atmospheric circulation, which can affect relative sea levels. In addition, many coastal areas are either subsiding or being uplifted.

The LGU may also consider international or local published studies which provide climate and climate change information applicable for their locality. Local or indigenous knowledge are also important sources of information. Indigenous peoples, particularly have a way of interpreting meteorological phenomena which have guided their responses to climate variation particularly in their livelihood practices. Downscaling of climate projections[17] at the municipal level, as demonstrated in Siligao, Southern Leyte, can also be pursued by LGUs to provide site specific climate change parameters.

Summary of the projected changes in climate variable

Prepare a summary of projected changes in the climate variables. Computed values can be further summarized and organized using the recommended summary table. This table shall facilitate the identification of the expected changes in climate variables and the comparison between the observed and projected changes. This output shall be used for the initial scoping of impacts in Step 2.

[15] IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 1461.
[16] Ibid, p. 11.
[17] CLUP Resource Book: Integrating Climate Change and Adaptation and Disaster Risk Reduction and Management, CCC-GIZ, October 2013, p.87

Table 3.1.6 Summary of Projected Changes in Climate Variables, Municipality of Opol, Misamis Oriental

Climate Variable (1)	Observed Baseline (1971-2000) (2)	Specific Change Expected and Reference Period (3)	General Changes Expected in Climate Variables (4)	Information about Patterns of Change (5)
Temperature	• 25.4ºC during the DJF • 26.8ºC during MAM • 26.9ºC during JJA • 26.5ºC during SON	• 26.4ºC by 2020 and 27.3ºC by 2050 during DJF • 28.0ºC by 2020 and 29.1ºC by 2050 during MAM • 28.1ºC by 2020 and 29.3ºC by 2050 during JJA • 27.5ºC by 2020 and 28.5ºC by 2050 during SON	• Increasing in temperature for all seasons expected in 2020 and 2050	• Slightly more warming in MAM, and in the JJA season
Rainfall	• 442.5 during the DJF • 296.0 during MAM • 615.7 during JJA • 581.1 during SON	• 462.86 by 2020 and 450.47ºC by 2050 during DJF • 265.22 by 2020 and 243.31 by 2050 during MAM • 592.92 by 2020 and 597.9 by 2050 during JJA • 597.95 by 2020 and 522.9 by 2050 during SON	• Increasing in rainfall during DJF for 2020 and 2050 • Decreasing in rainfall during MAM for 2020 and 2050 • Decreasing during JJA for 2020 and 2050 • Increasing in rainfall during SON for 2020 but decreasing in 2050	• Reduction in rainfall during the summer and *Habagat* seasons in 2020 and 2050 • Increase during *Amihan* season, but amount of rain expected to be lesser than the *Habagat* and transition seasons • Reduction in rainfall during the MAM and JJA months • Wetter *Amihan* months DJF and SON
Number of Hot days	• 383 days	• 4,539 days exceeding 35ºC in 2020 • 6,180 days exceeding 35ºC in 2050	• Increasing number of hot days (exceeding 35ºC)	• Significant increase in the number of hot days expected in 2020 and 2050
Number of Dry days	• 8,251 days	• 6,413 days with <2.5 mm of rain in 2020 • 7,060 days with <2.5 mm of rain in 2050	• Decreasing number of dry days (<2.5 mm of rain)	• There will be more days with rainfall (less days without rainfall compared to baseline)
Extreme daily Rainfall Events	• 10 extreme rainfall events exceeding 150mm	• 13 days with rainfall > 150 mm in 2020 • 9 days with rainfall > 150 mm in 2050	• Heavy daily rainfall >150 mm increasing in 2020 and decreasing by 2050	• More extreme daily rainfall expected (>150mm) in 2020 but more or less the same in 2050 compared to baseline.
Sea Level[1]		Projected change by 2100 relative to 1986-2005 Global mean sea level. • 0.26 to 0.55 m for RCP2.6, • 0.32 to 0.63 m for RCP4.5, • 0.33 to 0.63 m for RCP6.0, • 0.45 to 0.82 m for RCP8.5	• Potential increase in the current sea level by 2100	• A potential increase in global sea level by a range of 0.26 ro 0.82m by 2100. Note that municipal projected sea level rise may vary from global estimates.

[1] IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovern- mental Panel on Climate Change [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 11.

Task 1.2 Collect and organize hazard information

This task involves gathering and analyzing hazard information to better understand the various natural hazards affecting the locality. It also involves an inventory of historical disasters to establish patterns of hazards in terms of its intensity and magnitude, including the scale of damages to property (i.e. agriculture, houses, socio-economic support infrastructure and utilities) and how it affected local communities (fatalities, injuries and number of severely affected families). At the end of this task, LGUs should be able to compile the necessary hazard maps and describe the hazard susceptibilities of barangays or specific areas within the city/ municipality.

Sub-task 1.2.1 Gather Hazard Maps and characterize hazards

Gather available hazard maps from mandated agencies (refer to data sources of hazard maps). Hazard maps depict the spatial extent of hazards at different susceptibility levels and can also provide other technical information such as the magnitude/intensity, and in some cases, include information on the frequency or probability of the hazard occurrence. When analyzing hazards, the following descriptors should be discussed:

a. **Spatial Extent -** What areas/barangays within the municipality/city are likely to be inundated or affected by a particular hazard?

b. **Magnitude/Intensity -** What is the estimated strength of the hazard that will impact an area (i.e. flood can be expressed in depth, water flow velocity, and/or duration; storm surge expressed in wave heights; earthquake ground shaking expressed as intensity scale)?

c. **Frequency -** What is the estimated likelihood or the average recurrence interval (expressed in years) that a hazard event may happen?

d. **Duration –** How long will the hazard occur (expressed in seconds, minutes, days, weeks etc.)?

e. **Predictability –** Can human systems/technologies accurately determine when and where a hazard might occur including the estimated intensities?

f. **Speed of Onset –** Is the hazard slow/creeping (i.e. SLR, Drought) or rapid/fast (flashfloods, earthquakes, landslides)?

Table 3.1.7 Hazard Maps and Data Sources

Hazard Maps	Source/s	Scale	Remarks
Flood Susceptibility	Mines and Geosciences Bureau	1:50,000	Depicts areas susceptible to floods, classified as high, moderate, and low with supplemental information on flood heights. Available are selected regions, provinces and municipalities/ cities. Map availability can be viewed at http://gdis.denr.gov.ph/mgbviewer/
	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Office of Civil Defense (READY Project)	1:50,000, 1:10,000	Identifies areas prone to floods representing a worst case scenario. Available are selected provinces and municipalities/cities generated through the READY Project. Map availability can be viewed at http://www.ndrrmc.gov.ph/
	Department of Science and Technology-Nationwide Operational Assessment of Hazards Project (DOST-NOAH)	Various Map Scales	Flood hazard maps of selected areas within 18 major river basins. Provides flood inundation zones are based from 5, 10, 25, 50, and 100 year rainfall recurrence interval, with indicative flood heights. Map availability to selected areas can be verified at http://noah.dost.gov.ph/
Rain-Induced Landslide	Mines and Geosciences Bureau (MGB)	1:50,000	Depicts areas susceptible to rain-induced landslide, classified as high, moderate, and low. Available are selected regions, provinces and municipalities/cities. Availability can be viewed at http://gdis.denr.gov.ph/mgbviewer/
	Mines and Geosciences Bureau (MGB), Office of Civil Defense (READY Project)	1:50,000	Depicts areas susceptible to rain-induced landslide, classified as high, moderate, and low. Available are selected provinces and municipalities/cities generated through the READY Project. Map availability can be viewed at http://www.ndrrmc.gov.ph/
Storm Surge	Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Office of Civil Defense (READY Project)	1:50,000	Depicts areas prone to storm surge. Available are selected provinces and municipalities/cities generated through the READY Project. Map availability can be viewed at http://www.ndrrmc.gov.ph/
Ground Rupture	Philippine Institute of Volcanology and Seismology (PHIVOLCS), Office of Civil Defense (READY Project)	1:50,000	Depicts areas with known and inferred faults. Available are selected provinces and municipalities/cities generated through the READY Project. Map availability can be viewed at http://www.ndrrmc.gov.ph/
		1:250,000	Regional Active Faults and Trenches Map. Depicts areas with known and inferred active faults and trenches. Map availability can be viewed at http://www.phivolcs.dost.gov.ph/

Table 3.1.7 Hazard Maps and Data Sources

Hazard Maps	Source/s	Scale	Remarks
Ground Shaking	Philippine Institute of Volcanology and Seismology (PHIVOLCS), Office of Civil Defense (READY Project)	1:50,000	Composite ground shaking levels based on hypothetical maximum credible earthquake scenarios. Available are selected provinces and municipalities/cities generated through the READY Project. Map availability can be viewed at http://www.ndrrmc.gov.ph/ and http://www.phivolcs.dost.gov.ph/
		National Scale	Thenhaus Ground Shaking Maps of the Philippines. Estimated ground acceleration (g) for rock, hard, medium, and soft soils. Values expressed in g with a 90% probability of not being exceeded in 50 years. http://www.phivolcs.dost.gov.ph/
Liquefaction	Philippine Institute of Volcanology and Seismology (PHIVOLCS), Office of Civil Defense (READY Project)	1:50,000	Composite liquefaction susceptibility map based on hypothetical maximum credible earthquake scenarios. Available are selected provinces and municipalities/cities generated through the READY Project. Map availability can be viewed at http://www.ndrrmc.gov.ph/ and http://www.phivolcs.dost.gov.ph/
	Philippine Institute of Volcanology and Seismology (PHIVOLCS)	1:250,000	Indicative regional scale susceptibility map depicting areas prone to liquefaction. Map available can be viewed at http://www.phivolcs.dost.gov.ph/
Earthquake Induced Landslide	Philippine Institute of Volcanology and Seismology (PHIVOLCS), Office of Civil Defense (READY Project)	1:50,000	Composite earthquake induced landslide map based on hypothetical maximum credible earthquake scenarios. Available are selected provinces and municipalities/cities generated through the READY Project. Map availability can be viewed at http://www.ndrrmc.gov.ph/ and http://www.phivolcs.dost.gov.ph/
	Philippine Institute of Volcanology and Seismology (PHIVOLCS)	1:250,000	Indicative regional scale susceptibility map depicting areas prone to earthquake induced landslide. Levels of susceptibility expressed as the minimum critical acceleration to trigger landslide. Map availability can be viewed at http://www.phivolcs.dost.gov.ph/
Tsunami	Philippine Institute of Volcanology and Seismology (PHIVOLCS)	1:50,000	Areas depicting tsunami inundation zones with supplemental information on flood heights based modeling parameters (i.e. maximum credible earthquake magnitude and earthquake source). Available for selected Provinces. Map availability can be viewed at http://www.phivolcs.dost.gov.ph/

Table 3.1.7 Hazard Maps and Data Sources

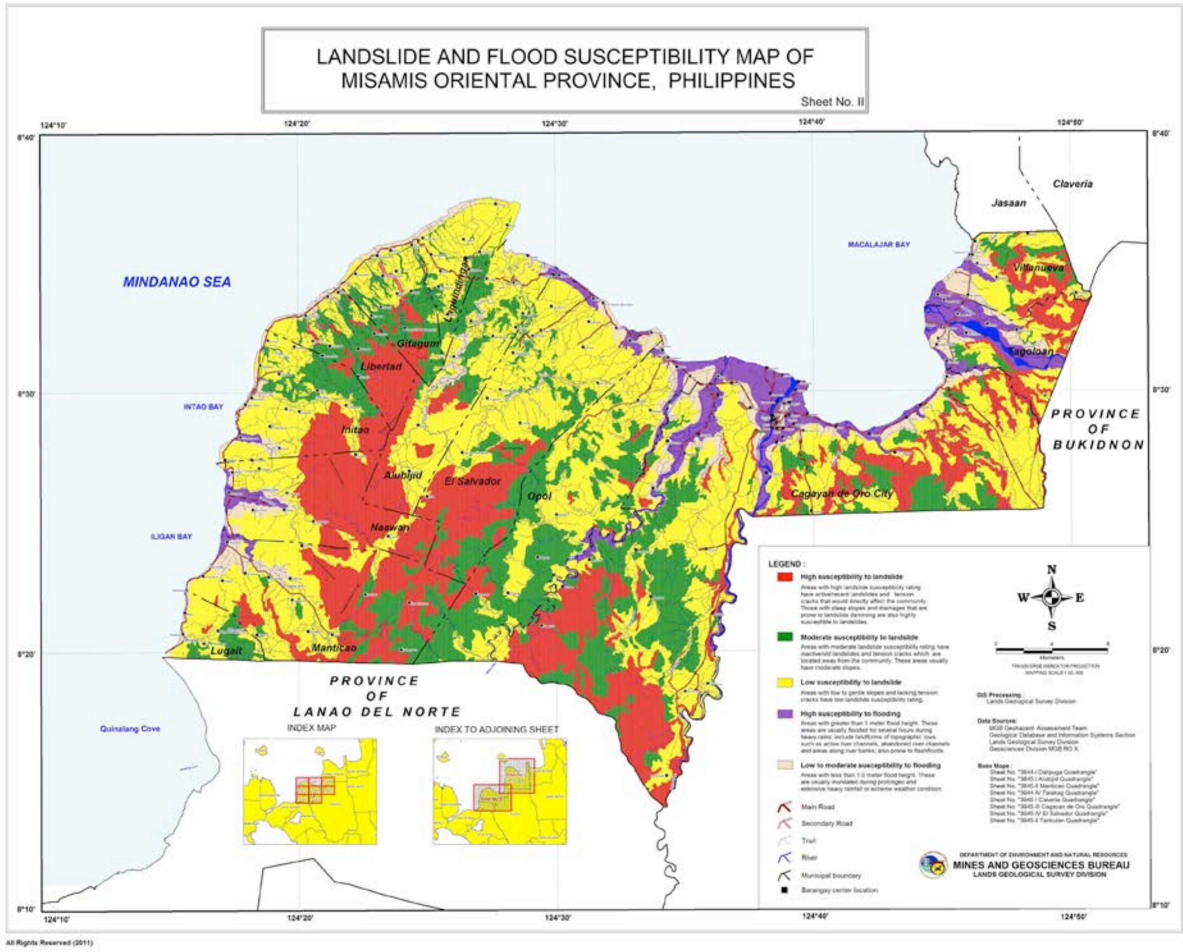
Hazard Maps	Source/s	Scale	Remarks
Volcanic Hazard Maps	Philippine Institute of Volcanology and Seismology (PHIVOLCS), Office of Civil Defense (READY Project)	1:50,000	Areas depicting tsunami inundation zones with supplemental information on flood heights based modeling parameters (i.e. maximum credible earthquake magnitude and earthquake source). Available are selected Provinces. Map availability can be viewed at http://www.phivolcs.dost.gov.ph/
	Philippine Institute of Volcanology and Seismology (PHIVOLCS)	Various Scales	Areas depicting volcanic associated hazards (i.e. *lahar* and pyroclastic flow). Available are selected active volcanoes. Map availability can be viewed at http://www.ndrrmc.gov.ph/ and http://www.phivolcs.dost.gov.ph/

When gathering hazard maps refer to following:

- Gather maps from the mandated agencies. The LGUs should seek assistance from the mandated agencies and establish communication and procedures (protocol) for the request of available hazard maps or generation of municipal level hazard maps and national agencies to respond to such requests;
- In all cases, conduct ground truthing / validation should be conducted;
- Conduct community-based hazard mapping, Document findings based on data, information, and evidences gathered through consultations with local stakeholders and experts and reviewed by the mandated hazard mapping agencies;
- Obtain current local studies and materials (e.g. technical reports, maps) initially from the mandated agencies to build information that identify and characterize the hazards. Gain more understanding on the hazard information provided through opinions, interpretations, and advice from the experts of these agencies and seek their recommendations on the possible hazard mitigation strategies that is applicable and can be implemented in the area/locality;
- Participate in trainings and workshops by sending representatives from the planning group who will later relay the findings and learnings, and provide inputs into the risk assessment.
- Seek assistance from the climate change community of experts to provide an indication, and if possible, a localized formal assessment of future impact scenarios and if impacts can be more or less severe, relative to current climate situation.

- Pursue special studies such as hazard analysis, delineation of flood outlines, and distribution of flood depth to reduce uncertainty in information and improve map accuracies.

Figure 3.1.1 Sample Flood and Rain-Induced Landslide Hazard Map, MGB-Region 10, 2011



The Mines and Geosciences Bureau also generates flood hazard maps. These are usually available at 1:50,000 scale with selected areas at 1:10,000 scale. The map indicates areas where flood and landslides might occur, categorized as high, moderate, and low with information of the technical description on flood heights (refer to Figure 3.1.1). These are based on field verification using geomorphological considerations, field surveys, and interviews. The map, however, does not indicate the antecedent rainfall that can trigger floods and landslide which can be used to estimate the return periods/ likelihood of occurrence of the hazard event. Establishing the likelihood of occurrence may require further verification, expert judgment, and other anecdotal accounts.

Figure 3.1.2 Flood Susceptibility Map of the Municipality of Opol, Misamis Oriental

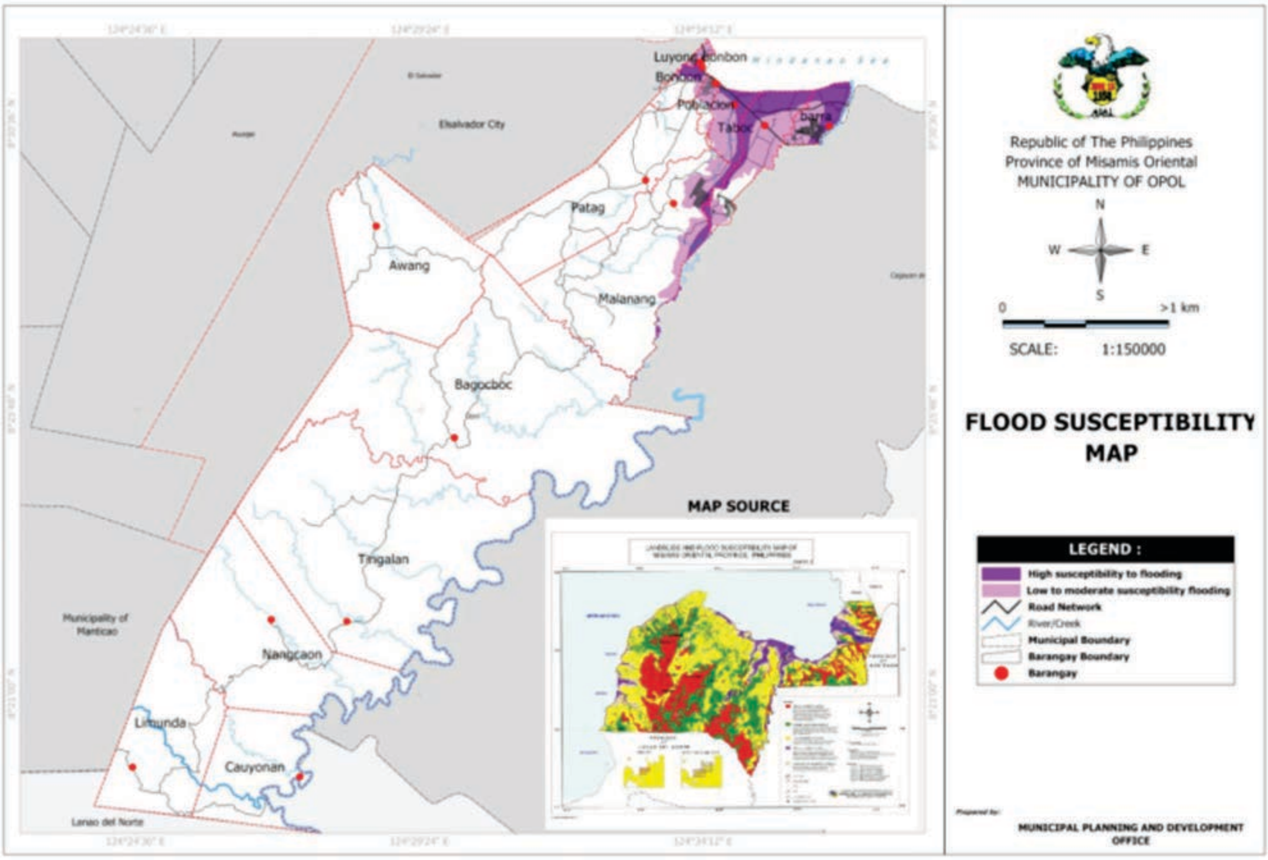


Figure 3.1.2 shows an example of a flood hazard map obtained from MGB, Region 10. It shows the susceptibility or proneness to floods of barangays in the Municipality of Opol. From the figure, the following can be observed:

- Coastal and low-lying barangays of the Municipality which include Barra, Igpit, Malanang, Poblacion, Taboc, Bonbon, and Luyong Bonbon are susceptible to flooding;
- Areas within the highly susceptible areas may experience flood heights, equal or above one meter;
- Areas within the low to moderately susceptible areas may experience flood heights of less than one meter;
- Floods in the Municipality are mostly due to the overflowing of the Iponan River, Buncalalan Creek. Some portions of low lying coastal communities, wetlands, and fish also experience coastal flooding as a result of inundation of sea water due to storms.

Sub-task 1.2.2 Prepare a summary hazard inventory matrix

Upon gathering the various hazard maps, prepare a matrix indicating the various information derived from the hazard maps. These can be complied and summarized using the sample table (refer to Table 3.1.8).

Table 3.1.8 Sample Inventory of Hazards and their description

Hazard	Map Information			Hazard Description				
	Source	Scale	Format/ Date/ Reference System	Susceptibility	Magnitude /Intensity	Speed of Onset	Likelihood of Occurrence	Areas Covered
1	2	3	4	5	6	7	8	7
Flood	MGB	1:50,000	JPEG/2011/ UTM Zone 51, Luzon Datum	High	1 meter and above	Sudden	Floods triggered by 180mm one- day rainfall with an estimated recurrence of 50-70 years	• Barra • Igpit • Taboc • Malanan g
				Moderate to Low	less than 1 meter		Floods may be triggered by >180mm one-day rainfall with an estimated recurrence of >100 years	• Poblacion • Luyong Bonbon

Source: Adopted Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning in the Philippines, NEDA-UNDP-EU, 2008

Sub-Task 1.2.3 Analyze previous disasters

The analysis of disaster events in the past provides a better understanding of hazards, specifically their pattern of occurrence, observed magnitude/intensity, and areas often affected. Historical disaster/damage data are available at the local Disaster Risk Reduction and Management Office and other provincial and regional sources (Office of Civil Defense, Provincial Disaster Risk Reduction and Management Office). At a minimum, disaster data should contain statistics on the date of occurrences of hazards by type; the affected areas indicated on a map; estimated casualties in terms of the number of fatalities, injuries, and individuals missing; number of houses totally and partly damaged; and estimated value of damages to property such as agriculture, private, and commercial buildings and infrastructure (refer to Table 3.1.9).

Table 3.1.9 Records of Previous Disasters, Municipality of Opol (2009-2012)

Hazard Events and Description	Affected Barangays	No. of casualties (Number of Individuals)			No. of affected		No. of houses damaged		Damage to properties in Philippine Pesos (PHP)					Source of Information
		Dead	Injured	Missing	Persons	Families	Totally	Partially	Infra	Agri	Inst.	Private/ Comm'l	Total	
2009 Tail end of the cold front July 11, 2009	14	0	0	0	12,948	2,548	63	71	13,466,390	29,898,000	1,611,800	5,810,000	50,786,190	Disaster report
Typhoon Ramon October 11, 2011	14	0	0	0	167	41	0	0	0	25,950	0	0	25,950	Disaster report
Typhoon Sendong December 2011	12	0	0	0	155	43	27	138	0	7,946,980	1,500,000	2,500,000	11,946,980	Disaster report
Typhoon Pablo Dec 3, 2012	14	0	0	0	3,065	613	51	562	0	1,100,000	0	1,700,000	2,800,000	Disaster report

Sub-Task 1.2.4 Prepare a hazard susceptibility inventory matrix

Based on the hazard maps, and climate change projections, prepare a hazard inventory matrix in order to describe the susceptibilities of the municipality/city for sudden and slow onset hazards. Hazard susceptibility attributed to climate change (i.e. sea-level rise), including past extreme weather events (drought) experienced by the municipality, can also be included (refer to Table 3.1.10).

Table 3.1.10 Sample Hazard Susceptibility Inventory Matrix

Barangay	Flood	Rain-Induced Landslide	Storm Surge	Drought	Sea Level Rise
Barra	√		√	√	√
Igpit	√	√	√	√	√
Taboc	√		√	√	√
Poblacion	√		√	√	√
Bonbon	√		√	√	√
Luyong Bonbon	√		√	√	√
Patag		√		√	
Malanang	√	√		√	
Awang		√		√	
Bagocboc		√		√	
Tingalan		√		√	
Nangcaon		√		√	
Cauyonan		√		√	
Limunda		√		√	

Source: Adopted from the Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans Project Report, NEDA-UNDP-HLURB, 2012

Step 2. Scoping the potential impacts of disasters and climate change

Objectives

- Scope the potential impacts of climate change and hazards on relevant sectors;

Outputs

- Summary of potential climate change impacts and potentially exposed units;
- Impact Chain Diagrams

Process

Task 2.1Identify the various climate stimulus;
Task 2.2 Prepare sectoral impact chain diagrams;
Task 2.3 Summarize findings;

Adaptation to climate change and mitigation of risks to natural hazards involves a very broad range of measures directed at reducing vulnerability to a range of climatic stimulus (changes in means, variability, and extremes) and risks to sudden onset hazards. It is therefore important to first identify the potential impacts and the spatial manifestations of climate change. Impacts are used to refer to the effects on natural and human systems of physical events, of disasters, and of climate change[18], which can be illustrated through impact chains. Climate impact chains are general cause-effect relations that describe how, in principle, climatic changes are expected to cause impacts on the sectors of concern[19].

This step summarizes the initial scoping of potential hazards, including the associated impacts of climate change and hazards, affecting the locality. These are based from the significant findings based on the initial information on climate change, compilation of hazard maps and historical damage/disaster reports.

[18] IPCC, Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change, 2012

[19] National Economic Development Authority, Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning in the Philippines, 2008.

Task 2.1 Identify the various climate stimulus

Based on the projected changes in the mean climate variables due to climate change identified in Step 1 (Table 3.1.6), derive the relevant climatic stimuli that would likely affect the locality and key sectors. These are indicated in columns 4 and 5 of Table 3.2.1. Indicate key sectors likely to be affected to facilitate the identification of potential impacts using sectoral or multi-sectoral impact chains.

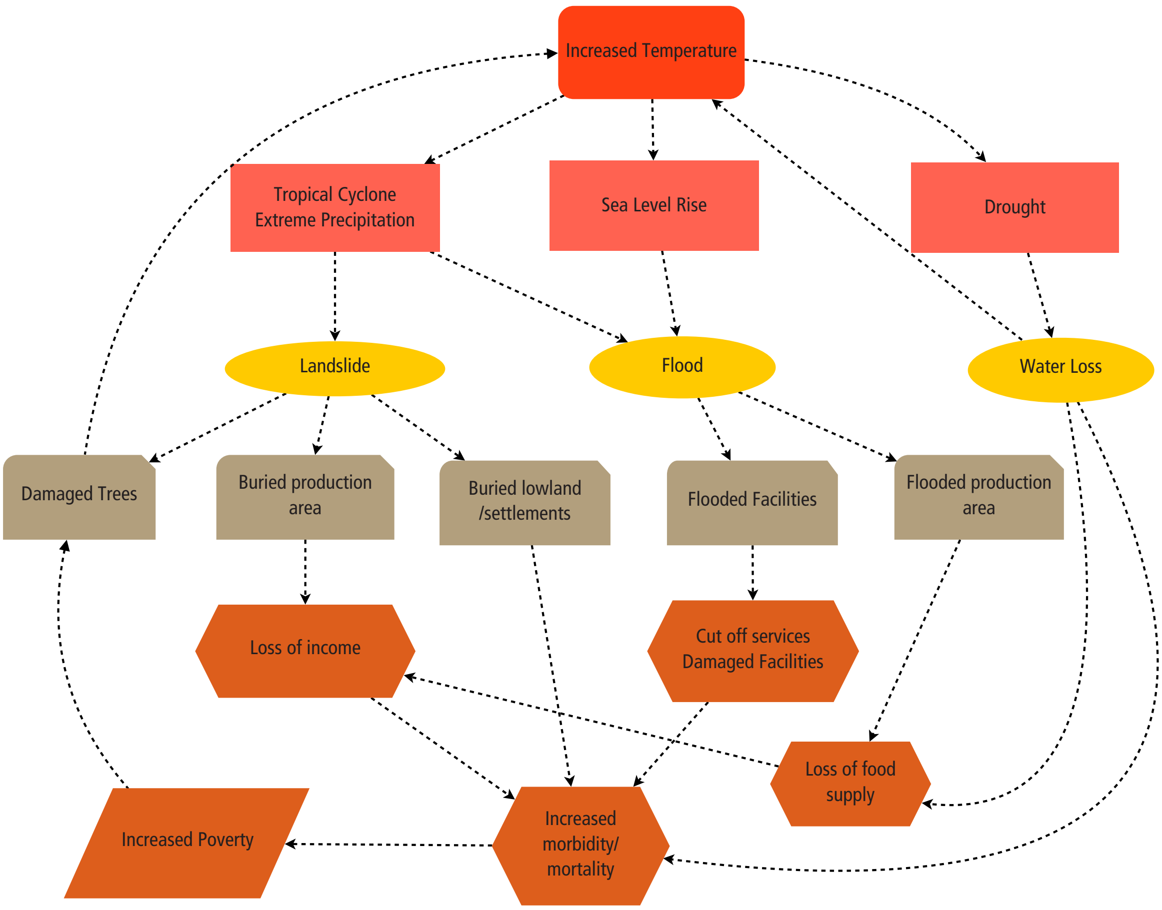
Table 3.2.1. Summary of Projected Changes in Climate Variables and potential affected exposure unit/s, Municipality of Opol

Climate Variable 1	Observed Baseline (1971-2000) 2	Specific Change Expected and Reference Period 3	General Changes Expected in Climate Variables 4	Information About Patterns of Change 5	Population 6	Natural Resource-based Production Areas 7	Critical Point Facilities 8	Urban Use Areas 9	Infrastructure and Utilities 10
Temperature	• 25.4°C during the DJF • 26.8°C during MAM • 26.9°C during JJA • 26.5°C during SON	• 26.4°C by 2020 and 27.3°C by 2050 during DJF • 28.0°C by 2020 and 29.1°C by 2050 during MAM • 28.1°C by 2020 and 29.3°C by 2050 during JJA • 27.5°C by 2020 and 28.5°C by 2050 during SON	• Increasing in temperature for all seasons expected in 2020 and 2050	• Slightly more warming in MAM, and in the JJA season	Yes	Yes	Yes	Yes	
Rainfall	• 442.5 during the DJF • 296.0 during MAM • 615.7 during JJA • 581.1 during SON	• 462.86 by 2020 and 450.47°C by 2050 during DJF • 265.22 by 2020 and 243.31 by 2050 during MAM • 592.92 by 2020 and 597.9 by 2050 during JJA • 597.95 by 2020 and 522.9 by 2050 during SON	• Increasing rainfall during DJF for 2020 and 2050 • Decreasing rainfall during MAM for 2020 and 2050 • Decreasing during JJA for 2020 and 2050 • Increasing rainfall during SON for 2020 but decreasing in 2050	• Reduction in rainfall during the summer and Habagat seasons in 2020 and 2050 • Increase during Amihan season, but amount of rain expected to be lesser than the Habagat and transition seasons • Reduction in rainfall during the MAM and JJA months • Wetter Amihan months DJF and SON	Yes	Yes	Yes	Yes	Yes
Number of Hot Days	• 383 days	• 4,539 days exceeding 35°C in 2020 • 6,180 days exceeding 35°C in 2050	• Increasing number of hot days (exceeding 35°C)	• Significant increase in the number of hot days expected in 2020 and 2050	Yes	Yes	Yes	Yes	
Number of Dry Days	• 8,251 days	• 6,413 days with <2.5 mm of rain in 2020 • 7,060 days with <2.5 mm of rain in 2050	• Decreasing number of dry days (<2.5 mm of rain)	• There will be more days with rainfall (less days without rainfall compared to baseline)		Yes		Yes	
Extreme Daily Rainfall Events	• 10 extreme rainfall events exceeding 150mm	• 13 days with rainfall > 150 mm in 2020 • 9 days with rainfall > 150 mm in 2050	• Heavy daily rainfall >150 mm increasing in 2020 and decreasing by 2050	• More extreme daily rainfall expected (>150mm) in 2020 but more or less the same in 2050 compared to baseline.	Yes	Yes	Yes	Yes	Yes
Sea Level		Projected change by 2100 relative to 1986-2005 Global mean sea level. • 0.26 to 0.55 m for RCP2.6, • 0.32 to 0.63 m for RCP4.5, • 0.33 to 0.63 m for RCP6.0, • 0.45 to 0.82 m for RCP8.5	• Potential increase in the current sea level by 2100	• A potential increase in global sea level by a range of 0.26 to 0.82m by 2100. Note that municipal projected sea level rise may vary from global estimates.	Yes	Yes	Yes	Yes	Yes

Task 2.2 Prepare sectoral impact chain diagrams

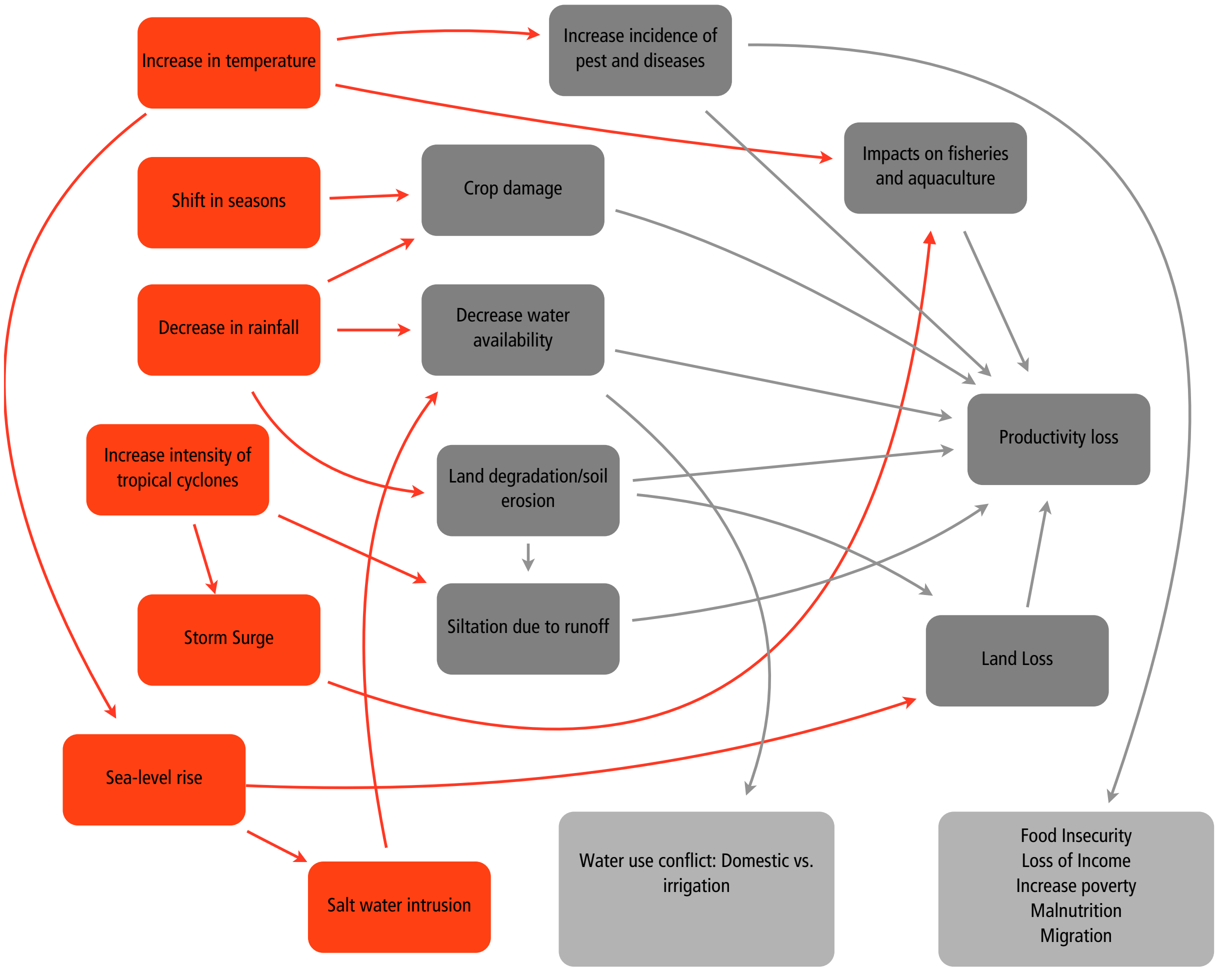
Based on the identified climate stimuli (including its impacts on the behavior of natural hazards that affect the locality), identify the potential direct and indirect impacts to the various thematic sectors such as agriculture, built-up/physical assets, water, health, coastal, and forestry. LGUs can develop impact chains by either focusing on one thematic sector or covering several sectors. Impact chains provide the most important chains of cause and effect leading to the potential impacts relevant in the planning area. This can help identify the key development areas/sectors where climate change and disasters will likely impact and guide the detailed study of establishing the level of risks and vulnerabilities of the area.

Figure 3.2.1 Sample Climate Change Impact Chain Multiple Sectors



Source: Mainstreaming CCA-DRR in the Comprehensive Land Use Plan, HLURB

Figure 3.2.2 Sample Agriculture Sector Impact Chain



Source: Housing and Land Use Regulatory Board, Climate Change Commission, Manila Observatory, Deutsche Gesellschaft fur Internationale Zeusammenarbeit, CLUP Resource Book, Integrating Climate Change Adaptation and Disaster Risk Reduction and Management, 2012.

Task 2.3 Summarize findings;

Enumerate identified potential impacts in Table 3.2.2 using the sectoral and/or multi-sectoral impact chain diagrams. At the end of this step, LGUs will have an initial scoping of the potential manifestations of climate change and the various direct and indirect impacts to the relevant land use planning sectors. This will facilitate the identification of relevant sectors in the municipality which will be covered in the climate and disaster risk assessment.

Table 3.2.2 Summary of Climate change Impacts, Municipality of Opol

Climate Variable 1	General Changes Expected in Climate Variables 4	Information About Patterns of Change 5	Population 6	Natural, Resource-Based Production Areas 7	Critical Point Facilities 8	Urban Use Areas 9	Infrastructure and Utilities 10	Potential Impact Area/s 11
Rainfall	• Increasing rainfall during DJF for 2020 and 2050 • Decreasing rainfall during MAM for 2020 and 2050 • Decreasing rainfall during JJA for 2020 and 2050 • Increasing rainfall during SON for 2020 but decreasing in 2050	• Reduction in rainfall during the summer and habagat seasons in 2020 and 2050 • Increase during Amihan season, but amount of rain expected to be lesser than the Habagat and transition seasons • Reduction in rainfall during the MAM and JJA months • Wetter Amihan months DJF and SON	• Potential reduction in available potable water which may impact quality of life and well-being;	• Reduced volume and quality of yields due to changes in seasonal patterns and reduction in the projected total annual accumulative rainfall; • Reduced soil moisture (temperature with reduced rainfall) • Reduction in food supply	• Reduced availability of potable water supply to sustain key services	• Reduced availability of potable water supply to sustain urban use areas	• Reduced water availability • Reduced water recharge rates • Potential changes in water quality • Potential problems in water supply allocation for competing users	• All brgys
Number of Hot Days	• Increasing number of hot days (exceeding 35ºC)	• Significant increase in the number of hot days expected in 2020 and 2050	• More heat-related stress, particularly among the elderly, the poor, and vulnerable population; • Increased energy consumption for cooling	• Reduced crop yield, fisheries, and livestock production due to heat stress • Higher costs of inputs to sustain crop and livestock production • Reduced food supply	• Increased energy consumption for cooling for the provision of key services (i.e. hospitals, governance, schools etc.)	• Increased temperatures in urban areas • Increased energy consumption for cooling	None	• All brgys
Extreme Daily Rainfall Events	• Heavy daily rainfall >150 mm increasing in 2020 and decreasing by 2050	• More extreme daily rainfall expected (>150mm) in 2020 but more or less the same in 2050 compared to baseline.	• possible deaths, injuries triggered by extreme rainfall events (i.e. floods, landslides) • Increased poverty incidence due to loss of income and damaged dwelling units;	• More frequent flooding resulting to damage to crops • Soil erosion and excessive run-off resulting to potential loss in soil fertility • Reduced food supply	• Possible damages or disruption to social support services/ facilities as a result of more frequent floods and landslides • Potential reduction in available supply and quality delivery of social support facilities	• Property damage • Disruption of economic activities • Reduction in overall economic outputs • Reduced quality of life	• Potential damages or disruption of key transportation infrastructure (bridges and roads) affecting area access and linkages • Potential damage and disruption of distribution networks and services (i.e. power, water and communication)	• Identified brgys within flood prone areas • Rain induced landslide prone areas • Coastal areas

Table 3.2.2 Summary of Climate change Impacts, Municipality of Opol

Climate Variable 1	General Changes Expected in Climate Variables 4	Information About Patterns of Change 5	Population 6	Natural, Resource-Based Production Areas 7	Critical Point Facilities 8	Urban Use Areas 9	Infrastructure and Utilities 10	Potential Impact Area/s 11
Sea Level	• Potential increase in the current sea level by 2100	• A potential increase in global sea level by a range of 0.26 ro 0.82m by 2100. Note that municipal projected sea level rise may vary from global estimates.	• Potential increase in residential areas exposure to storm surges including magnitude due to the potential increase in sea level; • Increased level of damages due to storm surges and coastal flooding	• Intrusion of salt water into rice lands • Reduced areas for crop production • Reduction in farmers' income • Reduced food supply • Loss of coastal wetlands and other coastal habitats such as mangroves	• Possible damages or disruption to existing social support services/ facilities due to sea inundation	• Changes in high and low tide patterns where sea water may inundate further inland; • Potential coastal erosion • Potential increase in urban use area exposure to storm surges and coastal flooding including magnitude due to the potential increase in sea level; • Salt water intrusion in coastal areas resulting to reduction in available potable ground water; • Loss of available lands along the coastal areas; • Sea water inundation within existing urban use areas along low-lying coastal areas. • Potential relocation of low-lying settlements to higher ground;	• Potential damages or disruption of key transportation infrastructure (bridges and roads) affecting area access and linkages along coastal areas • Potential damage and disruption of distribution networks and services (i.e. power, water and communication) along coastal areas	• Coastal areas (within 1 meter above sea level or areas within 1 km. from the coastline.

Step 3. Exposure Database Development

Objectives

- Prepare an exposure database that will contain baseline information on potentially affected elements covering population, urban use areas, natural resource production areas, critical point facilities and lifeline utilities/infrastructure
- Describe the vulnerabilities/sensitivities of the elements using indicators
- Describe the adaptive capacities of elements using indicators
- Provide the baseline information for the conduct of the Climate Change Vulnerability Assessment and Disaster Risk Assessment

Outputs

- Exposure Maps (Population, Urban Use Areas, Natural Resource-based Production Areas, Critical Points, lifeline/infrastructure)
- Attribute information on exposure, sensitivity/adaptive capacity of the various exposure units

Process

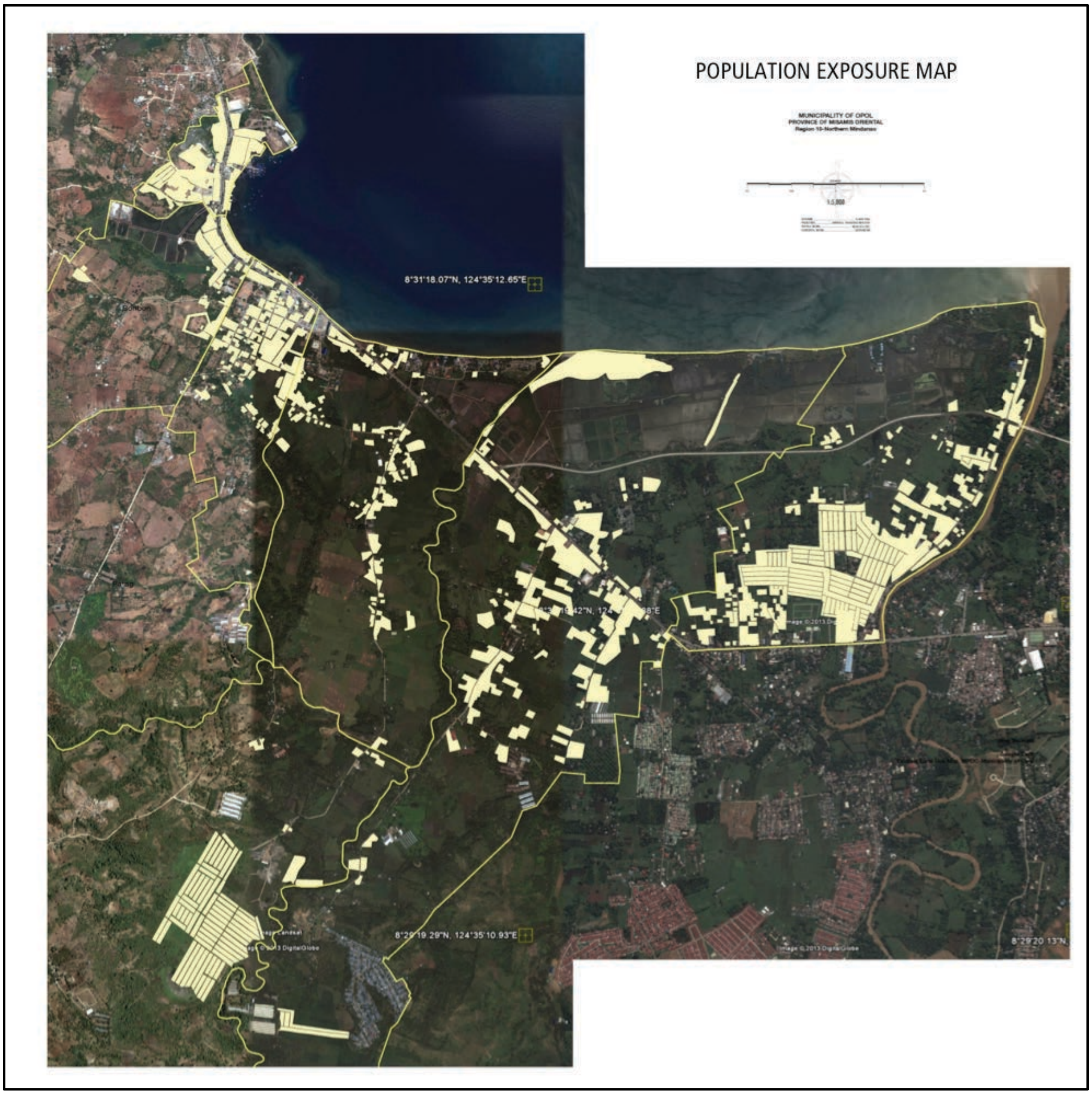
Task 3.1 Prepare the Population Exposure Maps and compile attribute information
Task 3.2 Prepare Urban Use Area Exposure Maps and compile exposure, sensitivity/adaptive capacity information
Task 3.3 Prepare Natural Resource Production Area Exposure Maps and compile exposure, sensitivity/adaptive capacity attribute information
Task 3.4 Prepare Critical Point Facilities Exposure Maps and compile exposure, sensitivity/ adaptive capacity attribute information
Task 3.5 Prepare Lifeline Facilities Area Exposure Maps and compile exposure, sensitivity/ adaptive capacity attribute information

The Exposure Database provides the baseline information pertaining to the elements at risk. It shall provide the location, vulnerability/sensitivity, and adaptive capacity attributes of the exposed elements which are necessary information when conducting a climate change vulnerability assessment (CCVA) and climate and disaster risk assessment (CDRA). Ideally, the exposure database should be map-based, indicating the approximate field location of the various elements and will be the bases in estimating the exposed elements expressed in terms of area, number and/or unit cost. Other area/element based information should also be gathered to establish the sensitivity/vulnerability and adaptive capacity of the exposed elements which will be the bases for estimating the level of risks and vulnerabilities.

Task 3.1 Prepare the population exposure maps and compile attribute information

Prepare a population exposure map by using the existing land use map. Extract all residential areas per barangay. Data can be aggregated at the barangay level. It is assumed that majority of the population resides and are located within residential areas. A sample population exposure map is presented below (refer to figure 3.3.1) and a sample attribute table (refer to Table 3.3.1) containing the exposure, sensitivity/ vulnerability and adaptive capacity indicators.

Figure 3.3.1 Sample Existing Population Exposure Map, Municipality of Opol



Using the suggested indicators for exposure, sensitivity/vulnerability, and adaptive capacity identified in Chapter 3 when assessing population vulnerability and risks, the Municipality of Opol derived barangay level data from the Community-based Monitoring System (CBMS) database, National Statistics Office Census (NSO), and focus group discussions with municipal and barangay level sectoral representatives. A sample table on population exposure database for the municipality of Opol is presented in Table 3.3.1.

Table 3.3.1 Sample Existing Population Exposure Attribute Table, Municipality of Opol

EXPOSURE				SENSITIVITY / VULNERABILITY						ADAPTIVE CAPACITY				
Barangay	Residential Area (Hectares)	Barangay Population	Population Density per Hectare of Residential Area[1]	Percentage of Informal Settlers	Percentage of Population Living in Dwelling Units with Walls Made from Light to Salvageable Materials	Percentage of Young and Old Dependents	Percentage of Persons with Disabilities	Percentage of Households Living Below the Poverty Threshold	Percentage Malnourished Individuals	Access to Post Disaster Financing	PhilHealth Coverage	Household Financial Capacities to Relocate or Retrofit	Government Capacity to Generate Jobs	Government Resources
Barra	51.94	14,334	276	1.06%	0.84%	33.58%	0.7%	14.55%	0.61%	There is willingness to relocate subject to assistance from the local government. There is also willingness to retrofit existing highly vulnerable structures but may take them medium to long-term.	Majority of non-residential structures/property owners have current property insurance coverage or have capacities to purchase within the short term. Majority of residential structures do not have property insurances	Alternative sites are still available within the municipality which can accommodate existing land uses if needed	Local government resources are very limited but funds for adaptation can be sourced from the regional and national governments or through public private partnerships.	Majority of non-residential structures can conform with added zoning regulations in the medium term. Majority of residential structures may have difficulties conforming to the added regulations and may take them medium to long term to conform to new regulations
Bonbon	11.34	2,698	238	3.13%	5.06%	34.31%	1.01%	35.86%	2.2%					
Igpit	58.72	10,123	172	7.27%	1.75%	36.3%	0.7%	27.16%	1.06%					
Poblacion	14.53	3,690	254	4.06%	6.08%	32.24%	2.23%	21.29%	1.5%					
Taboc	12.75	2,918	229	4.45%	8.74%	35.67%	0.89%	31.29%	0.59%					

[1]Population Density per Hectare of Residential Area = Barangay Population / Residential area in hectares. This will be used to compute for the estimated population exposure depending on the area (in hectares) affected/exposed.

Task 3.2 Prepare the urban use area exposure map and attribute information

The urban use area exposure database will cover land uses such as commercial, residential, industrial, tourism, parks and recreation, cemetery and other urban uses unique to the locality (Note: Institutional uses will be covered in critical point facility exposure map).

Sub-task 3.2.1 Prepare the urban use area exposure map

The exposure map can be prepared using the existing land use map by extracting the above mentioned urban use area categories. At the minimum, data should be aggregated per barangay per urban use area category (refer to Figure 3.3.2 and Table 3.3.2).

Figure 3.3.2 Sample Existing Urban Use Areas Exposure Map, Municipality of Opol

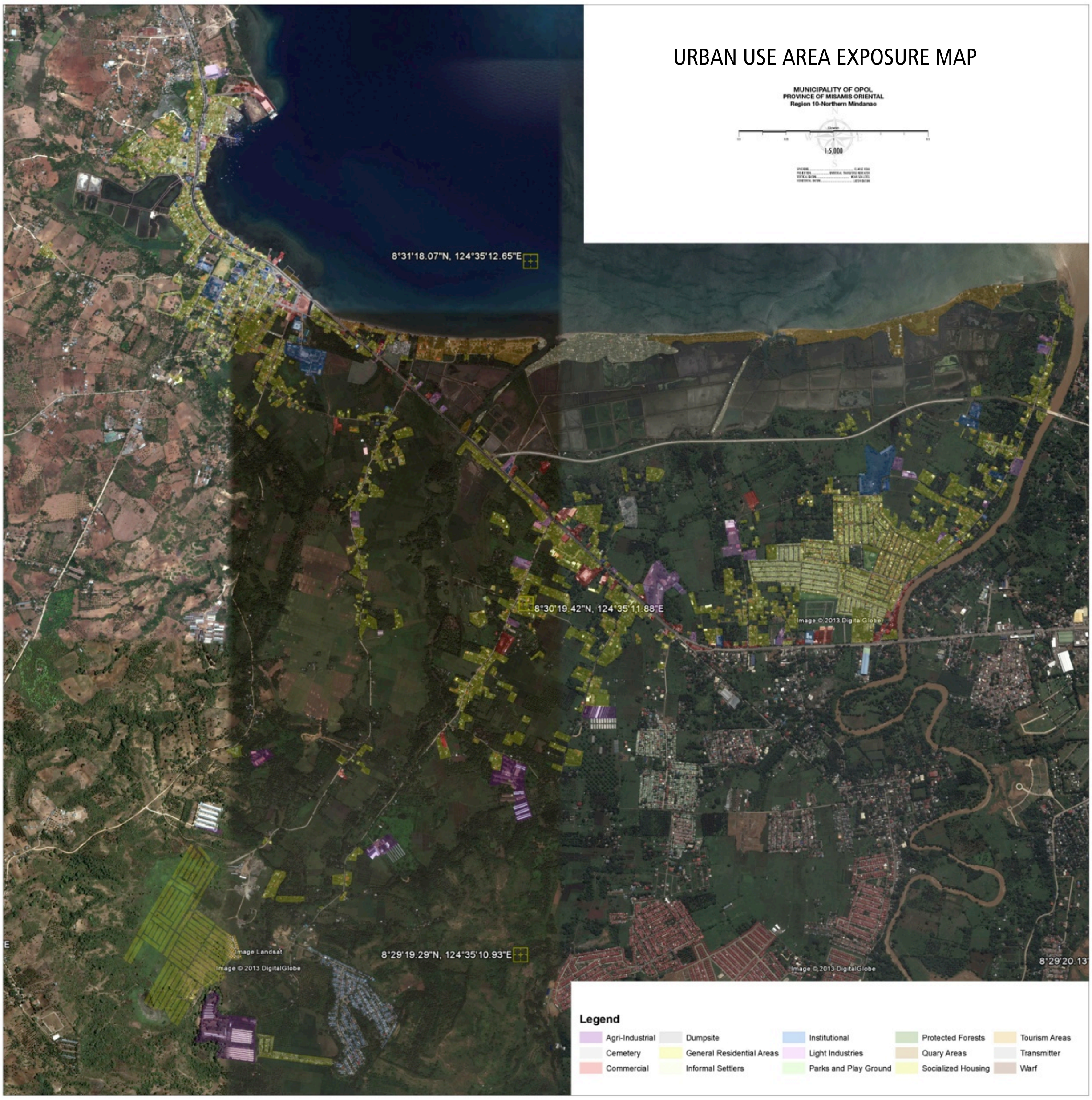


Table 3.3.2 Sample Existing Urban Use Areas Exposure Attribute Table, Municipality of Opol

EXPOSURE				SENSITIVITY / VULNERABILITY[1]				ADAPTIVE CAPACITY				
Barangay	Existing Land Use (Specific Use)	Total Area Allocation per Land Use Per Barangay	Replacement Cost (PHP per Sq. Meter)	Percentage of Buildings with Walls with Light to Salvageable Materials	Percentage of Buildings in Dilapidated/ Condemned Condition	Percentage Structures Not Employing Hazard-Resistant Building Design	No Access/ Area Coverage to Infrastructure - Related Hazard Mitigation Measures	Capacity And Willingness to Retrofit or Relocate or Conform with New Regulations	Insurance Coverage	Available alternative sites	Government Resources	Local Government Capacity to Impose/ Implement Zoning Regulations
Bonbon	Commercial	0.08	8,672	Moderate	Moderate	Moderate	Very High	There is willingness to relocate subject to assistance from the local government. There is also willingness to retrofit existing highly vulnerable structures but may take them medium to long-term.	Majority of non-residential structures/ property owners have current property insurance coverage or have capacities to purchase within the short term. Majority of residential structures do not have property insurances	Alternative sites are still available within the municipality which can accommodate existing land uses if needed	Local government resources are very limited but funds for adaptation can be sourced from the regional and national governments or through public private partnerships.	Majority of non-residential structures can conform with added zoning regulations in the medium term. Majority of residential structures may have difficulties conforming to the added regulations and may take them medium to long term to conform to new regulations
Bonbon	Infrastructure and Utilities - Transmitter	0.03	1,000	Moderate	Low	Moderate	Very High					
Bonbon	Parks and Play Ground	0.05	3,254	Low	Low	Low	Very High					
Bonbon	Residential	11.34	5,400	High	Moderate	Moderate	Very High					
Igpit	Cemetery	1.27	1,500	Residual	Residual	Very High	Very High					
Igpit	Commercial	4.22	8,672	Low	Low	Moderate	Very High					
Igpit	Light Industries	5.3	8,672	Very Low	Very Low	Moderate	Very High					
Igpit	Residential - Informal Settlement	9.48	3,543	Very High	High	Very High	Very High					
Igpit	Residential	35.84	5,400	High	Moderate	High	Very High					

[1] Very High = >50%, High >30-50%, Moderate >15-30%, Low >5-15%, Very Low >2-5%, Residual 0-2%

Sub-task 3.2.2 Gather indicators related to vulnerability/sensitivity and adaptive capacity of urban use areas

At the minimum, exposure will be expressed in terms of hectares. If data is available, exposure can be further described in terms of replacement value (expressed as the unit cost of replacement per square meter) or assessed value. Vulnerability/sensitivity indicators can be aggregated at the barangay level per urban use category vulnerability/sensitivity, and adaptive capacity indicators can be expressed quantitatively as proportion or number. However, proportions can be described qualitatively using percentage range (refer to the recommended range and qualitative description). Given that data are aggregated at the barangay level, it assumes that these indicators are evenly distributed within particular land use category per barangay which may not necessarily reflect the actual site conditions.

Task 3.3 Prepare the Natural Resource Production Areas Exposure Maps and compile attribute information

Natural resource production areas refer to areas used for agricultural, fisheries, and forestry-based production. These shall cover areas such as croplands, livestock production areas, fishery areas, production forests, and other resource production areas unique to the locality.

Sub-task 3.3.1 Prepare a Natural Resource Production Area Exposure Map

Natural resource-based production exposure map can be derived from the existing land use map of the locality. This can be done through field surveys or barangay level land use mapping. The exposure map covers crop production areas, fishery areas, production forests, and other natural resource production areas unique to the locality. At the minimum, information can be aggregated to the barangay level to account for the differences in the vulnerability/sensitivity and adaptive capacity indicators per barangay (please refer to Figure 3.3.3 and Table 3.3.3)

Figure 3.3.3 Sample Existing Natural Resource-based Exposure Map, Municipality of Opol

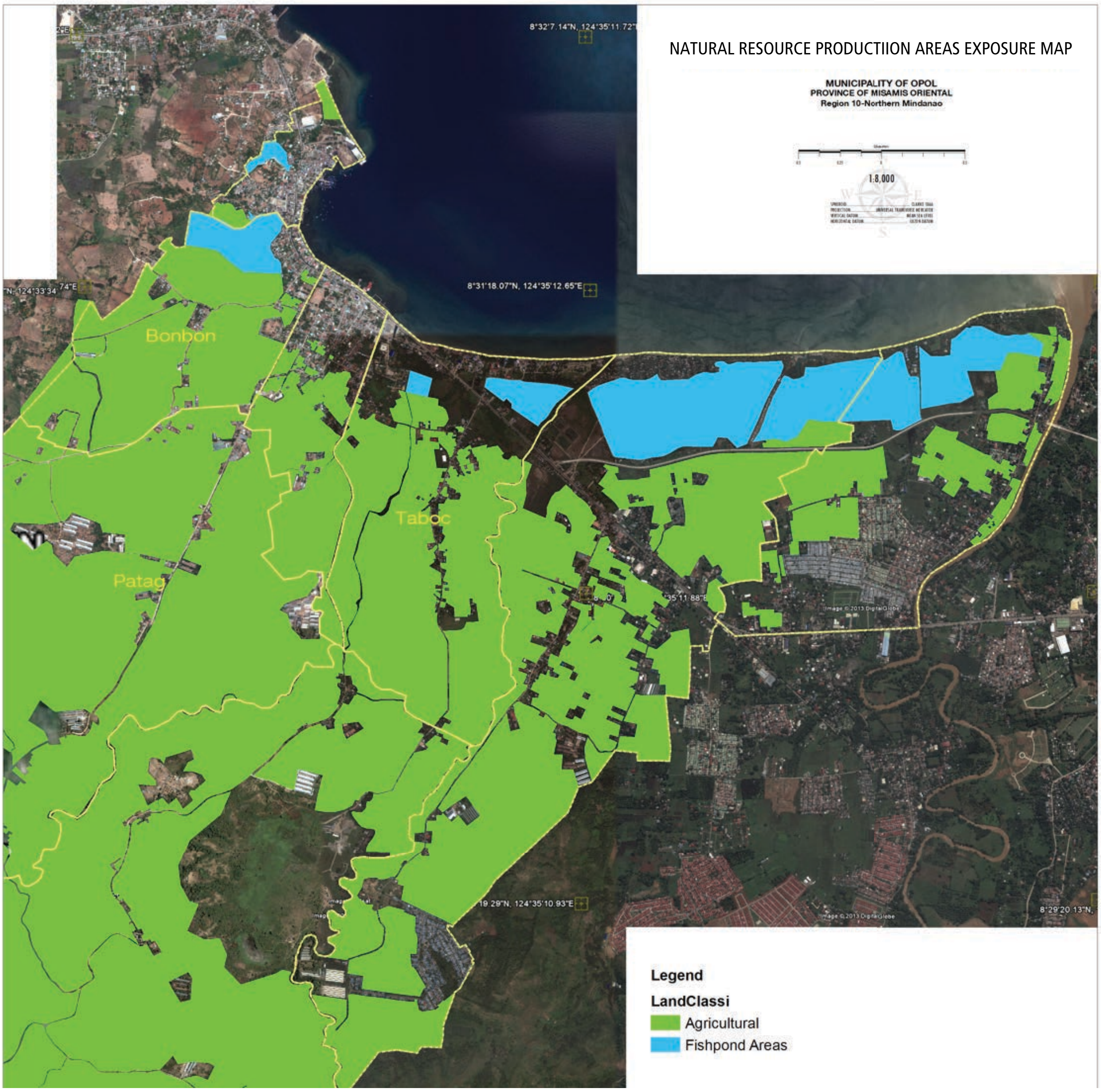


Table 3.3.3 Sample Natural Resource Production Area Exposure Attributes

EXPOSURE					SENSITIVITY / VULNERABILITY						ADAPTIVE CAPACITY				
Barangay	Number of Farming Dependent Households	Total Area Allocation (Hectares)	Dominant Crop/ Variety of Produce	Average Output Per Hectare (PHP)	Number of Farming Families who Attended Climate Field School	Percentage of Farming Families Using Sustainable Production Techniques	Percentage of Famers with Access to Hazard Information	Percentage of Production Areas with Infrastructure Coverage	Percentage Areas with Irrigation Coverage	Percentage Areas with Water Impoundment	Access to Insurance	Agricultural Extension Services of the Local Government	Early Warning Systems	Alternative Livelihood	Government Resources
Barra	127	58.66	Vegetable	150,000	NONE	0%	27%	NONE	0%	0%	Approximately 15% of farming families can afford crop insurance. Cost sharing to cover key production areas with crop insurance can be pursued by the Local Government.	Only 37% of the farming families have access to agricultural extension services of the local government. However, the LGU has the capacity to develop and fund programs on extension to cover the remaining farming families.	Approximately 37% of farming families have access to early warning systems (EWS) related to agricultural production. However, EWS can be further improved to cover the remaining farming communities.	Only 15% of farming families have access to alternative livelihood opportunities. Current rate of job creation in the LGU is not enough to provide adequate opportunities to farming communities.	Available government resources are not enough to fund infrastructure related projects
Barra	10	30.67	Tilapia/ Bangus	32,843	NONE	0%	27%	NONE	100%	0%					
Bonbon	18	108.93	Rice	91,605	NONE	0%	100%	NONE	0%	0%					
Bonbon	4	13.56	Tilapia/ Bangus	32,843	NONE	0%	100%	NONE	100%	0%					
Igpit	123	281.75	Rice	91,605	NONE	4%	20%	NONE	40%	20%					
Igpit	14	64.32	Tilapia/ Bangus	32,843	NONE	0%	20%	NONE	100%	20%					
Malanang	657	1750.28	Rice	91,605	NONE	2%	35%	NONE	36%	0%					
Poblacion	50	53.26	Rice	91,605	NONE	0%	100%	NONE	25%	0%					

Sub-task 3.3.2 Gather indicators related to vulnerability/sensitivity and adaptive capacity

At the minimum, exposure will be expressed in terms of hectares. However, if data is available, exposure can be further expressed in terms of replacement value (cost for replanting per hectare). Vulnerability/sensitivity and adaptive capacity can be expressed quantitatively in terms of proportion or number or qualitatively, described as a range. At the minimum, vulnerability/sensitivity indicators should be aggregated at the barangay level per land use category.

Task 3.4 Prepare Critical Point Facilities Exposure map and compile attribute information

Critical point facilities map will cover the various critical point facilities associated with the delivery of basic social services such as hospitals, schools, social welfare facilities, government buildings, protective services; point facilities associated with water, power, communication, bridges, evacuation centers, seaports, airports, food storage facilities; and other unique critical point facilities in the locality.

Sub-task 3.4.1 Prepare Critical Point Facilities Exposure map

The critical exposure map can be prepared using available inventory/thematic maps generated by the locality. These can be compiled into one map where the spatial distribution of the facilities by type are indicated (refer to Figure 3.3.4). Sample thematic maps that can be used to prepare the exposure database on critical point facilities include inventory of schools, health related facilities, social welfare facilities, government buildings (i.e. barangay halls, municipal/city hall,), water-related point facilities (i.e. pumping stations, potable water point sources), power-related point facilities (sub-stations, power plants, etc), communication facilities (cell sites/towers), transportation (sea ports, airports, bridges), and recreation buildings and facilities (gymnasiums, covered courts).

Sub-task 3.4.2 Gather indicators related to exposure, vulnerability/sensitivity and adaptive capacity

Exposure will be expressed in terms of capacity (i.e number of classrooms, bed capacity), area allocation (expressed in terms of hectares or floor area), construction cost (total cost of the structure) and/or replacement value per square meter floor area, where the total replacement cost can be derived based on the total floor area of the structure. Vulnerability/ sensitivity attributes are determined on a per structure basis for critical point facilities (refer to Table 3.3.4).

Figure 3.3.4 Sample Existing Critical Point Facilities Exposure Map, Municipality of Opol

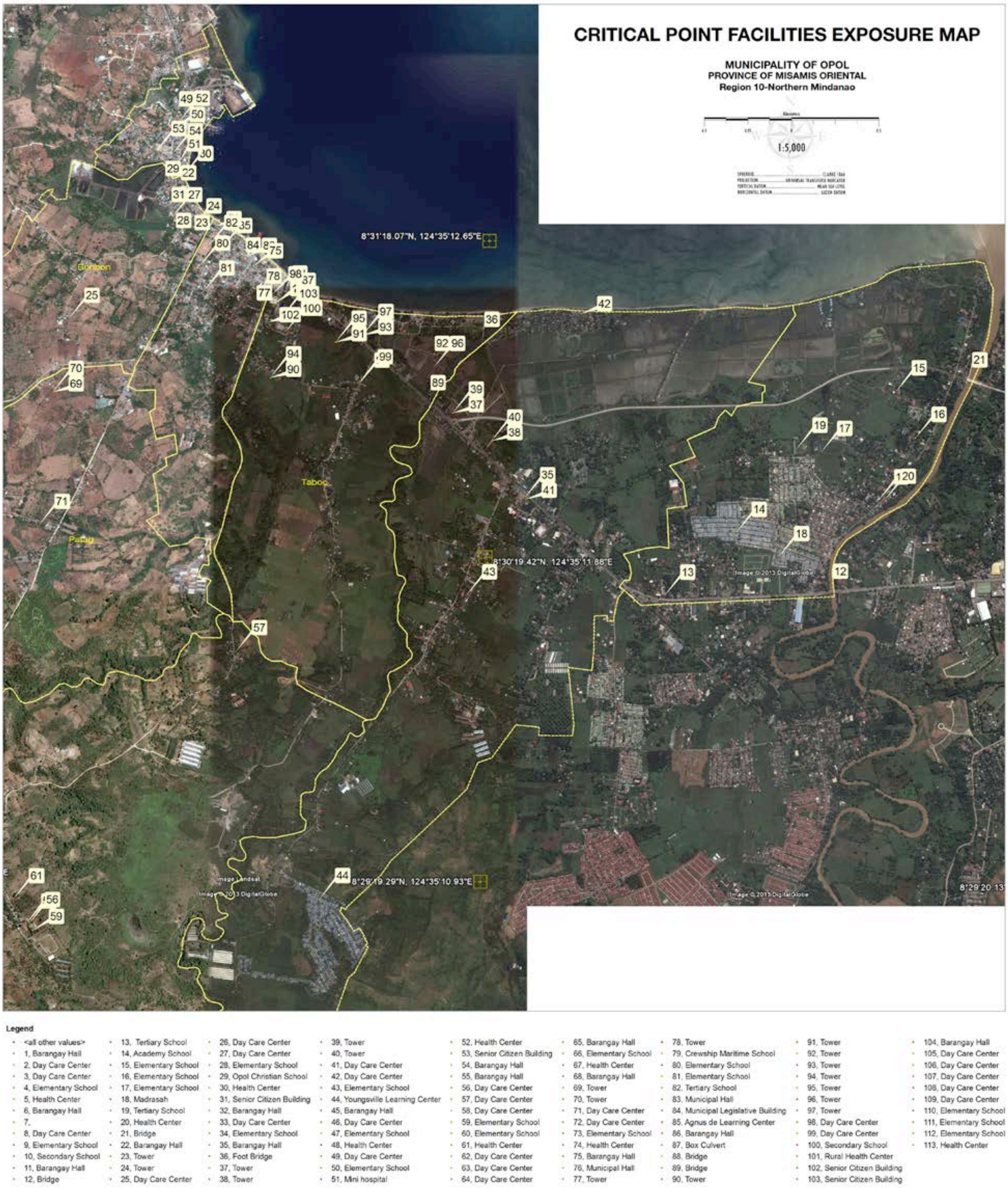


Table 3.3.4 Sample Critical Point Facilities Exposure Attribute Table, Municipality of Opol

EXPOSURE					SENSITIVITY / VULNERABILITY			ADAPTIVE CAPACITY	
Barangay	Type	Name	Area (Sq. Meters)	Capacity (Classrooms, Bed Capacity, Loading Capacity)	Wall Materials Used	Existing Condition	Structure Employing Hazard Resistant Design	Insurance Coverage	Local Government Resources for Risk Mitigation
Barra	Bridge	Barra Bridge		20 Tons	Concrete	Good	Yes	Majority of the exposed critical points (i.e. schools, rural heath units, barangay health centers and local governance buildings) are not covered by property damage insurance. Only the Barra day care centers (1 and 2) are covered by property damage insurance.	For LGU owned buildings, the LGU does not have available resources for retrofitting and relocation. However, funds can be set aside for such purposes but it may significantly affect the implementation of other local development programs and projects. Majority of the schools are either privately owned or managed by the Regional DepEd. Funds for planned adaptation (i.e. retrofitting and relocation) can be coursed through the regional agencies with possible counterpart funding from the LGU. Existing Bridges are mainly under the jurisdiction of the DPWH, retrofitting or establishment of new bridges may be coursed through DPWH.
Barra	Day Care Center	Barra Day Care Center 2	50		Concrete	Good	Yes		
Barra	Day Care Center	Barra Day Care Center	50		Concrete	Good	Yes		
Barra	Elementary School	Barra Elementary School	6404	15 Classrooms	Concrete	Good	No		
Bonbon	Day Care Center	Luyong Bonbon Day Care Center	50		Mixed	Poor/needs major repair	No		
Bonbon	Elementary School	Opol Grace Christian School	10,000	6 Classrooms	Wood	needs repair	No		
Bonbon	Senior Citizen Building	Bonbon Senior Citizen	50		Mixed	Poor/needs major repair	No		
Luyong Bonbon	Elementary School	Luyong Bonbon Elementary School	4845	8 Classrooms	Concrete	needs repair	No		
Luyong Bonbon	Health Center	Luyong Bonbon Health Center	75	4 Bed Capacity	Wood	Poor	No		
Poblacion	Elementary School	Opol Central School	9879	6 Classrooms	Mixed	Good	Yes		
Poblacion	Elementary School	SDA Elementary School	8034	12 Classrooms	Concrete	needs repair	Yes		

Task 3.5 Prepare Lifeline Utilities Exposure map and compile attribute information

Lifeline facilities refer to major linkage and distribution systems associated with transportation access systems and power, water, and communication distribution/line systems. At the minimum, LGUs can focus on roads linking the municipality/city to other important nodes within the Province/Region, linkage systems within major functional areas within the city/ municipality, and those, major water, power and communication distribution networks.

Sub-task 3.5.1 Prepare a lifeline utilities exposure map

An exposure map for lifeline utilities can be derived from existing road, power, water, and communication inventory maps available on the municipality and city. These can also be prepared through GPS-assisted surveys and derived secondary data from provincial and regional level agencies (refer to Figure 3.3.5).

Sub-task 3.5.2 Gather indicators related to vulnerability/sensitivity and adaptive capacity

Information on vulnerability/sensitivity and adaptive capacity can be compiled using existing inventory tables prepared in socio-economic profiling. However, supplemental information should also be gathered such as replacement cost (average cost per linear kilometer), hazard design standards, and other anecdotal accounts to describe the adaptive capacity of the locality (i.e. presence of alternative routes/back-up systems, available government resources for the establishment and retrofitting of the various lifelines (refer to Table 3.3.5).

Figure 3.3.5 Sample Existing Lifeline Utilities Exposure Map, Municipality of Opol

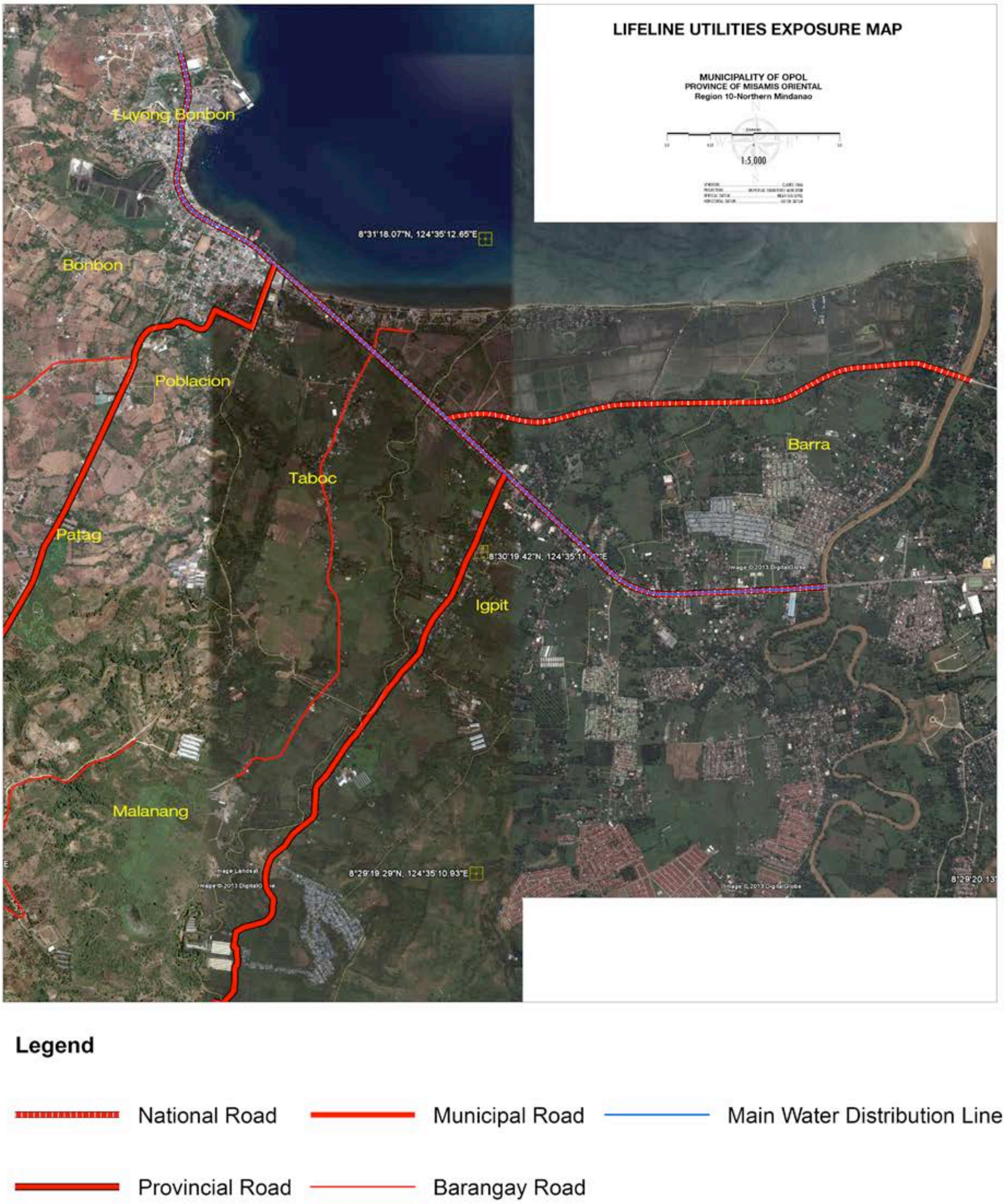


Table 3.3.5 Sample Lifeline Utilities Exposure Attribute Table, Municipality of Opol

EXPOSURE			SENSITIVITY / VULNERABILITY			ADAPTIVE CAPACITY	
Road Name	Road Classification	Replacement Cost per linear kilometer	Surface Type	Existing Condition	Hazard Resistant Design	Insurance Coverage	Available Government Resources
Metro Cagayan Road	National road	23,000,000	Concrete	Good	Yes	All existing roads do not have damage insurance coverage. Addressing damages are mostly done through repairs using either local government fund resources or those funded by regional line agencies.	Local Government do not have available resources to fund road improvements, and or establishment of new roads (*barangay* and municipal). Regional DPWH, however, has available financial resources to fund national road improvements or retrofitting within the municipality but fund availability will depend on their current priorities. Also, LGU can impose special levy taxes for projects benefiting local constituents but local capacities may not be able to pay the additional taxes.
Main Water Distribution Line	Water Pipe	No Information	Steel	Good	Yes		
Old National Road	National road	23,000,000	Concrete	Good	Yes		
Highway-Junction Tulahon Road	Provincial road	18,000,000	Concrete / Gravel	Needs Major Repairs	No		
National Highway to Narulang Road	Provincial road	18,000,000	Concrete	Needs Major Repairs	No		
Poblacion to Limunda Road	Provincial road	18,000,000	Concrete	Good	Yes		
Roan Road	*Barangay* Road	11,036,000	Concrete	Good	Yes		
National highway to Zone 1 Road	*Barangay* Road	11,036,000	Concrete	Good	Yes		
National highway to Pag-ibig Citi Homes	*Barangay* Road	11,036,000	Concrete	Good	No		
National Highway	National road	23,000,000	Concrete	Good	Yes		
National Road to Malingin	*Barangay* Road	11,036,000	Dirt Road	Poor	No		

Step 4. Conduct a Climate Change Vulnerability Assessment (CCVA)

Objectives

- Determine exposed elements to the various climate stimuli
- Analyze and determine sensitivities
- Identify potential impacts of climate change to the system
- Analyze adaptive capacities
- Determine level of vulnerabilities
- Identify land use planning decision sectors and/or areas

Outputs

- CCVA summary decision areas and issues matrix
- CCVA vulnerability assessment map

Process

Task 4.1 Identify the System of Interest, Climate Stimuli, and Impact Area
Task 4.2 Determine Exposed Units
Task 4.3 Conduct a Sensitivity Analysis
Task 4.4 Enumerate the Potential Impacts and rate the Degree of Impact
Task 4.5 Evaluate and rate the Adaptive Capacity
Task 4.6. Compute for the Vulnerability Index
Task 4.7 Prepare a Vulnerability Assessment map
Task 4.8 Identify Decision Areas issues matrix

The Climate Change Vulnerability Assessment (CCVA) is a tool which assesses the vulnerabilities of the locality to various climate- related stimuli. The tool is qualitative in approach in order to determine the level of vulnerability and the underlying factors contributing to vulnerability by looking into the extent of exposure, and analyzing sensitivities and adaptive capacities. This will facilitate the identification of decision areas, planning implications, and policy interventions.

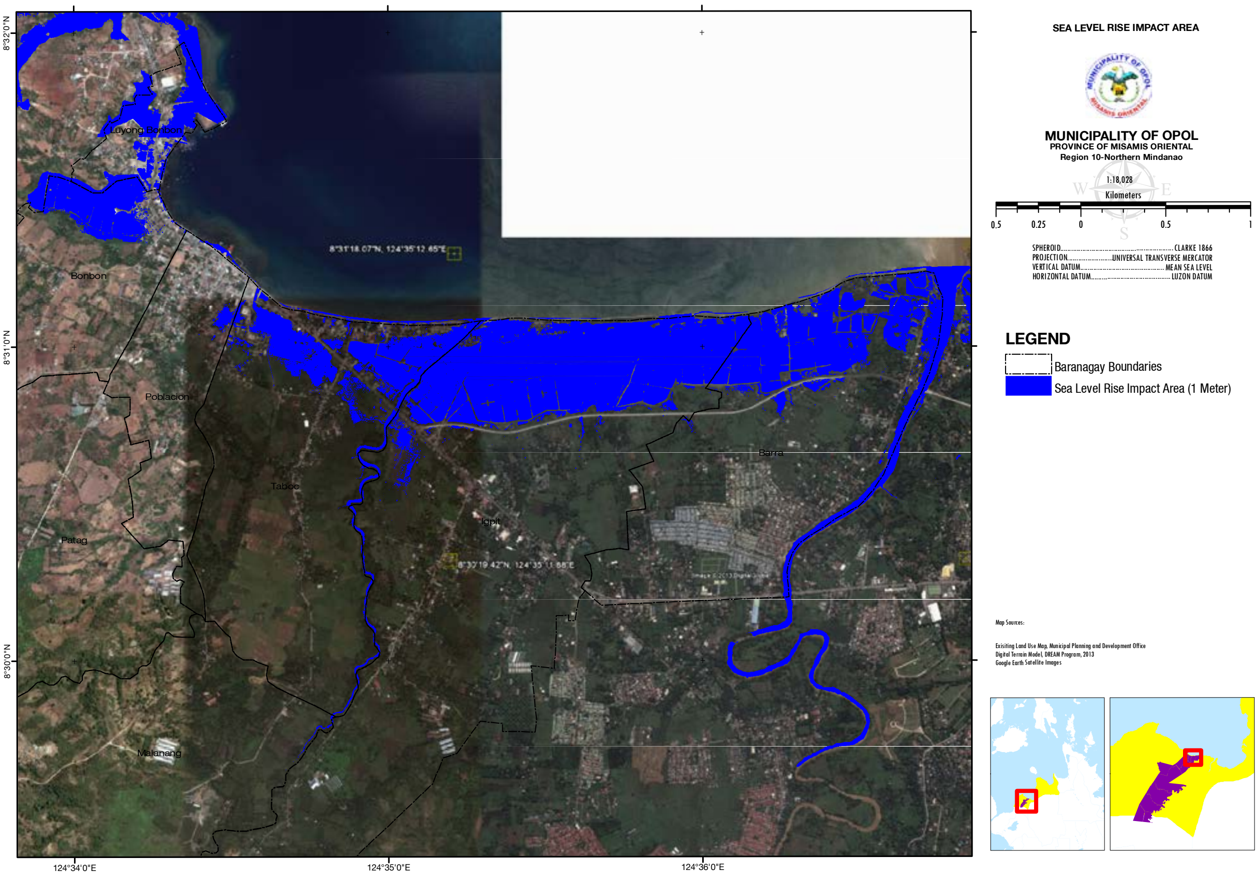
Task 4.1 Identify Climate Stimuli and potential System of Interest, and determine the Impact Area

Based on the initial scoping Step 2 and taking off from the summary matrix, select and list down the various climate stimuli in column 1 (refer to Table 3.4.1: Sample Impact Area and Climate Stimuli). Determine the estimated impact area where the climate stimuli will manifest (column 2). An impact area can be mapped out to represent the area coverage and facilitate the identification of potentially affected areas. Impact area can represent a particular area such as those within one meter of the current mean sea level to represent sea level rise impact area or it may cover the whole municipality (i.e. changes in the rainfall pattern, changes in temperature, increase in the number of dry days). List down the potential systems of interest, which will be assessed.

Table 3.4.1 Sample Impact Area and Climate Stimuli

Climate Stimuli (1)	Impact area (2)	System/s of Interest (3)
Potential 0.82 using the RCP 8.5 increase in the current mean sea level by 21001	Coastal areas 1 meter above the mean sea level	• Population • Natural resource based production areas • Urban use areas • Critical point facilities • Infrastructure and lifeline utilities

Figure 3.4.1 Sample Impact Area Map for Sea Level Rise, Municipality of Opol



Task 4.2 Determine the exposed units

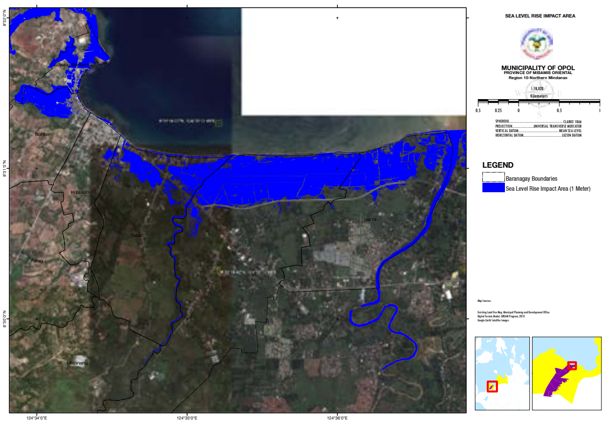
The exposure database serves as source of information on exposure which includes the location and attributes of the system of interest. Exposure data gathered in Step 3 serves as the baseline information to describe elements in the impact area. Based on the overlay of the exposure maps and the impact area, identify the exposed elements for each system of interest.

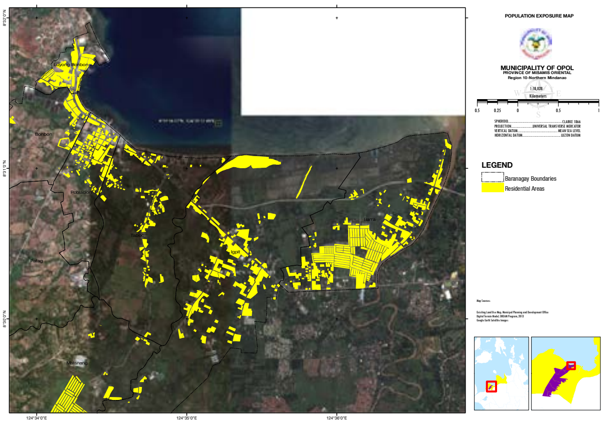
Sub-task 4.2.1 Determine Population Exposure

Overlay the population exposure map with the impact area map (refer to Figure 3.4.2a). The map overlaying will determine the extent of area exposed where the number of exposed individuals can be computed, including the sensitivity and adaptive capacity attributes of the elements exposed (refer to Table 4.4.2a). Determining exposure can be facilitated using Geographic Information System (GIS) or overlay mapping using paper maps and transparencies (refer to Figure 3.4.2a),

- Compute for the residential area to population density by dividing the barangay population by the total estimated residential areas (Column D)
- Estimate the affected area using GIS (Column E)
- Compute for the affected population by multiplying the the estimated affected area by the residential area to population density (Column F).
- Determine the exposure percentage of affected population relative to the total barangay population by dividing the affected population and the total barangay population (Column G)
- A sample computation of exposure is presented below (refer to table 3.4.2a).
- Note: Columns H-M are the gathered sensitivity indicators in the exposure database.

Figure 3.4.2a Sample Population Exposure to Sea Level Rise, Municipality of Opol





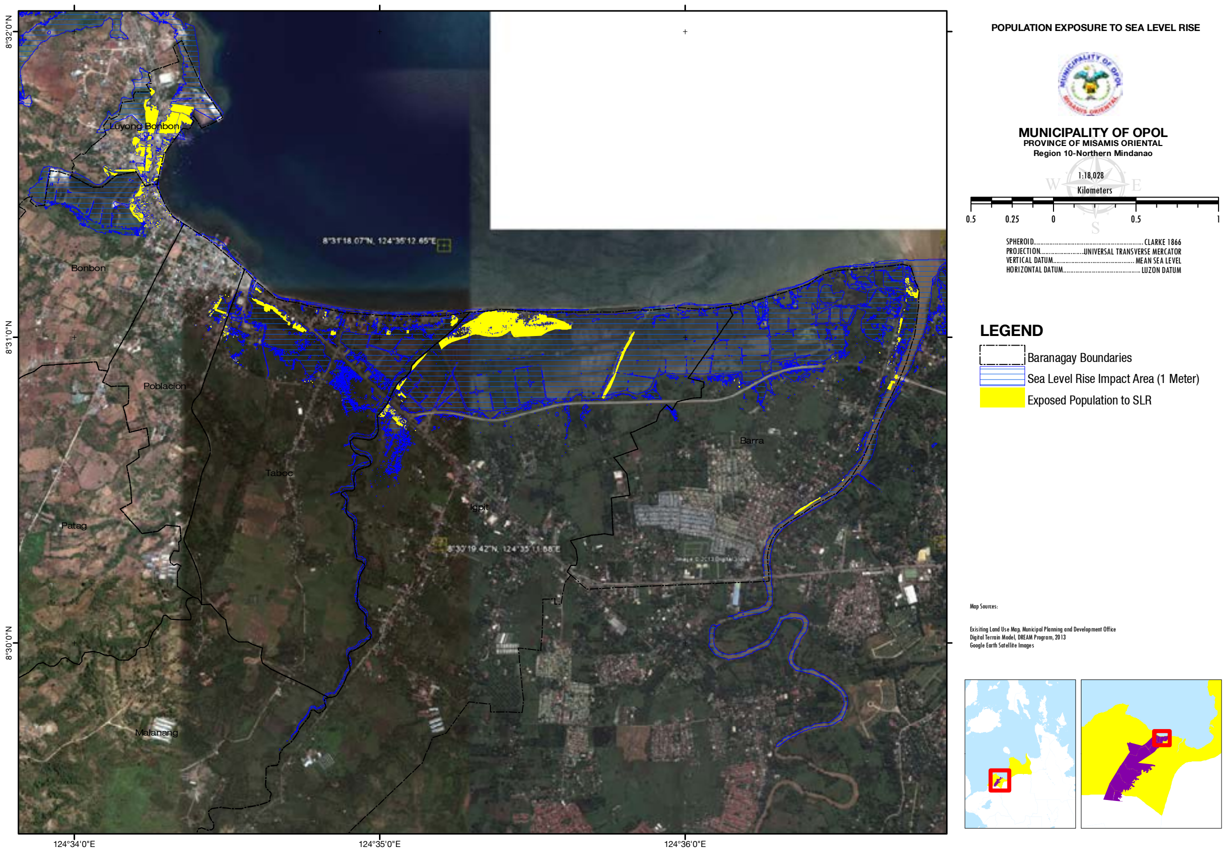


Table 3.4.2a Sample Population Exposure Estimation

A	B	C	D	E	F	G	H	I	J	K	L	M
	EXPOSURE						SENSITIVITY					
Barangay	Barangay Population	Estimated Residential Area (Hectares)	Population Density per Hectare of Residential Area (Persons/ Hectare)[1]	Affected Area (Hectares)[2]	Exposed Population[3]	Exposure Percentage	Percentage of Informal Settlers	Percentage of Population Living in Dwelling Units with Walls Made from Light to Salvageable Materials	Percentage of Young and Old Dependents	Percentage of Persons with Disabilities	Percentage of Households Living Below the Poverty Threshold	Percentage Malnourished Individuals
			B / C		D x E	I / E						
Barra	13,040	51.94	251.06	0.54	136	1.04%	1.06%	0.84%	33.58%	0.70%	14.55%	0.61%
Bonbon	3,008	11.34	265.19	0.99	263	8.73%	3.13%	5.06%	34.31%	1.01%	35.86%	2.20%
Igpit	9,628	58.72	163.98	7.29	1,195	12.42%	7.27%	1.75%	36.30%	0.70%	27.16%	1.06%
Luyong Bonbon	3,768	13.48	279.58	5.25	1,468	38.95%	2.00%	8.55%	35.43%	0.40%	41.51%	1.80%
Poblacion	3,369	14.53	231.84	0.36	83	2.48%	4.06%	6.08%	32.24%	2.23%	21.30%	1.50%
Taboc	2,868	12.75	224.92	0.93	209	7.29%	4.45%	8.74%	35.67%	0.89%	31.29%	0.59%

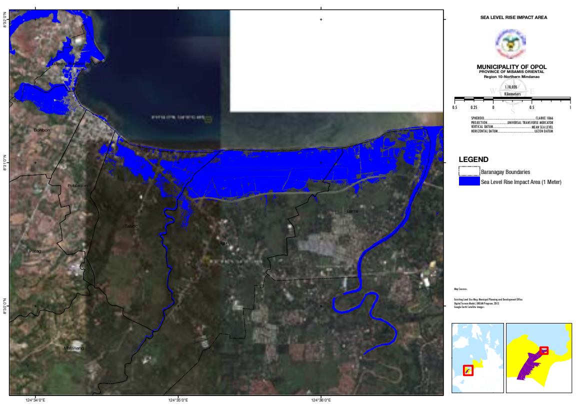
[1] Residential Area Population Density derived by dividing the estimated population and residential areas.
[2] Estimated exposed areas expressed in hectares are GIS derived.
[3] Estimated affected population derived from multiplying the exposed areas by the estimated Residential area to population Density.
[4] Exposure percentage derived by dividing the estimated exposed population to the barangay population

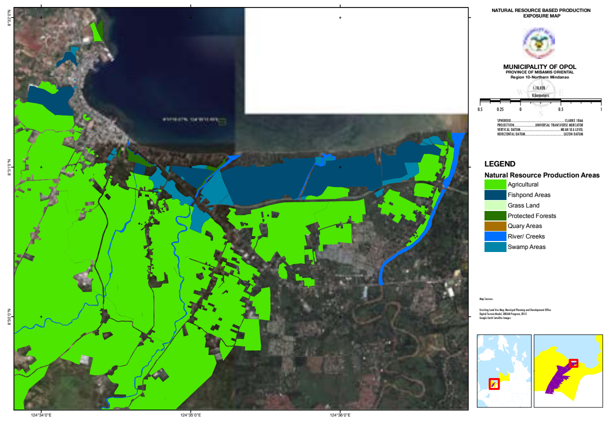
Sub-task 4.2.2 Determine Natural Resource-based Production Area Exposure

Similar to population exposure, overlay the natural resource-based production area exposure map prepared in Step 3 (exposure database) with the impact area (refer to Figure 3.4.2b). The impact area map will be used to determine the extent of area exposed by type of natural resource-based production area per barangay. Based on the map overlaying, the estimated exposed elements can be computed and summarized, including the sensitivity and adaptive capacity attributes of the elements exposed (refer to Table 3.4.2b). Proceed and compute for the estimated affected area and value, including the exposure percentage:

- Estimate the exposed natural resource-based production areas per barangay in hectares (Column D);
- Determine the exposure percentage of exposed natural resource-based production area relative to the total area allocation by dividing the exposed area and the barangay allocation by dominant crop (Column E);
- Compute for the exposed value by multiplying the estimated flooded area by the estimated average annual output per hectare (Column G);
- Note: Columns H-M are the gathered sensitivity indicators in the exposure database;
- Sample computation is presented below (refer to Table 3.4.2b).

Figure 3.4.2b Sample Natural Resource-based Production Area Exposure Map to Sea Level Rise, Municipality of Opol





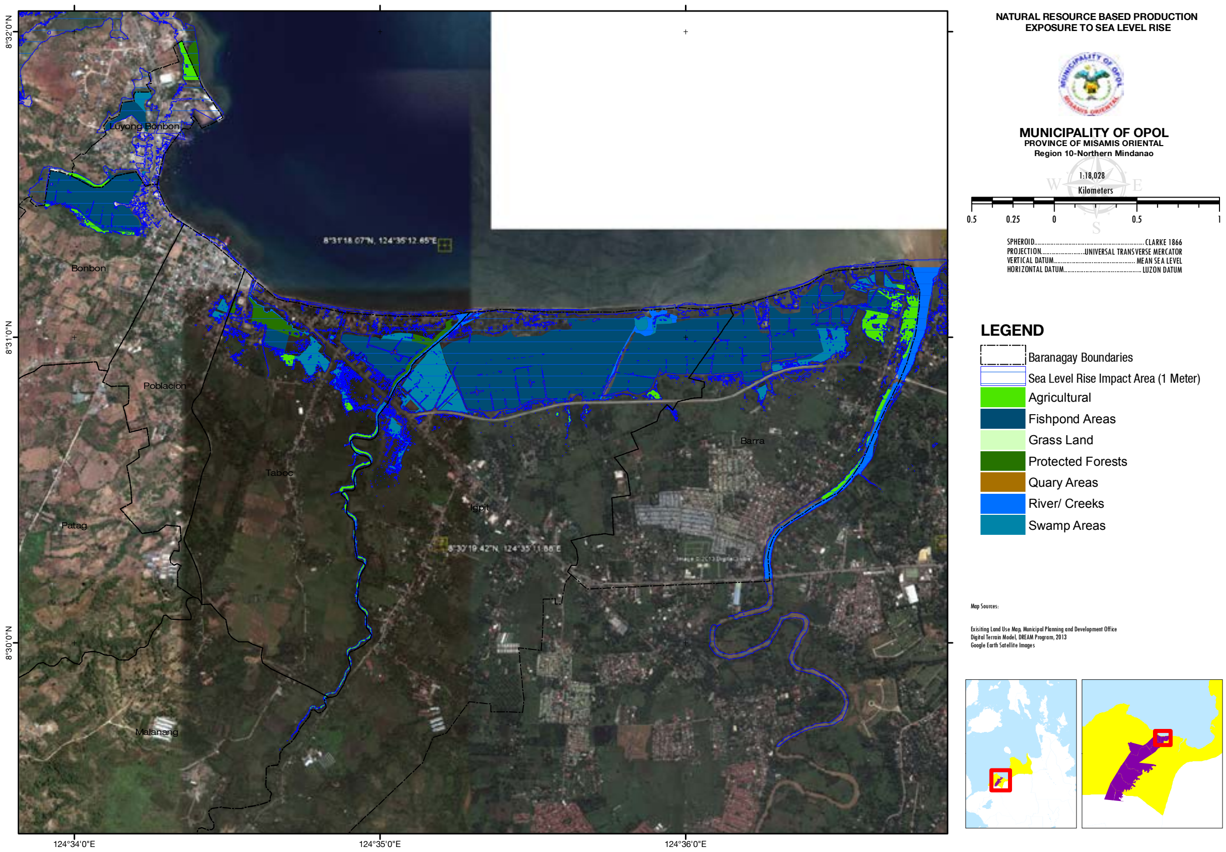


Table 3.4.2b Sample Natural Resource Production Area Exposure Table

A	B	C	D	E	F	G	H	I	J	K	L	M
EXPOSURE							SENSITIVITY					
Barangay	Area by Dominant Crop (Hectares)	Dominant Crop	Exposed Area[1] (Hectares)	Exposure Percentage[2]	Average potential income per hectare per year (PHP)	Exposed Value (Php)[3]	Number of Farming Families who Attended Climate Field School	Percentage of Farming Families Using Sustainable Production Techniques	Percentage of Famers with Access to Hazard Information	Number of Production Areas with Infrastructure Coverage	Percentage Areas with Irrigation Coverage	Percentage Areas with Water Impoundment
				D / B		F x D						
Barra	58.66	Vegetable	6.88	11.73%	150,000.00	1,032,000	NONE	0%	27%	NONE	0%	0%
Bonbon	108.93	Rice	0.93	0.85%	91,605.00	85,193	NONE	0%	100%	NONE	0%	0%
Igpit	281.75	Rice	1.51	0.54%	91,605.00	138,324	NONE	4%	20%	NONE	40%	20%
Luyong Bonbon	3.75	Corn	1.63	43.47%	70,200.00	114,426	NONE	0%	35%	NONE	0%	0%
Malanang	1,750.28	Rice	0.18	0.01%	91,605.00	16,489	NONE	2%	35%	NONE	36%	0%
Taboc	149.28	Rice	2.31	1.55%	91,605.00	211,608	NONE	15%	35%	NONE	35%	30%
Barra	30.67	Tilapia/Bangus	25.90	84.45%	32,843	850,634	NONE	0%	27%	NONE	100%	0%
Bonbon	13.56	Tilapia/Bangus	12.91	95.21%	32,843	424,003	NONE	0%	100%	NONE	100%	0%
Igpit	64.32	Tilapia/Bangus	61.35	95.38%	32,843	2,014,918	NONE	0%	20%	NONE	100%	20%
Luyong Bonbon	2.46	Tilapia/Bangus	2.13	86.59%	32,843	69,956	NONE	0%	35%	NONE	100%	0%
Taboc	9.40	Tilapia/Bangus	8.47	90.11%	32,843	278,180	NONE	0%	35%	NONE	100%	30%

[1] Estimated exposed areas expressed in hectares based on overlay is GIS derived
[2] Exposure percentage derived by dividing the affected area by the total barangay allocation
[3] Estimated affected value derived by multiplying average output per hectare with the affected area.

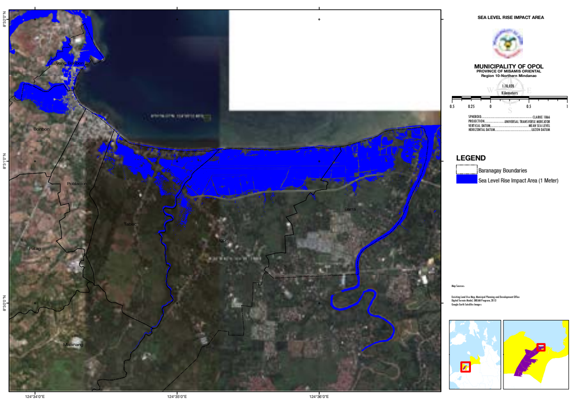
Sub-task 4.2.3 Determine Urban Use Area Exposure

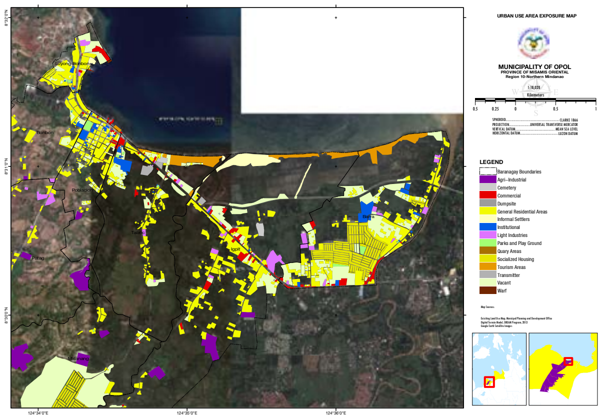
Overlay the urban use area exposure map prepared in Step 3 with the impact area map to determine the extent of area exposure by type of land use category (refer to Figure 3.4.2c). Based on the map overlaying, the estimated exposed area can be determined, including other exposure statistics and summarized, including the sensitivity and adaptive capacity attributes of the elements exposed (refer to Table 3.4.2c).

Proceed and compute for the estimated exposed area and value, including the exposure percentage:

- Estimate exposed area per urban use area per barangay in hectares (Column D);
- Determine the exposure percentage of affected urban use area relative to the total barangay allocation by dividing the affected population and the total barangay population (Column E);
- Compute for the exposed value by multiplying the estimated flooded area by the estimated replacement cost per square meter multiplied by 10,000 (Column G);
- Note: Columns H-K are the gathered sensitivity indicators in the exposure database;
- Sample computation is presented below (refer to table 3.4.2c).

Figure 3.4.2c Sample Urban Use Areas Exposure Map to Sea Level Rise, Municipality of Opol





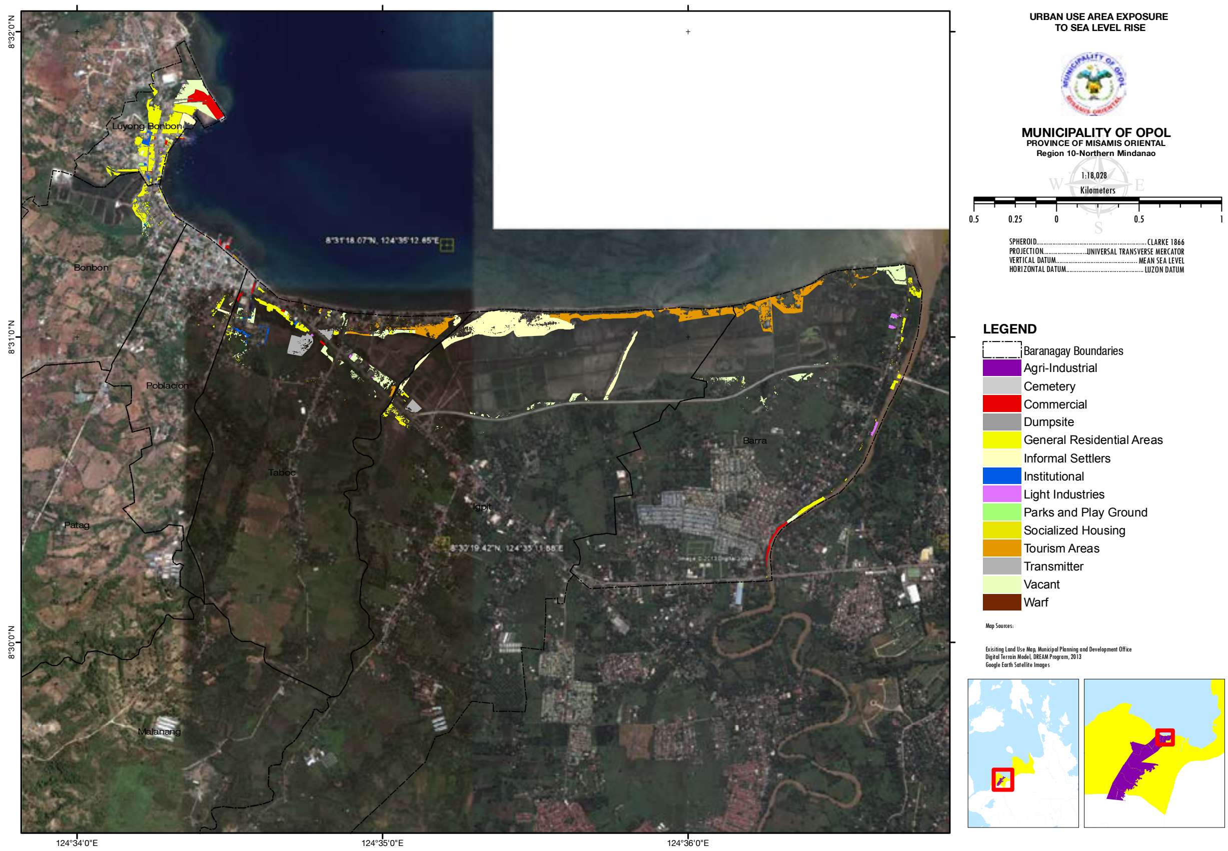


Table 3.4.2c Sample Urban Use Area Exposure to Seal Level Rise, Municipality of Opol

A	B	C	D	E	F	G	H	I	J	K
EXPOSURE							SENSITIVITY			
Barangay	Existing Land Use (Specific Use)	Area per land use Category in Hectares	Exposed Area in Hectares [1]	% Exposure [2]	Replacement Cost per Sq. Meter(PHP)	Exposed Value (PHP) [3]	Percentage of Buildings with Walls with Light to Salvageable Materials	Percentage of Buildings in Dilapidated/ Condemned Condition	Percentage of Structures Not Employing Hazard-Resistant Building Design	No Access/Area Coverage to Infrastructure-Related Hazard Mitigation Measures
				D / C		**D x 10000 x F**				
Igpit	Residential - Informal Settlements	9.48	9.29	98%	3,543	329,027,781	Very High	High	Very High	Very High
Luyong Bonbon	Residential - Informal Settlements	0.63	0.55	88%	3,543	19,660,107	Very High	High	Very High	Very High
Poblacion	Residential - Informal Settlements	0.15	0.15	98%	3,543	5,186,952	Very High	High	High	Very High
Taboc	Residential - Informal Settlements	0.20	0.20	100%	3,543	7,061,199	Very High	Moderate	High	Very High
Bonbon	Residential Areas	11.34	4.30	38%	5,400	232,378,046	High	Moderate	Moderate	Very High
Igpit	Residential Areas	35.84	9.37	26%	5,400	505,674,413	High	Moderate	High	Very High
Luyong Bonbon	Residential Areas	12.85	7.51	58%	5,400	405,678,850	Moderate	Moderate	Moderate	Very High
Poblacion	Residential Areas	14.39	4.47	31%	5,400	241,184,827	Low	Low	Moderate	Very High
Taboc	Residential Areas	12.55	8.33	66%	5,400	449,998,931	Low	Low	High	Very High

[1] Estimated exposed areas expressed in hectares based on hazard overlay is GIS derived
[2] Exposure percentage derived by dividing the affected area by the total barangay allocation
[3] Estimated exposed value derived by multiplying replacement cost per square meter and the estimated exposed area in hectares multiplied by 10000 (one hectare = 10000 sq. meters).

Sub-task 4.2.4 Determine Critical Point Facility Exposure

Overlay the critical point facility exposure map prepared in Step 3 with the impact area map to determine the exposed critical point facilities (refer to Figure 3.4.2d). Based on the map overlaying, the estimated exposed critical points can be determined and summarized, including the sensitivity and adaptive capacity attributes of the elements exposed (refer to Table 3.4.2d).

Figure 3.4.2d Sample Critical Point Facilities Exposure Map to Sea Level Rise, Municipality of Opol

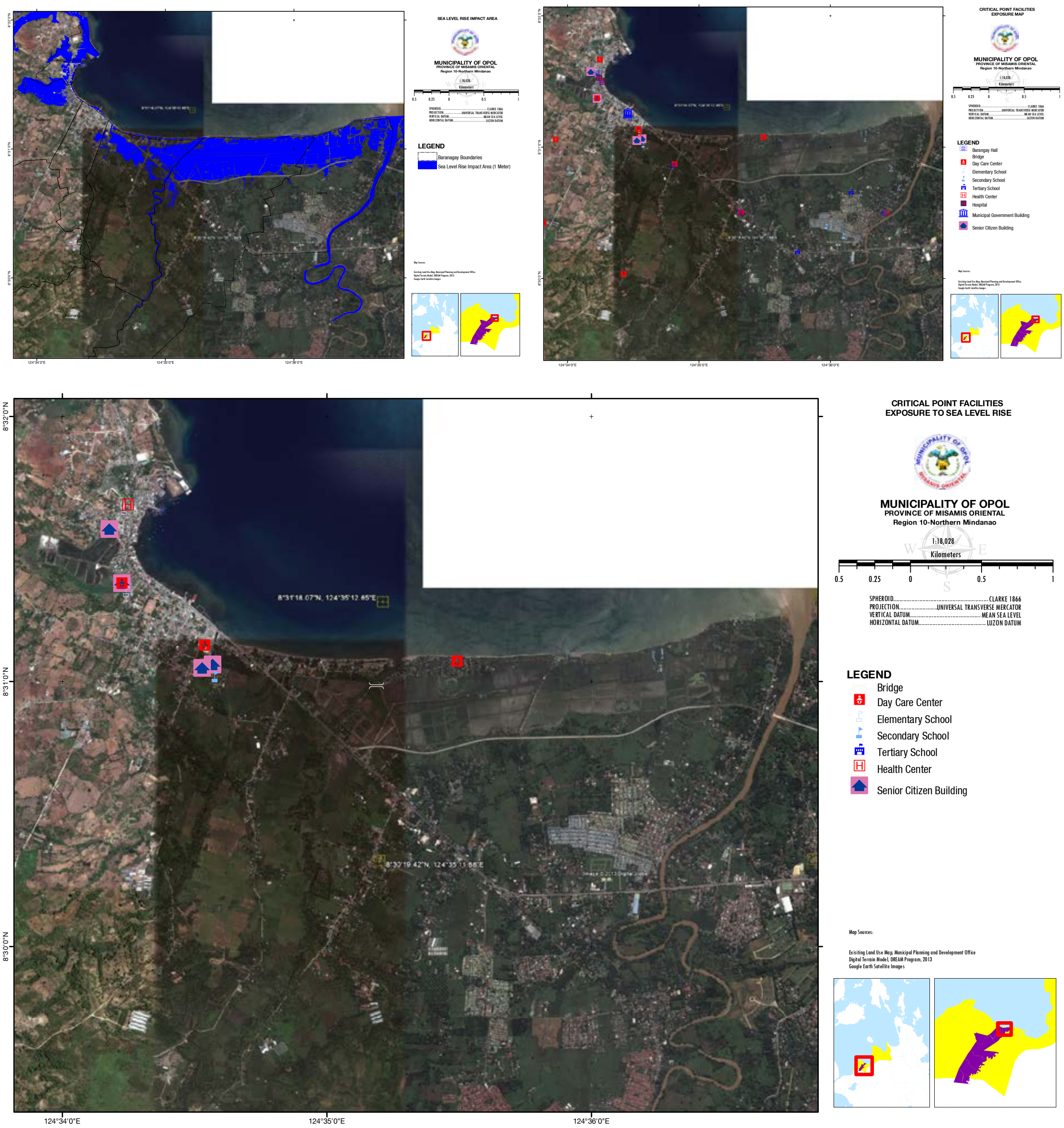


Table 3.4.2d Critical Point Facilities Exposure to Sea Level Rise, Municipality of Opol

A	B	C	D	E	F	G	H	I
EXPOSURE						SENSITIVITY		
Barangay	Type	Name	Storeys	Area	Capacity (Classrooms, Bed Capacity, Loading Capacity)	Wall Materials Used	Existing Condition	Structure Employing Hazard Resistant Design
Taboc	Senior Citizen Building	Temp. OCC School	1	50 sq meters		Concrete	Good	No
Bonbon	Senior Citizen Building	Bonbon Senior Citizen	2	50 sq meters		Mixed	Poor/needs major repair	No
Luyong Bonbon	Senior Citizen Building	Luyong Bonbon Senior Citizen	1	50 sq meters		Concrete	Good	Yes
Taboc	Senior Citizen Building	Senior Citizen	1	50 sq meters		Concrete	Needs repair	No
Taboc	Secondary School	ONSTS	2	10.01 Hectares		Concrete	Needs repair	Yes
Luyong Bonbon	Health Center	Luyong Bonbon Health Center	1	75 sq. meters	4 Bed Capacity	Wood	Poor	No
Igpit	Foot Bridge	Bungcalalan Foot Bridge	N/A		3 Tons	Steel Centered Cable Wire	Needs minor repair	No
Bonbon	Elementary School	Opol Grace Christian School	1	10000 sq meters	6 Classrooms	Wood	needs repair	No
Luyong Bonbon	Elementary School	Luyong Bonbon Elementary School	1	4845 sq. meters	8 Classrooms	Concrete	needs repair	No
Igpit	Day Care Center	Day Care Center	1	50 sq meters		Concrete	Poor	No
Taboc	Day Care Center	Poblacion Day Care Center	1	100 sq meters		Concrete	Good	No
Bonbon	Day Care Center	Luyong Bonbon Day Care Center	2	50 sq meters		Mixed	Poor/needs major repair	No

Sub-task 4.2.5 Lifeline Utilities

Exposure can be expressed in the linear kilometers exposed and the construction cost/ replacement values. At the minimum, LGUs can limit exposure to major or significant access/ distribution networks (refer to Figure 3.4.2e).

- Estimate the length of exposed length per segment per susceptibility level in kilometers (Column D);
- Compute for the exposed value by multiplying the estimated exposed segment with the estimated replacement cost per linear kilometer (Column E);
- Note: Columns F-H are the gathered sensitivity indicators in the exposure database;
- Sample computation is presented below (refer to Table 3.4.2e).

Figure 3.4.2e Sample Lifeline Utilities Exposure Map to Sea Level Rise, Municipality of Opol

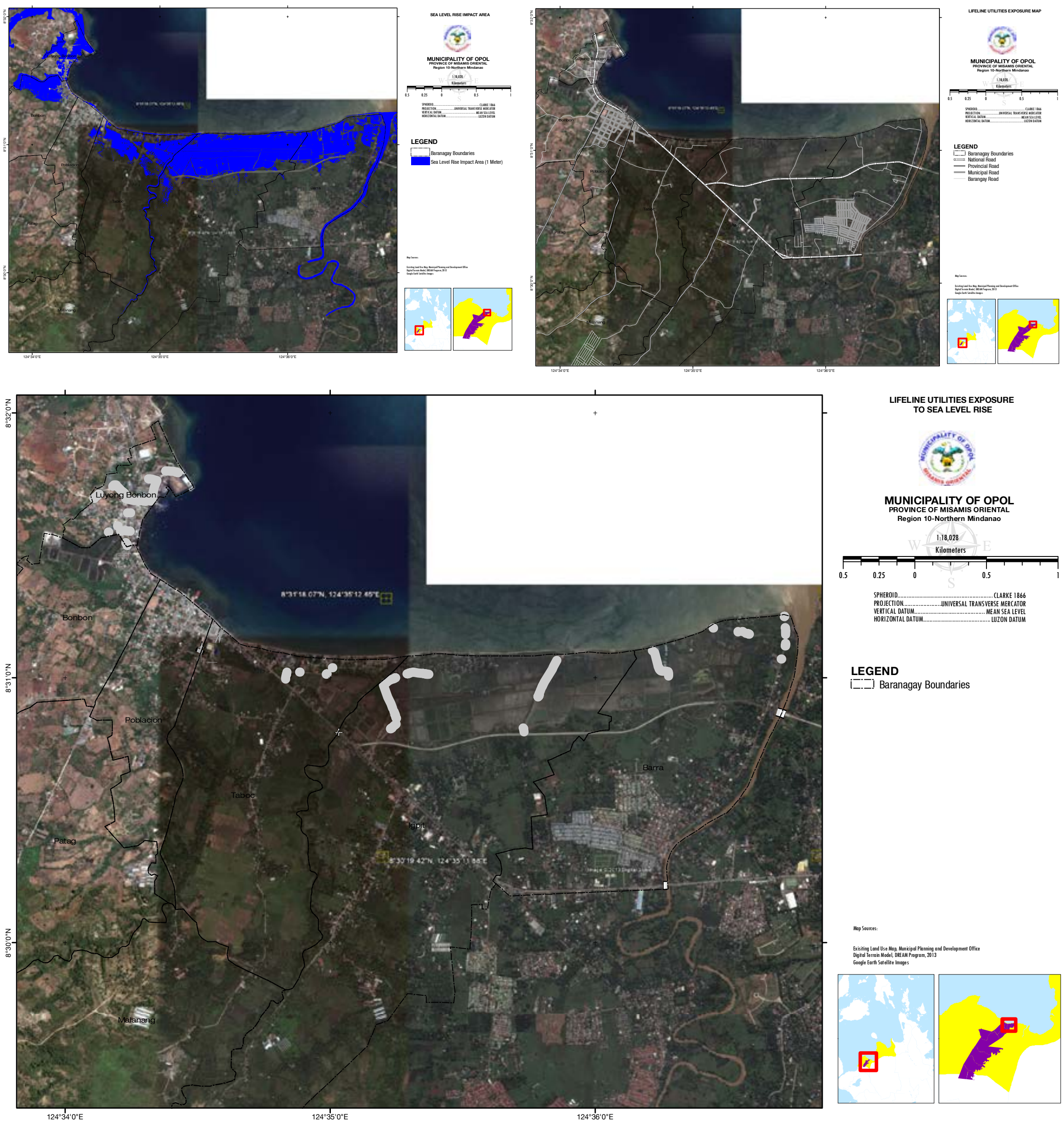


Table 3.4.2e Lifeline Utilities Exposure to Sea Level Rise, Municipality of Opol

A	B	C	D	E	F	G	H
EXPOSURE					SENSITIVITY		
Road Name	Road Classification	Replacement Cost per linear kilometer	Exposed length (Linear Kilometers)[1]	Value of exposed Lifeline[2]	Surface Type	Existing Condition	Hazard Resistant Design
				G*I			
Metro Cagayan road	National road	23,000,000.00	0.03	782,000	Concrete	Good	Yes
Barra Landless Road	Barangay Road	11,036,000.00	0.29	3,145,260	Concrete/Gravel	Needs Major Repairs	No
Malingin Road	Barangay Road	11,036,000.00	0.47	5,153,812	Concrete/Gravel	Needs Major Repairs	No
Luyong Bondon Access Road	Barangay Road	18,000,000.00	0.26	4,665,060	Concrete	Needs Major Repairs	No
Poblacion to Limunda road	Provincial road	18,000,000.00	0.04	698,580	Concrete	Good	Yes
Zone 1 Road	Barangay Road	11,036,000.00	0.15	1,641,936	Concrete/Gravel	Needs Major Repairs	No
National highway to Zone 1 road	Barangay Road	11,036,000.00	0.06	611,725	Concrete	Good	No
NIA to Bible Camp Road	Barangay Road	11,036,000.00	0.20	2,196,716	Concrete/Gravel	Needs Major Repairs	No
National Road to Malingin	Barangay Road	11,036,000.00	0.27	2,979,720	Dirt Road	Poor	No

[1] Estimated exposed lifelines expressed in linear kilometers are GIS derived.

[2] Estimated affected value derived by multiplying replacement cost per linear kilometer and affected linear distance.

Task 4.3 Conduct a Sensitivity Analysis and describe the Potential Impacts

Given the exposed units, LGUs can further describe the intrinsic characteristics of the exposed elements using the gathered sensitivity indicators in the exposure database. Analyze the sensitivity indicators and determine important ones that contribute to the area/element sensitivity to the expected climate stimuli. Discuss among the group the potential impacts and expound further the identified impacts and impact chains prepared in Step 2 (scoping the potential impacts of disasters and climate change). This shall facilitate the rating of the degree of impact in the succeeding step.

Task 4.4 Rate the Degree of Impact

Based on the estimated exposure, the degree of sensitivities of the exposed units, and identified potential impacts, qualitatively determine the degree of impact score using the suggested rating scale (see Table 3.4.3). The impact rating represents the level and kind of impacts the system is likely to experience, and time and resources needed for interventions to return to pre-impact levels.

LGUs can organize workshop sessions and seek the participation of local stakeholders, members of the Planning and Development Council (C/MPDC), representatives/experts from mandated hazard mapping related agencies and representatives from the Disaster Risk Reduction and Management Office. Participants shall be asked to give their subjective degree of impact scores (Table 3.4.4a), guided by the information on exposure, sensitivity, and list of potential impacts. Estimating the degree of damage can be qualitatively assigned using the degree of impact score. The final composite degree of damage score will be the average of scores derived, representing the consensus of the participants. Assign the degree of impact score for population, urban use areas, natural resource production area, critical points, and lifeline infrastructure (refer to Tables 3.4.4a to 3.4.4e).

Table 3.4.3 Degree of Impact Score

Degree of Impact	Degree of Impact Score	Description
High	3	Estimated direct impacts in terms of number of fatalities, injuries and value of property damage will be disastrous given the extent of exposure and current sensitivity of the system. Medium to long term indirect impacts will also be experienced which may affect development processes. Significant costs needed to return to pre-impact levels.
Moderate	2	Moderate direct impacts in terms of terms of number of fatalities, injuries and value of property damage are expected given the extent of exposure and current sensitivities of the system. Short to medium term indirect impacts will also be experienced which may affect development processes. Medium to low cost needed to return to pre-impact levels within a short to medium time period.
Low	1	Estimated direct and indirect impacts are low to negligible which can be felt within a short term period. Minimal impacts to development processes and no significant cost needed to return to pre-impact levels.

Table 3.4.4a Population Degree of Impact Rating to Sea Level Rise, Municipality of Opol

A	E	F	G	H	I	J	K	L	M	N	O	P	Q
EXPOSURE				SENSITIVITY						IMPACT			
Barangay	Affected Area (Hectares) [2]	Exposed Population [3]	Exposure Percentage	Percentage of Informal Settlers	Percentage of Population Living in Dwelling Units with Walls Made from Light to Salvageable Materials	Percentage of Young and Old Dependents	Percentage of Persons with Disabilities	Percentage of Households Living Below the Poverty Threshold	Percentage Malnourished Individuals	Degree of Impact			
										Group 1	Group 2	Group 3	Average
Barra	0.54	136	1.04%	1.06%	0.84%	33.58%	0.70%	14.55%	0.61%	3	3	3	3.00
Bonbon	0.99	263	8.73%	3.13%	5.06%	34.31%	1.01%	35.86%	2.20%	3	2	3	2.67
Igpit	7.29	1,195	12.42%	7.27%	1.75%	36.30%	0.70%	27.16%	1.06%	3	2	3	2.67
Luyong Bonbon	5.25	1,468	38.95%	2.00%	8.55%	35.43%	0.40%	41.51%	1.80%	3	3	2	2.67
Poblacion	0.36	83	2.48%	4.06%	6.08%	32.24%	2.23%	21.30%	1.50%	3	2	3	2.67
Taboc	0.93	209	7.29%	4.45%	8.74%	35.67%	0.89%	31.29%	0.59%	2	3	3	2.67

Note: Columns N-P are the assigned scores per group. Column Q represents the average of group scores which will represent the consensus degree of impact score

Table 3.4.4b Natural Resource based Production Areas, Degree of Impact Rating to Sea Level Rise, Municipality of Opol

A	C	D	E	G	H	I	J	K	L	M	N	O	P	Q
EXPOSURE					SENSITIVITY						IMPACT			
Barangay	Dominant Crop	Exposed Area[1] (Hectares)	Exposure Percentage[2]	Exposed Value (Php)[3]	Number of Farming Families who Attended Climate Field School	Percentage of Farming Families Using Sustainable Production Techniques	Percentage of Famers with Access to Hazard Information	Number of Production Areas with Infrastructure Coverage	Percentage Areas with Irrigation Coverage	Percentage Areas with Water Impoundment	Degree of Impact			
											Group 1	Group 2	Group 3	Average
Barra	Vegetable	25.76	43.92%	3,864,570	NONE	0%	27%	NONE	0%	0%	3	3	3	3.00
Bonbon	Rice	5.20	4.77%	476,080	NONE	0%	100%	NONE	0%	0%	3	3	3	3.00
Igpit	Rice	34.29	12.17%	3,141,346	NONE	4%	20%	NONE	40%	20%	3	3	3	3.00
Luyong Bonbon	Corn	1.52	40.51%	106,655	NONE	0%	35%	NONE	0%	0%	3	3	3	3.00
Malanang	Rice	0.25	0.01%	22,800	NONE	2%	35%	NONE	36%	0%	3	3	3	3.00
Taboc	Rice	22.06	14.78%	2,020,678	NONE	15%	35%	NONE	35%	30%	3	3	3	3.00
Barra	Tilapia/Bangus	30.67	100.01%	1,007,446	NONE	0%	27%	NONE	100%	0%	3	2	3	2.67
Bonbon	Tilapia/Bangus	13.56	99.98%	445,246	NONE	0%	100%	NONE	100%	0%	2	2	2	2.00
Igpit	Tilapia/Bangus	64.20	99.81%	2,108,376	NONE	0%	20%	NONE	100%	20%	3	2	3	2.67
Luyong Bonbon	Tilapia/Bangus	2.46	99.94%	80,748	NONE	0%	35%	NONE	100%	0%	2	2	2	2.00
Taboc	Tilapia/Bangus	9.40	100.01%	308,744	NONE	0%	35%	NONE	100%	30%	3	3	2	2.67

Note: Columns N-P are the assigned scores per group. Column Q represents the average of group scores which will represent the consensus degree of impact score

Table 3.4.4c Urban Use Area, Degree of Impact Rating to Sea Level Rise, Municipality of Opol

A	B	D	E	G	H	I	J	K	L	M	N	O
	EXPOSURE				SENSITIVITY				IMPACT			
Barangay	Land Use Category	Exposed Area in Hectares [1]	% Exposure [2]	Exposed Value (PHP) [3]	Percentage of Buildings with Walls with Light to Salvageable Materials	Percentage of Buildings in Dilapidated/ Condemned Condition	Percentage of Structures Not Employing Hazard-Resistant Building Design	No Access/Area Coverage to Infrastructure-Related Hazard Mitigation Measures	Degree of Impact			
									Group 1	Group 2	Group 3	Average
Igpit	Informal Settlers	9.29	98%	329,027,781	Very High	High	Very High	Very High	3	2	3	2.67
Luyong Bonbon	Informal Settlers	0.55	88%	19,660,107	Very High	High	Very High	Very High	2	3	3	2.67
Poblacion	Informal Settlers	0.15	98%	5,186,952	Very High	High	High	Very High	2	3	3	2.67
Taboc	Informal Settlers	0.20	100%	7,061,199	Very High	Moderate	High	Very High	3	2	3	2.67
Bonbon	General Residential Areas	4.30	38%	232,378,046	High	Moderate	Moderate	Very High	3	2	3	2.67
Igpit	General Residential Areas	9.37	26%	505,674,413	High	Moderate	High	Very High	3	3	3	3.00
Luyong Bonbon	General Residential Areas	7.51	58%	405,678,850	Moderate	Moderate	Moderate	Very High	1	1	1	1.00
Poblacion	General Residential Areas	4.47	31%	241,184,827	Low	Low	Moderate	Very High	1	1	2	1.33
Taboc	General Residential Areas	8.33	66%	449,998,931	Low	Low	High	Very High	1	1	1	1.00

Note: Columns L-N are the assigned scores per group. Column O represents the average of group scores which will represent the consensus degree of impact score

Table 3.4.4d Critical Point Facilities, Degree of Impact Rating to Sea Level Rise, Municipality of Opol

A	B	C	D	E	F	G	H	I	J	K	L	M
EXPOSURE						SENSITIVITY			IMPACT			
Barangay	Type	Name	Storeys	Area	Capacity (Classrooms , Bed Capacity, Loading Capacity)	Wall Materials Used	Existing Condition	Structure Employing Hazard Resistant Design	Degree of Impact			
									Group 1	Group 2	Group 3	Average
Bonbon	Senior Citizen Building	Bonbon Senior Citizen	2	50 sq meters		Mixed	Poor/needs major repair	No	3	3	2	2.67
Bonbon	Elementary School	Opol Grace Christian School	1	10000 sq meters	6 Classrooms	Wood	needs repair	No	2	2	3	2.33
Bonbon	Day Care Center	Luyong Bonbon Day Care Center	2	50 sq meters		Mixed	Poor/needs major repair	No	3	3	3	3.00
Igpit	Foot Bridge	Bungcalalan Foot Bridge	N/A		3 Tons	Steel Centered Cable Wire	Needs minor repair	No	3	3	3	3.00
Igpit	Day Care Center	Day Care Center	1	50 sq meters		Concrete	Poor	No	3	3	2	2.67
Luyong Bonbon	Senior Citizen Building	Luyong Bonbon Senior Citizen	1	50 sq meters		Concrete	Good	Yes	2	2	2	2.00
Luyong Bonbon	Health Center	Luyong Bonbon Health Center	1	75 sq. meters	4 Bed Capacity	Wood	Poor	No	3	3	3	3.00
Luyong Bonbon	Elementary School	Luyong Bonbon Elementary School	1	4845 sq. meters	8 Classrooms	Concrete	needs repair	No	2	2	2	2.00
Taboc	Senior Citizen Building	Temp. OCC School	1	50 sq meters		Concrete	Good	No	1	1	1	1.00
Taboc	Senior Citizen Building	Senior Citizen	1	50 sq meters		Concrete	Needs repair	No	1	1	2	1.33
Taboc	Secondary School	ONSTS	2	10.01 Hectares		Concrete	Needs repair	Yes	1	1	1	1.00
Taboc	Day Care Center	Poblacion Day Care Center	1	100 sq meters		Concrete	Good	No	1	1	1	1.00

Note: Columns J-L are the assigned scores per group. Column M represents the average of group scores which will represent the consensus degree of impact score

Table 3.4.4e Lifeline Utilities, Degree of Impact Rating to Sea Level Rise, Municipality of Opol

A	B	D	E	F	G	H	I	J	K	L
	EXPOSURE			SENSITIVITY			IMPACT			
Name	Classification	Exposed length (Linear Kilometers)[1]	Value of exposed Lifeline[3]	Surface Type	Existing Condition	Hazard Resistant Design	Degree of Impact			
							Group 1	Group 2	Group 3	Average
Metro Cagayan road	National road	0.0340	782,000	Concrete	Good	Yes	1	1	1	1.00
Barra Landless Road	Barangay Road	0.2850	3,145,260	Concrete/ Gravel	Needs Major Repairs	No	3	3	2	2.67
Malingin Road	Barangay Road	0.4670	5,153,812	Concrete/ Gravel	Needs Major Repairs	No	3	3	3	3.00
Luyong Bondon Access Road	Barangay Road	0.2592	4,665,060	Concrete	Needs Major Repairs	No	3	3	3	3.00
Poblacion to Limunda road	Provincial road	0.0388	698,580	Concrete	Good	Yes	1	1	1	1.00
Zone 1 Road	Barangay Road	0.1488	1,641,936	Concrete/ Gravel	Needs Major Repairs	No	2	2	2	2.00
National highway to Zone 1 road	Barangay Road	0.0554	611,725	Concrete	Good	No	1	1	1	1.00
NIA to Bible Camp Road	Barangay Road	0.1991	2,196,716	Concrete/ Gravel	Needs Major Repairs	No	3	2	2	2.33
National Road to Malingin	Barangay Road	0.2700	2,979,720	Dirt Road	Poor	No	3	3	2	2.67

Note: Columns I-K are the assigned scores per group. Column L represents the average of group scores which will represent the consensus degree of impact score

Task 4.5 Evaluate the Adaptive Capacity

Evaluate the various adaptive capacities of the system being studied by referring to the adaptive capacity indicators in the exposure database. These indicators of adaptive capacities can describe whether the system is able to accommodate or cope with the impacts with very minimal disruption or short to long term detrimental effects/impacts (refer to Table 3.4.5).

Similar to the step in assigning of degree of impact score, organize stakeholders and experts to qualitatively assign the adaptive capacity score for each element exposed using the suggested scoring system (refer to Table 3.4.5). Low adaptive capacities can be described as systems/areas where the transformation/adaption process will be medium to long term and far exceeds local capacities requiring national to international intervention. High adaptive capacities are areas where transformation can be implemented on the short term where the costs/resources, knowledge are within the capacities of the element exposed requiring minimal intervention from the local government (refer to Tables 3.4.5a to 3.4.5e for sample worktables).

Table 3.4.5 Adaptive Capacity Scores and Descriptions

Degree of Adaptive Capacity	Adaptive Capacity Rating[1]	Description
Low	3	The system is not flexible to accommodate changes in the climate. Addressing the impacts will be costly. The LGU and property owners will require external assistance to address the impacts.
Moderate	2	Addressing the impacts will require significant cost but it is still within the capacity of the system to adapt to potential impacts. It can accommodate within its resources the cost for adapting and mitigating impacts.
High	1	The system is able to accommodate changes in climate. There are adaptation measures in place to address impacts.

[1]Higher adaptive capacity is given a low rating/score while lower adaptive capacities are given higher rating/score.

Table 3.4.5a Population, Adaptive Capacity to Sea Level Rise, Municipality of Opol

A	E	F	G	Q	R	S	T	U	V	W	X	Y	Z
EXPOSURE				IMPACT	ADAPTIVE CAPACITY								
Barangay	Affected Area (Hectares) [2]	Exposed Population [3]	Exposure Percentage	Degree of Impact Score	Access to Post Disaster Financing	PhilHealth Coverage	Household Financial Capacities to Relocate or Retrofit	Government Capacity to Generate Jobs	Government Resources	Adaptive Capacity Score			
										Group 1	Group 2	Group 3	Average
Barra	0.54	136	1.04%	**3.00**	There is willingness to relocate subject to assistance from the local government. There is also willingness to retrofit existing highly vulnerable structures but may take them medium to long-term.	Majority of non-residential structures/ property owners have current property insurance coverage or have capacities to purchase within the short term. Majority of residential structures do not have property insurances	Alternative sites are still available within the municipality which can accommodate existing land uses if needed	Local government resources are very limited but funds for adaptation can be sourced from the regional and national governments or through public private partnerships.	Majority of non-residential structures can conform with added zoning regulations in the medium term. Majority of residential structures may have difficulties conforming to the added regulations and may take them, medium to long term.	3	3	3	3.00
Bonbon	0.99	263	8.73%	**2.67**						3	3	3	3.00
Igpit	7.29	1,195	12.42%	**2.67**						3	3	3	3.00
Luyong Bonbo	5.25	1,468	38.95%	**2.67**						2	2	1	1.67
Poblacion	0.36	83	2.48%	**2.67**						3	3	2	2.67
Taboc	0.93	209	7.29%	**2.67**						2	3	3	2.67

Note: Columns R-V are the the adaptive capacity indicators in the exposure database
Columns W-Y are the assigned scores per group. Column Z represents the average of group scores which will represent the consensus adaptive capacity score

Table 3.4.5b Natural Resource based Production Areas, Adaptive Capacity to Sea Level Rise, Municipality of Opol

A	C	D	E	G	Q	R	S	T	U	V	W	X	Y	Z
EXPOSURE					IMPACT	ADAPTIVE CAPACITY								
Barangay	Dominant Crop	Exposed Area[1] (Hectares)	Exposure Percentage[2]	Exposed Value (Php)[3]	Degree of Impact	Access to Insurance	Agricultural Extension Services of the Local Government	Early Warning Systems	Alternative Livelihood	Government Resources	Adaptive Capacity Score			
											Group 1	Group 2	Group 3	Average
Barra	Vegetable	6.88	11.73%	1,032,000	**3.00**	Approximately 15% of farming families can afford crop insurance. Cost sharing to cover key production areas with crop insurance can be pursued by the Local Government.	Only 37% of the farming families have access to agricultural extension services of the local government. However, the LGU has the capacity to develop and fund programs on extension to cover the remaining farming families.	Approximately 37% of farming families have access to early warning systems (EWS) related to agricultural production. However, EWS can be further improved to cover the remaining farming communities.	Only 15% of farming families have access to alternative livelihood opportunities. Current rate of job creation in the LGU is not enough to provide adequate opportunities to farming communities.	Available government resources are not enough to fund infrastructure related projects	3	3	3	3.00
Bonbon	Rice	0.93	0.85%	85,193	**3.00**						3	3	3	3.00
Igpit	Rice	1.51	0.54%	138,324	**3.00**						3	3	3	3.00
Luyong Bonbon	Corn	1.63	43.47%	114,426	**3.00**						3	2	2	2.33
Malanang	Rice	0.18	0.01%	16,489	**3.00**						3	2	3	2.67
Taboc	Rice	2.31	1.55%	211,608	**3.00**						3	3	3	3.00
Barra	Tilapia/Bangus	25.90	84.45%	850,634	**2.67**						3	3	2	2.67
Bonbon	Tilapia/Bangus	12.91	95.21%	424,003	**2.33**						2	3	2	2.33
Igpit	Tilapia/Bangus	61.35	95.38%	2,014,918	**2.67**						3	3	2	2.67
Luyong Bonbon	Tilapia/Bangus	2.13	86.59%	69,956	**2.33**						2	1	1	1.33
Taboc	Tilapia/Bangus	8.47	90.11%	278,180	**2.67**						3	3	2	2.67

Note: Columns R-V are the the adaptive capacity indicators in the exposure database
Columns W-Y are the assigned scores per group. Column Z represents the average of group scores which will represent the consensus adaptive capacity score

Table 3.4.5c Urban Use Areas, Adaptive Capacity to Sea Level Rise, Municipality of Opol

A	B	D	E	G	O	P	Q	R	S	T	U	V	W	X
EXPOSURE					IMPACT	ADAPTIVE CAPACITY								
Barangay	Land Use Category	Exposed Area in Hectares	% Exposure	Exposed Value (PHP) 3	Degree of Impact Score	Capacity and willingness to retrofit or relocate or conform with new regulations	Insurance Coverage	Available alternative sites	Government Resources	Local government capacity to impose/ implement zoning regulations	Adaptive Capacity Score			
											Group 1	Group 2	Group 3	Average
Igpit	Informal Settlers	9.29	98%	329,027,781	**2.67**	There is willingness to relocate subject to assistance from the local government. There is also willingness to retrofit existing highly vulnerable structures but may take them medium to long-term to conform to new regulations	Majority of non-residential structures/ property owners have current property insurance coverage or have capacities to purchase within the short term. Majority of residential structures do not have property insurances	Alternative sites are still available within the municipality which can accommodate existing land uses if needed	Local government resources are very limited but funds for adaptation can be sourced from the regional and national governments or through public private partnerships.	Majority of non-residential structures can conform with added zoning regulations in the medium term. Majority of residential structures may have difficulties conforming with added regulations and may take them medium to long term.	3	3	3	3.00
Luyong Bonbon	Informal Settlers	0.55	88%	19,660,107	**2.67**						3	3	3	3.00
Poblacion	Informal Settlers	0.15	98%	5,186,952	**2.67**						3	3	3	3.00
Taboc	Informal Settlers	0.20	100%	7,061,199	**2.67**						1	2	1	1.33
Bonbon	General Residential Areas	4.30	38%	232,378,046	**2.67**						3	3	3	3.00
Igpit	General Residential Areas	9.37	26%	505,674,413	**3.00**						3	3	3	3.00
Luyong Bonbon	General Residential Areas	7.51	58%	405,678,850	**1.33**						3	3	3	3.00
Poblacion	General Residential Areas	4.47	31%	241,184,827	**1.33**						2	3	1	2.00
Taboc	General Residential Areas	8.33	66%	449,998,931	**1.00**						3	3	3	3.00

Note: Columns P-T are the the adaptive capacity indicators in the exposure database
Columns U-W are the assigned scores per group. Column X represents the average of group scores which will represent the consensus adaptive capacity score

Table 3.4.5d Critical Point Facilities, Adaptive Capacity to Sea Level Rise, Municipality of Opol

A	B	C	E	M	N	O	P	Q	R	S
EXPOSURE				IMPACT	ADAPTIVE CAPACITY					
Barangay	Facility Type	Name	Area	Degree of Impact	Insurance Coverage	Available Local Government Resources	Adaptive Capacity Score			
							Group 1	Group 2	Group 3	Average
Bonbon	Senior Citizen Building	Bonbon Senior Citizen	50 sq meters	2.67	Majority of the exposed critical points (i.e. schools, rural heath units, barangay health centers and local governance buildings) are not covered by property damage insurance. Only the Barra day care centers (1 and 2) are covered by property damage insurance.	For LGU owned buildings, the LGU does not have available resources for retrofitting and relocation. However, funds can be set aside for such purposes but it may significantly affect the implementation of other local development programs and projects. Majority of the schools are either privately owned or managed by the Regional DepEd. Funds for planned adaptation (i.e. retrofitting and relocation) can be coursed through the regional agencies with possible counterpart funding from the LGU. Existing Bridges are mainly under the jurisdiction of the DPWH, retrofitting or establishment of new bridges may be coursed through DPWH.	1	1	1	1.00
Bonbon	Elementary School	Opol Grace Christian School	10000 sq meters	2.33			3	2	2	2.33
Bonbon	Day Care Center	Bonbon Day Care Center	50 sq meters	3.00			3	3	3	3.00
Igpit	Foot Bridge	Bungcalalan Foot Bridge		3.00			3	3	3	3.00
Igpit	Day Care Center	Day Care Center	50 sq meters	2.67			3	3	3	3.00
Luyong Bonbon	Senior Citizen Building	Luyong Bonbon Senior Citizen	50 sq meters	2.00			3	3	2	2.67
Luyong Bonbon	Health Center	Luyong Bonbon Health Center	75 sq. meters	3.00			2	2	3	2.33
Luyong Bonbon	Elementary School	Luyong Bonbon Elementary School	4845 sq. meters	2.00			2	1	1	1.33
Taboc	Senior Citizen Building	Temp. OCC School	50 sq meters	1.00			3	3	3	3.00
Taboc	Senior Citizen Building	Senior Citizen	50 sq meters	1.33			2	3	3	2.67
Taboc	Secondary School	ONSTS	10.01 Hectares	1.00			3	2	1	2.00
Taboc	Day Care Center	Poblacion Day Care Center	100 sq meters	1.00			3	3	3	3.00

Note: Columns N-O are the the adaptive capacity indicators in the exposure database
Columns P-R are the assigned scores per group. Column S represents the average of group scores which will represent the consensus adaptive capacity score

Table 3.4.5e Lifeline Utilities, Adaptive Capacity to Sea Level Rise, Municipality of Opol

A	B	D	E	L	M	N	O	P	Q	R
	EXPOSURE			IMPACT	ADAPTIVE CAPACITY					
Name	Classification	Exposed length (Linear Kilometers)[1]	Value of exposed Lifeline[3]	Degree of Impact	Insurance Coverage	Available Government Resources	Adaptive Capacity Score			
							Group 1	Group 2	Group 3	Average
Metro Cagayan road	National road	0.03	782,000	**1.00**	All existing roads do not have damage insurance coverage. Addressing damages are mostly done through repairs using either local government fund resources or those funded by regional line agencies.	Local Government do not have available resources to fund road improvements, and or establishment of new roads (barangay and municipal). Regional DPWH, however, has available financial resources to fund national road improvements or retrofitting within the municipality but fund availability will depend on their current priorities. Also, LGU can impose special levy taxes for projects benefiting local constituents but local capacities may not be able to pay the additional taxes.	1	1	1	1.00
Barra Landless Road	Barangay Road	0.29	570,000	**2.67**			2	1	2	1.67
Malingin Road	Barangay Road	0.47	10,741,000	**3.00**			2	1	2	1.67
Luyong Bondon Access Road	Barangay Road	0.26	4,665,060	**3.00**			2	2	2	2.00
Poblacion to Limunda road	Provincial road	0.04	698,580	**1.00**			2	2	2	2.00
Zone 1 Road	Barangay Road	0.15	2,678,040	**2.00**			2	2	1	1.67
National highway to Zone 1 road	Barangay Road	0.06	611,725	**1.00**			3	3	3	3.00
NIA to Bible Camp Road	Barangay Road	0.20	2,196,716	**2.33**			3	3	3	3.00
National Road to Malingin	Barangay Road	0.27	2,979,720	**2.67**			3	3	3	3.00

Note: Columns M-N are the the adaptive capacity indicators in the exposure database
Columns O-Q are the assigned scores per group. Column R represents the average of group scores which will represent the consensus adaptive capacity score

Task 4.6 Compute for the vulnerability index and finalize the CCVA summary table

Compute for the vulnerability index by multiplying the Impact and Adaptive Capacity Scores (refer to tables 3.4.6a-3.4.6e). Based on the computed vulnerability index, categorize the index scores into categories presented in Table 3.4.6. The vulnerability category shall indicate whether the vulnerability of the system is high or low. Areas with high vulnerability can be described as areas where the expected impacts of the climate stimuli is high, due to exposure and sensitivities, and the adaptive capacities are low to accommodate or cope with the expected impacts. Systems with low vulnerability can be described as systems where the impacts are considered high but adaptive capacities are also high.

Table 3.4.6 Vulnerability Index Scores

Degree of Impact Score	**Adaptive Capacity Score**			**Vulnerability**	**Vulnerability Index Range**
	High (1)	Moderate (2)	Low (3)		
High (3)	**3**	**6**	**9**	**High**	**>6-9**
Moderate (2)	**2**	**4**	**6**	**Moderate**	**>3-6**
Low (1)	**1**	**2**	**3**	**Low**	**≤3**

Task 4.7 Prepare Vulnerability Assessment Maps

Prepare map/s indicating the level of vulnerability of the population, natural resource-based production areas, urban use areas, critical point facilities, and lifeline utilities. These maps shall facilitate the identification of areas which should be the subject of land use related policy and program interventions. Sample output maps are presented below (refer to Figures 3.4.3a-e).

Figure 3.4.3a Sample Population Vulnerability Map to Sea Level Rise, Municipality of Opol

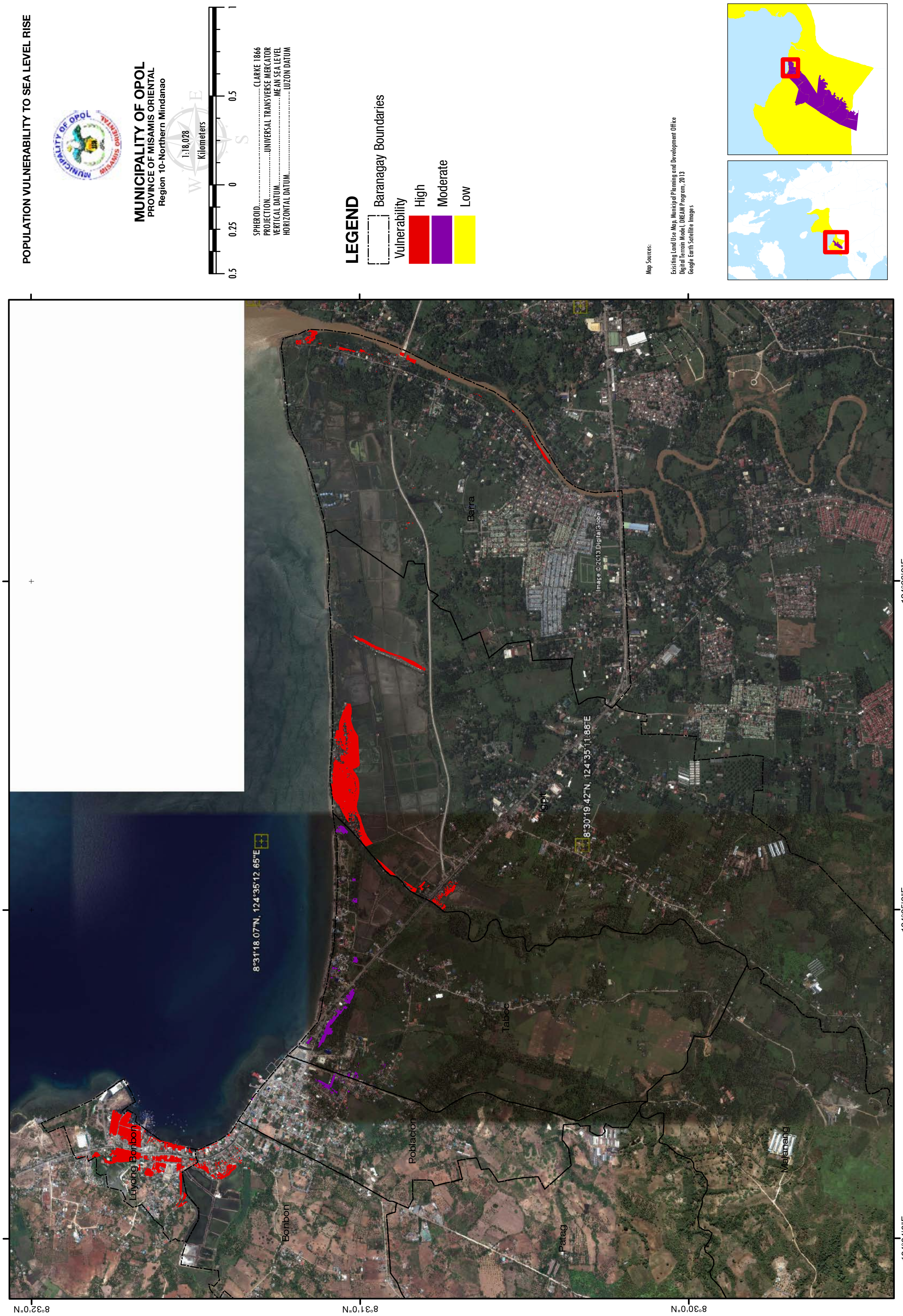


Table 3.4.6a Population Vulnerability to Sea Level Rise, Municipality of Opol

A	E	F	G	Q	Z	AA	AB
Barangay	**Affected Area (Hectares) [2]**	**Exposed Population [3]**	**Exposure Percentage**	**Degree of Impact Score**	**Adaptive Capacity Score**	**Vulnerability Index[1]**	**Vulnerability Category[2]**
						Q x Z	
Barra	0.54	136	1.04%	**3.00**	**3.00**	**9.00**	**High**
Bonbon	0.99	263	8.73%	**2.67**	**3.00**	**8.00**	**High**
Igpit	7.29	1,195	12.42%	**2.67**	**3.00**	**8.00**	**High**
Luyong Bonbon	5.25	1,468	38.95%	**2.67**	**1.67**	**4.44**	**Moderate**
Poblacion	0.36	83	2.48%	**2.67**	**2.67**	**7.11**	**High**
Taboc	0.93	209	7.29%	**2.67**	**2.00**	**5.33**	**Moderate**

[1]Vulnerability Index derived by multiplying the Degree of Impact Score (Column Q) and the Adaptive Capacity Score (Column Z)
[2]Vulnerability categorized using the suggested vulnerability index ranges in Table 3.4.6

Figure 3.4.3b Sample Natural Resource based Production Areas Vulnerability Map to Sea Level Rise, Municipality of Opol

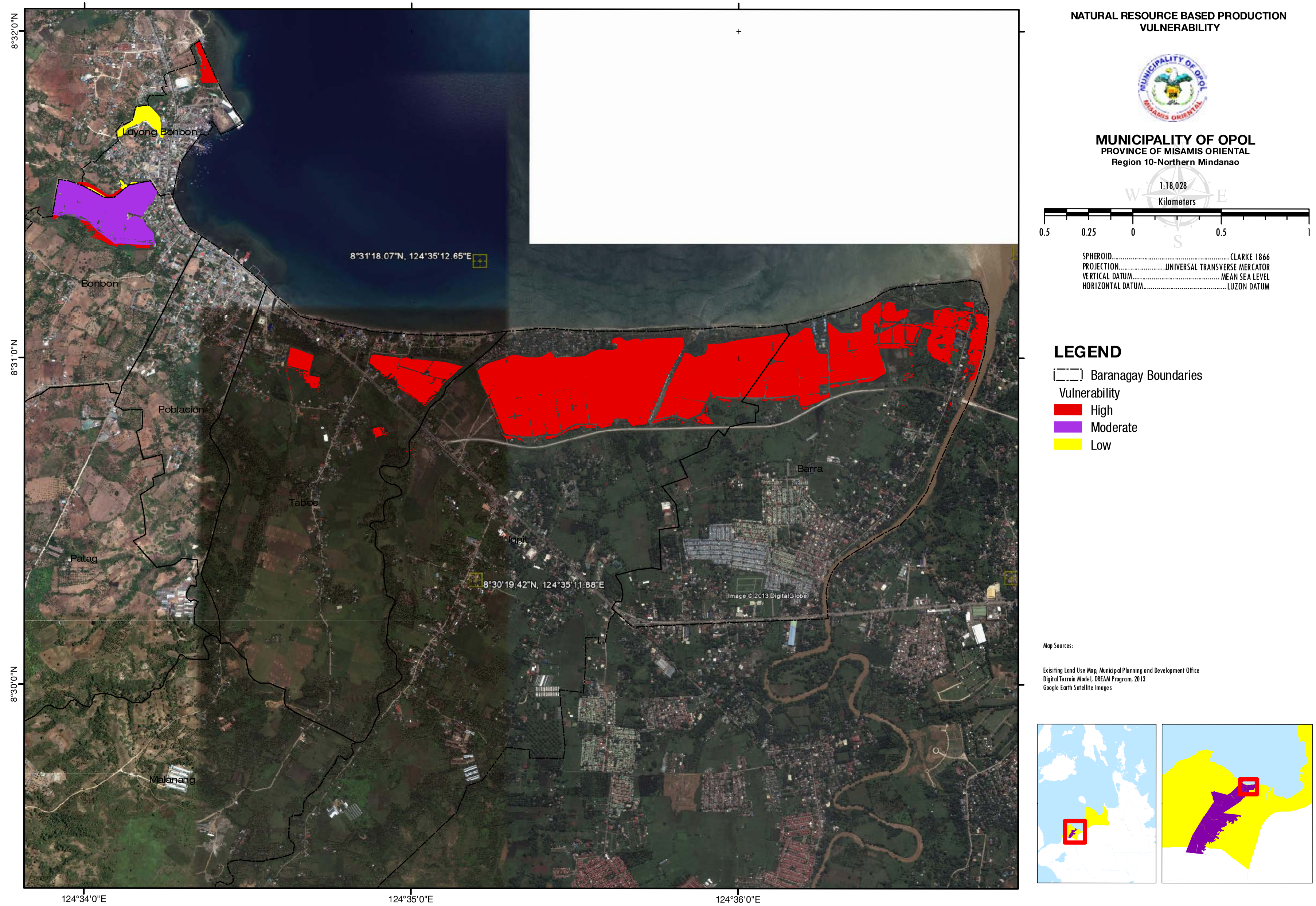


Table 3.4.6b Natural Resource based Production Areas Vulnerability to Sea Level Rise, Municipality of Opol

A	B	C	D	E	F	G	Q	Z	AA	AB
Barangay	Area by Dominant Crop (Hectares)	Dominant Crop	Exposed Area[1] (Hectares)	Exposure Percentage[2]	Average potential income per hectare per year (PHP)	Exposed Value (Php)[3]	Degree of Impact	Adaptive Capacity Score	Vulnerability Index[1]	Vulnerability Category
									Q x Z	
Barra	58.66	Vegetable	6.88	11.73%	150,000.00	1,032,000	3.00	3.00	9.00	High
Bonbon	108.93	Rice	0.93	0.85%	91,605.00	85,193	3.00	3.00	9.00	High
Igpit	281.75	Rice	1.51	0.54%	91,605.00	138,324	3.00	3.00	9.00	High
Luyong Bonbon	3.75	Corn	1.63	43.47%	70,200.00	114,426	3.00	2.33	7.00	High
Malanang	1,750.28	Rice	0.18	0.01%	91,605.00	16,489	3.00	2.67	8.00	High
Taboc	149.28	Rice	2.31	1.55%	91,605.00	211,608	3.00	3.00	9.00	High
Barra	30.67	Tilapia/Bangus	25.90	84.45%	32,843	850,634	2.67	2.67	7.11	High
Bonbon	13.56	Tilapia/Bangus	12.91	95.21%	32,843	424,003	2.00	2.33	4.67	Moderate
Igpit	64.32	Tilapia/Bangus	61.35	95.38%	32,843	2,014,918	2.67	2.67	7.11	High
Luyong Bonbon	2.46	Tilapia/Bangus	2.13	86.59%	32,843	69,956	2.00	1.33	2.67	Low
Taboc	9.40	Tilapia/Bangus	8.47	90.11%	32,843	278,180	2.67	2.67	7.11	High

[1]Vulnerability Index derived by multiplying the Degree of Impact Score (Column Q) and the Adaptive Capacity Score (Column Z)

Figure 3.4.3c Sample Urban Use Areas Vulnerability Map to Sea Level Rise, Municipality of Opol

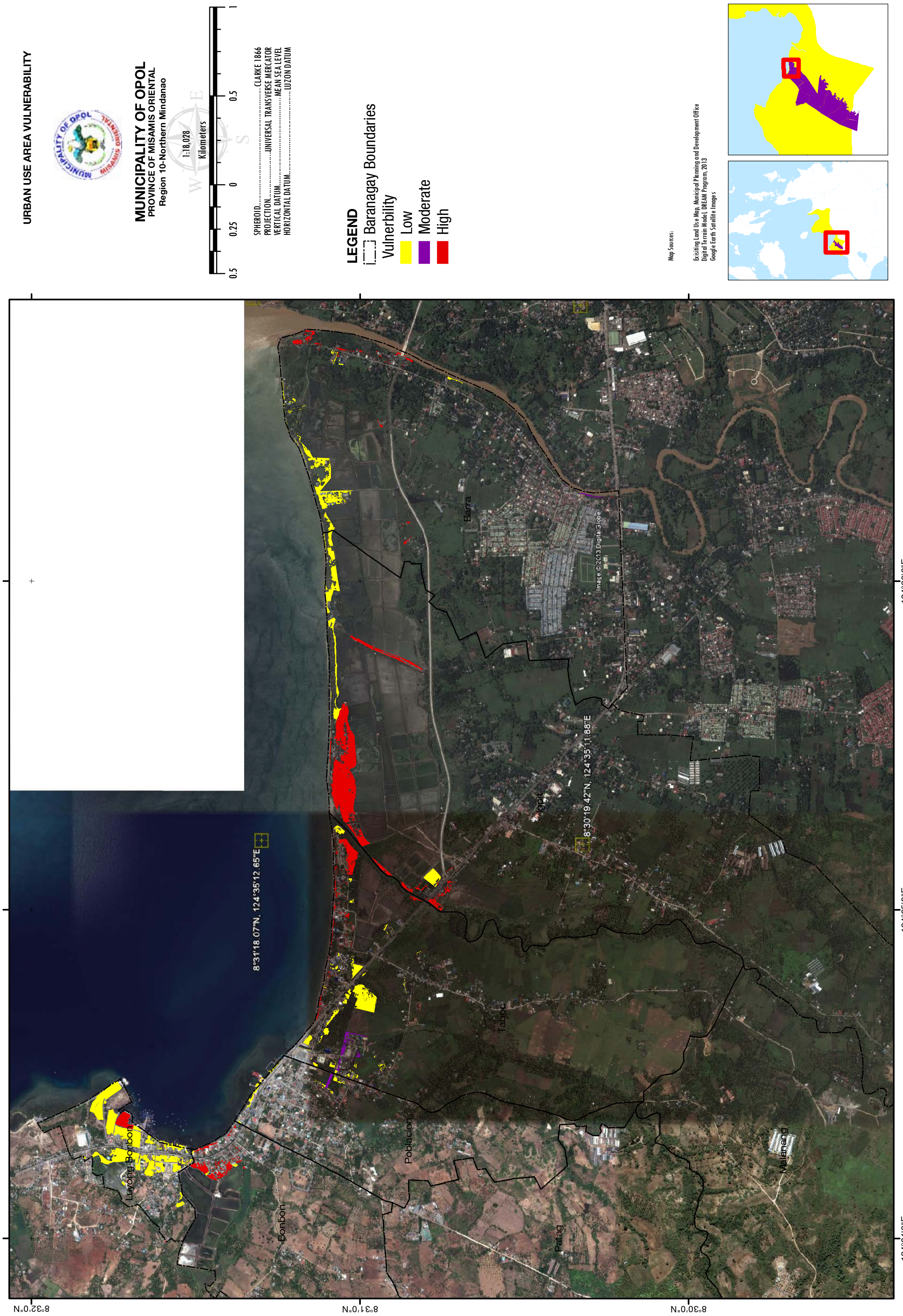


Table 3.4.6c Urban Use Areas Vulnerability to Sea Level Rise, Municipality of Opol

A	B	C	D	E	F	G	O	X	Y	Z
Barangay	**Land Use Category**	**Area per land use Category in Hectares**	**Exposed Area in Hectares**	**% Exposure**	**Replacement Cost per Sq. Meter(PHP)**	**Exposed Value (PHP)[3]**	**Degree of Impact Score**	**Adaptive Capacity Score**	**Vulnerability Index[1]**	**Vulnerability Category**
									O x X	
Igpit	Informal Settlers	9.48	9.29	98%	3,543	329,027,781	2.67	3.00	**8.00**	**High**
Luyong Bonbon	Informal Settlers	0.63	0.55	88%	3,543	19,660,107	2.67	3.00	**8.00**	**High**
Poblacion	Informal Settlers	0.15	0.15	98%	3,543	5,186,952	2.67	3.00	**8.00**	**High**
Taboc	Informal Settlers	0.20	0.20	100%	3,543	7,061,199	2.67	1.33	**3.56**	**Moderate**
Bonbon	General Residential Areas	11.34	4.30	38%	5,400	232,378,046	2.67	3.00	**8.00**	**High**
Igpit	General Residential Areas	35.84	9.37	26%	5,400	505,674,413	3.00	3.00	**9.00**	**High**
Luyong Bonbon	General Residential Areas	12.85	7.51	58%	5,400	405,678,850	1.00	3.00	**3.00**	**Low**
Poblacion	General Residential Areas	14.39	4.47	31%	5,400	241,184,827	1.33	2.00	**2.67**	**Low**
Taboc	General Residential Areas	12.55	8.33	66%	5,400	449,998,931	1.00	3.00	**3.00**	**Low**

[1]Vulnerability Index derived by multiplying the Degree of Impact Score (Column O) and the Adaptive Capacity Score (Column X)

Figure 3.4.3d Sample Critical Point Facilities Vulnerability Map to Sea Level Rise, Municipality of Opol

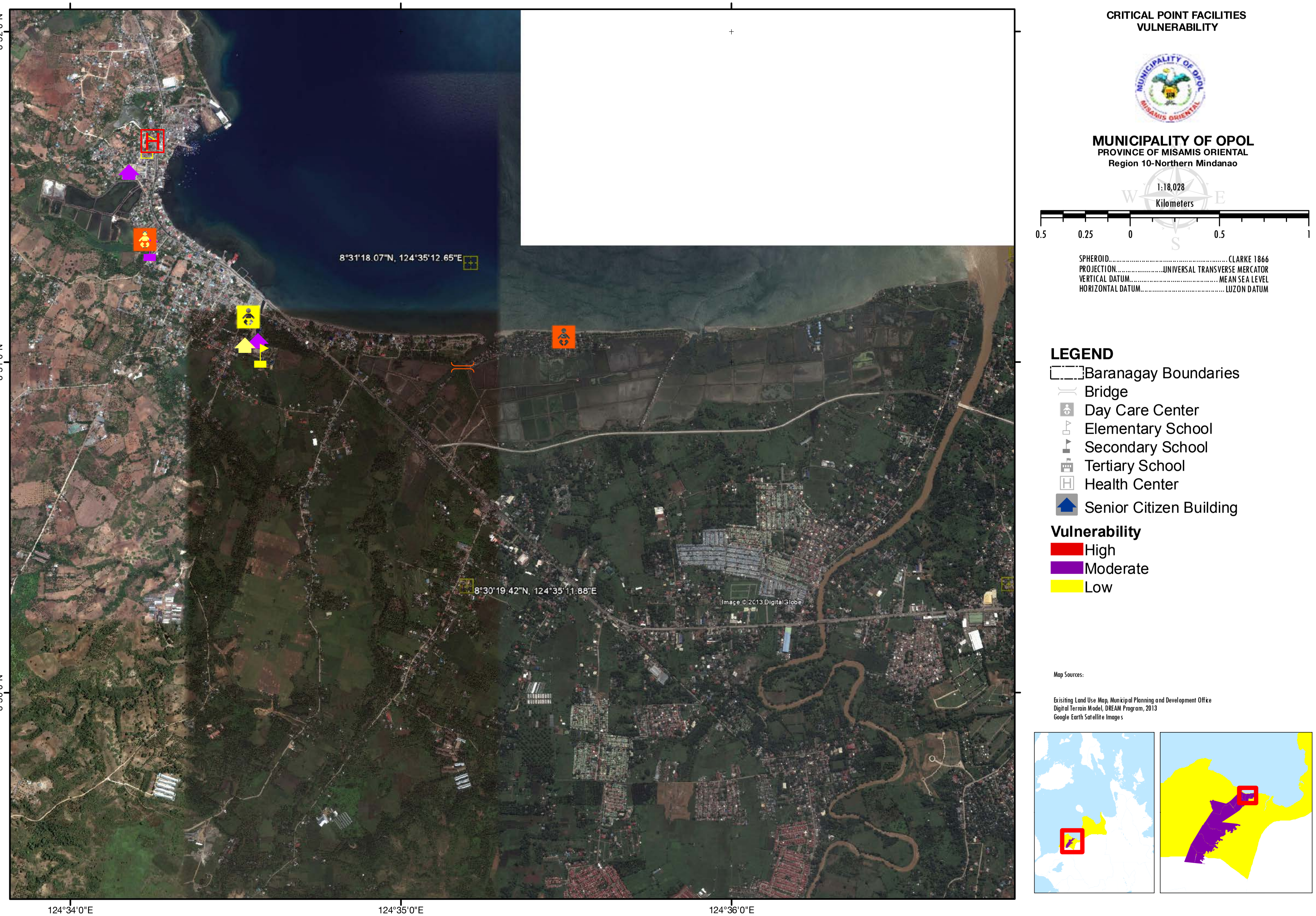


Table 3.4.6d Critical Points Facilities Vulnerability Coastal Impact Areas

A	B	C	E	M	S	U	V
Barangay	**Facility Type**	**Name**	**Area**	**Degree of Impact**	**Adaptive Capacity Score**	**Vulnerability Index[1]**	**Vulnerability Category**
						M x S	
Bonbon	Senior Citizen Building	Bonbon Senior Citizen	50 sq meters	2.67	1.00	**2.67**	**Low**
Bonbon	Elementary School	Opol Grace Christian School	10000 sq meters	2.33	2.33	**5.44**	**Moderate**
Bonbon	Day Care Center	Bonbon Day Care Center	50 sq meters	3.00	3.00	**9.00**	**High**
Igpit	Foot Bridge	Bungcalalan Foot Bridge		3.00	3.00	**9.00**	**High**
Igpit	Day Care Center	Day Care Center	50 sq meters	2.67	3.00	**8.01**	**High**
Luyong Bonbon	Senior Citizen Building	Luyong Bonbon Senior Citizen	50 sq meters	2.00	2.67	**5.33**	**Moderate**
Luyong Bonbon	Health Center	Luyong Bonbon Health Center	75 sq. meters	3.00	2.33	**7.00**	**High**
Luyong Bonbon	Elementary School	Luyong Bonbon Elementary School	4845 sq. meters	2.00	1.33	**2.67**	**Low**
Taboc	Senior Citizen Building	Temp. OCC School	50 sq meters	1.00	3.00	**3.00**	**Low**
Taboc	Senior Citizen Building	Senior Citizen	50 sq meters	1.33	2.67	**3.56**	**Moderate**
Taboc	Secondary School	ONSTS	10.01 Hectares	1.00	2.00	**2.00**	**Low**
Taboc	Day Care Center	Poblacion Day Care Center	100 sq meters	1.00	3.00	**3.00**	**Low**

[1]Vulnerability Index derived by multiplying the Degree of Impact Score (Column M) and the Adaptive Capacity Score (Column S)

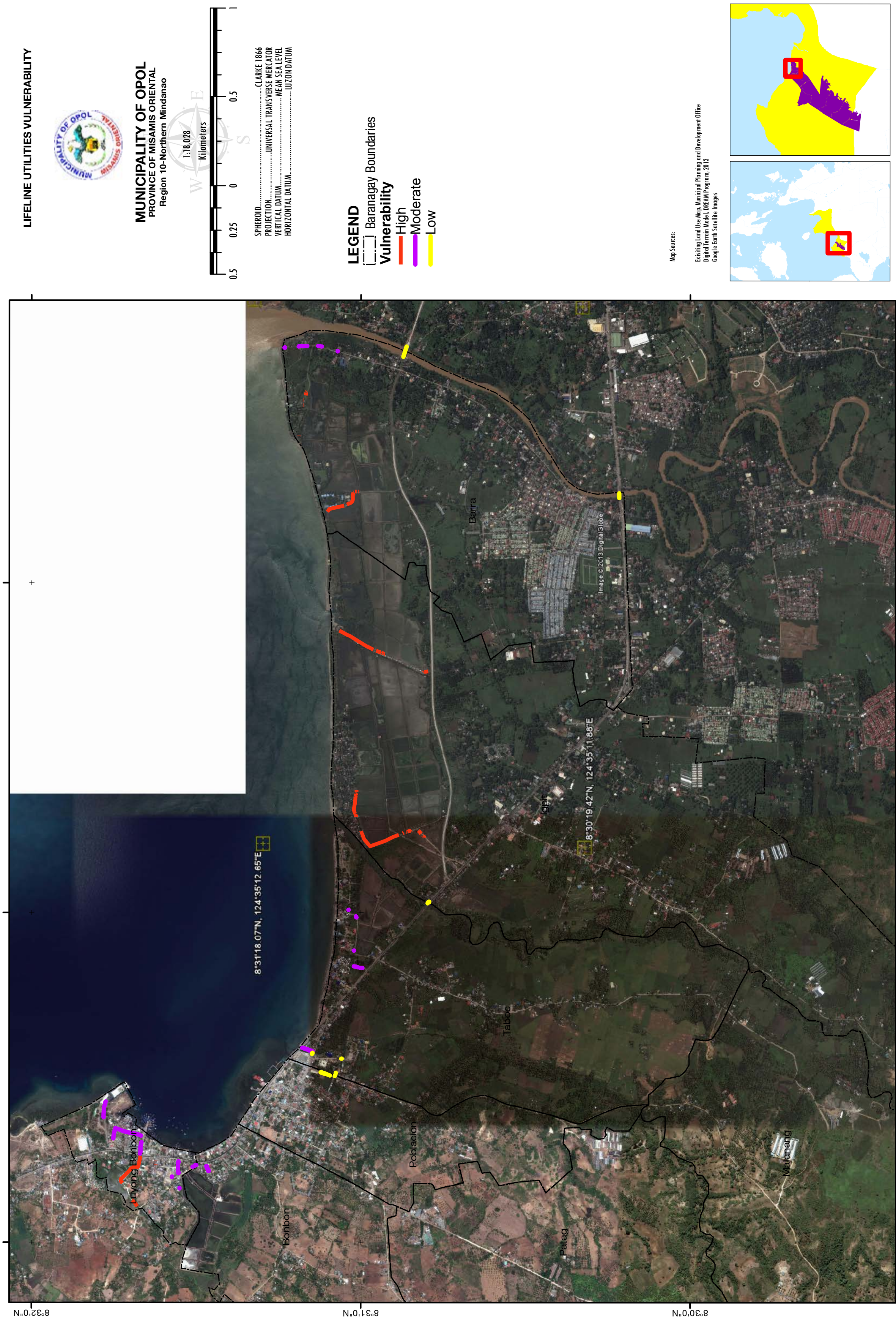


Figure 3.4.3e Sample Lifeline Utilities Vulnerability Map to Sea Level Rise, Municipality of Opol

Table 3.4.6e Lifeline Utilities Vulnerability to Sea Level Rise, Municipality of Opol

A	B	C	D	E	L	R	S	T
Name	Road Classification	Replacement Cost per linear Kilometer	Exposed length (Linear Kilometer)	Value of exposed Lifeline	Degree of Impact	Adaptive Capacity Score	Vulnerability Index[1]	Vulnerability Category[2]
							L x R	
Metro Cagayan road	National road	23,000,000.00	0.0340	782,000	1.00	1.00	1.00	Low
Barra Landless Road	Barangay Road	11,036,000.00	0.2850	3,145,260	2.67	2.67	7.11	High
Malingin Road	Barangay Road	11,036,000.00	0.4670	5,153,812	3.00	2.67	8.00	High
Luyong Bondon Access Road	Barangay Road	18,000,000.00	0.2592	4,665,060	3.00	2.33	7.00	High
Poblacion to Limunda road	Provincial road	18,000,000.00	0.0388	698,580	1.00	1.67	1.67	Low
Zone 1 Road	Barangay Road	11,036,000.00	0.1488	1,641,936	2.00	3.00	6.00	Moderate
National highway to Zone 1 road	Barangay Road	11,036,000.00	0.0554	611,725	1.00	2.33	2.33	Low
NIA to Bible Camp Road	Barangay Road	23,000,000.00	0.1991	4,578,150	2.33	3.00	7.00	High
National Road to Malingin	Barangay Road	11,036,000.00	0.2700	2,979,720	2.67	2.67	7.11	High

[1]Vulnerability Index derived by multiplying the Degree of Impact Score (Column L) and the Adaptive Capacity Score (Column R)

Task 4.8 Identify the Decision Areas and prepare a summary CCVA issues] matrix

Sub-task 4.8.1 Identify Decision Areas

Based on the vulnerability maps generated for the various exposure units, highlight and identify decision areas or elements. Decision areas can be a specific site in the locality or an area cluster (i.e coastal areas). The derived level of vulnerability can be used to identify decision areas. These can be enumerated in column A (Tables 3.4.7)

Sub-task 4.8.2 Enumerate technical findings

The technical findings can be derived from the working tables prepared in the previous steps. List down the significant findings by describing the area or element in terms of the level of vulnerability, highlighting the various contributing factors such as exposure, sensitivity, and adaptive capacity in column B.

Sub-task 4.8.3. Enumerate the Implications

List down the planning/development implications when the identified vulnerabilities in the various decision areas are not addressed in column C. These can be derived from the impact chain analysis and summary sectoral impact table.

Table 3.4.7 Sample Climate Change Vulnerability Assessment Summary Matrix

Decision Area/s	Technical Findings	Implications	Policy Interventions
A	B	C	D
• Identify decision areas in need of intervention based on the vulnerability maps; • This can be identified as high to moderate vulnerable areas or may pertain to a specific area in the barangay;	• Identify the climate stimuli and how these may manifest in the identified decision area; • Expound on the exposure information (i.e. number of affected population, exposure percentage, exposed area and cost); • Highlight relevant sensitivities of the exposed element to the identified climate stimulus; • Highlight relevant adaptive capacity indicators of the exposed element to the identified climate stimuli;	• Highlight potential impacts as mentioned in the sectoral impact chains; • Highlight future scenario if vulnerabilities are not addressed; • Identify future needs with emphasis on the spatial framework plan of the municipality/city;	• Identify the various climate change adaptation and mitigation measures to reduce vulnerabilities to acceptable and tolerable levels;

Sub-task 4.8.4 Evaluate Vulnerability and identify Policy Interventions to reduce vulnerabilities

The various policy interventions to be identified should seek to reduce the level of vulnerability by addressing the exposure, sensitivity, with consideration to the current adaptive capacities. LGUs should be guided by the acceptability ratings and disaster threshold levels to ensure that identified land use policy and strategy decisions will contribute to the treatment of potential impacts that are within acceptable or tolerable levels in the long term (refer to table 3.4.8). Sample CCVA summary matrixes are presented in Tables 3.4.9a-3.4.9e.

Table 3.4.8 Disaster Thresholds and acceptability rating per exposure type

Acceptability Rating	Disaster Thresholds/Exposure Unit				
	Population	Natural Resource Production Areas	Urban Use Areas	Critical Point Facilities	Lifeline Utilities
Highly Unacceptable[1]	≥20% of the population are affected and in need of immediate assistance	≥ 40% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	≥40% of non-residential structures are severely damaged ≥20% of residential structures are severely damaged	Damages lead to the disruption of services lasting one week or more	Disruption of service lasting one week or more for municipalities and one day for highly urbanized areas
Highly Intolerable	>10 - <20% of affected population in need of immediate assistance	20-<40% of exposed production areas/ means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	>20 to <40% of non-residential structures are severely damaged >10-20% residential structures are severely damaged	Disruption of services lasting three days to less than a week	Disruption of service lasting approximately five days for municipalities and less than 18 hours for highly urbanized areas
Tolerable	>5%-10% of affected population in need of immediate assistance	5-<20% of exposed production areas/ means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	>10 to 20% non-residential structures are severely damaged >5 to10% of residential structures are severely damaged	Disruption of service lasting for one day to less than three days	Disruption of service lasting approximately three days for municipalities and less than six hours for highly urbanized areas
Acceptable	≤ 5% of the affected population in need of immediate assistance.	≤5% of exposed production areas/ means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	≤10% of non-residential structures are severely damaged ≤5% of residential structures are severely damaged	Disruption of service lasting less than one day	Disruption of service lasting approximately one day for municipalities and less than six hours for highly urbanized areas

[1]Disaster threshold percentages based on the criteria of declaring a state of calamity, NDCC Memo no. 4, series of 1998.

Table 3.4.9a Sample Climate Change Vulnerability Assessment Summary Matrix for Population, Sea Level Rise

Decision Area/s	Technical Findings	Implications	Policy Interventions
A	**B**	**C**	**D**
Igpit	• High population vulnerability to a 1-meter SLR • Approximately 7,29 hectares of residential areas and 1,195 individuals exposed (Exposure); • High number of exposed elements located adjacent to coastal areas are made from light to salvageable materials (Sensitivity); • Around 27% of individuals living below the poverty threshold; • Majority are considered informal settlers with no security of tenure (Sensitivity); • Low awareness among inhabitants regarding the potential impacts of climate change and SLR (Sensitivity); • No available government resources to pursue mitigation-related infrastructure and relocation (Adaptive Capacity); • Inhabitants are willing to be relocated into safer areas if government provides assistance (Adaptive Capacity);	• Potential submergence of low-lying settlement areas and reduction in available lands for residential uses (Impact); • Exposure may increase in the future due to natural population growth and uncontrolled growth of informal settlers; • Increase in mean sea level may change coastal tidal patterns and magnitude of sudden onset hazards affecting coastal areas (i.e. storm surges and coastal flooding) and affect residential structures and its inhabitants; • Redirection of government resources for disaster response, reconstruction/rehabilitation; • Reduction in available lands for residential uses; • Retaining residential areas may be too costly to manage and mitigate in the long term;	• Identification of new residential areas to accommodate the relocation of approximately 1,195 individuals; • Seek assistance from NGAs in the provision of housing for low income families; • Disallow further upgrading of residential areas in the impact areas; • Reclassify areas to protection or open space type land uses • Rehabilitate wetlands and mangrove areas; • Provide alternative livelihood opportunities for families below the poverty threshold; • Establishment of early warning systems and contingency plans for coastal-related hazards (i.e. coastal flooding and storm surges)
Luyong Bonbon	• Moderate population vulnerability to a 1-meter SLR • Approximately 5.25 hectares of residential areas and 1,468 individuals exposed (Exposure); • Around 10% of exposed elements are made from light to salvageable materials (Sensitivity); • 42% of individuals are below the poverty threshold (Sensitivity); • Majority are considered informal settlers with no security of tenure (Sensitivity); • Low awareness among inhabitants regarding the potential impacts of climate change and SLR (Sensitivity); • No available government resources to pursue mitigation-related infrastructure and relocation (Adaptive Capacity); • Inhabitants are willing to be relocated into safer areas if government provides assistance (Adaptive Capacity);	• Potential submergence of low-lying settlement areas and reduction in available lands for residential uses (Impact); • Exposure may increase in the future due to natural population growth and uncontrolled growth of informal settlers; • Increase in mean sea level may change coastal tidal patterns and magnitude of sudden onset hazards affecting coastal areas (i.e. storm surges and coastal flooding) and affect residential structures and its inhabitants; • Redirection of government resources for disaster response, reconstruction/rehabilitation; • Retaining residential areas may be too costly to manage and mitigate in the long term;	• Identification of new residential areas to accommodate the relocation of approximately 1,468 individuals and to seek assistance from NGAs in the provision of housing for low income families; • Rehabilitate impact areas through wetlands and mangrove restoration or set aside for production land uses; • Disallow further upgrading of residential areas in the impact areas; • Provide alternative livelihood opportunities for families below the poverty threshold; • Reclassify areas to protection or open space type land uses • Establishment of early warning systems and contingency plans for coastal-related hazards (i.e. coastal flooding and storm surges);

Table 3.4.9b Sample Climate Change Vulnerability Assessment Summary Matrix for Natural Resource Production Areas, Sea Level Rise

Decision Area/s	Technical Findings	Implications	Policy Interventions
A	**B**	**C**	**D**
Barra	• High agricultural crop vulnerability to 1-meter SLR; • Approximately 6.88 hectares or 1.032M value of vegetable crop production areas exposed (Exposure) ; • Area with no access to hazard information and SLR mitigation infrastructure coverage (Sensitivity); • Low awareness among inhabitants regarding the potential impacts of climate change and SLR to crop production, all farming families did not attend climate field school and practices climate resilient/sustainable production techniques (Sensitivity); • Majority of farmers cannot afford crop insurance (Adaptive Capacity); • Local government can provide agricultural extension services (Adaptive Capacity); • Limited alternative livelihood opportunities (Adaptive Capacity); • A third of the farming communities have access to EWS for agricultural production (Adaptive Capacity);	• Permanent submergence of crop production areas and reduction in available areas for crop production; • Potential reduction in vegetable crop volume output/yield and municipal food sufficiency; • Detrimental effect on the socio-economic wellbeing of farming dependent families; • The need to anticipate the reduction of available production areas and production yield; • Reduction in total by identifying new production areas for vegetable production (6.88 hectares);	• Allocation of additional 6.88 hectares of crop production areas to anticipate potential losses due to permanent submersion; • Identify other natural resource production areas or tap other resource areas within the municipality to provide alternative livelihood to potentially affected farming families; • Maintain existing areas for production land use and employ an incremental adaptation approach to ensure sustained productivity, encourage the application of climate smart production techniques; • Provide extension services with emphasis on utilizing area for fisheries production given the potential changes in the ecology of the area due to SLR;
Igpit	• High inland fisheries vulnerability to 1-meter SLR; • Approximately 61.35 hectares or 2.00M value of fisheries production areas exposed, representing 95% of total inland fisheries production area of the barangay (Exposure); • Absence of SLR mitigation infrastructure (Sensitivity); • Absence of sustainable/adaptation fisheries production techniques (Sensitivity) • Limited alternative livelihood opportunities (Adaptive Capacity); • Limited government resources (Adaptive Capacity); • Local government can provide extension services for fisheries (Adaptive Capacity);	• Permanent submergence of inland fisheries production areas or damage to fish plots/cages for freshwater fish production; • Economic losses of inland fisheries dependent families; • Need to shift to sea water/ brackish water-based fish production; • Reduction of 61.35 hectares of fish production areas and potential loss of income; • Provision of alternative livelihood or utilizing other resources for agriculture production for potentially affected families;	• Shift to sustainable fisheries production consistent with mangrove and wetland type habitats; • Identify other natural resource production areas to provide alternative livelihood to potentially affected farming families; • Maintain existing areas for fisheries production and employ an incremental adaptation approach to ensure sustained productivity, • Provide extension services with emphasis on utilizing area for fisheries production given the potential changes in the ecology of the area due to SLR;

Table 3.4.9c Sample Climate Change Vulnerability Assessment Summary Matrix for Urban Use Areas, Sea Level Rise

Decision Area/s	Technical Findings	Implications	Policy Interventions
A	B	C	D
Igpit - Informal settler areas	• 9.29 hectares or 98% of informal settler areas exposed in the barangay; • High proportion of buildings with light and salvageable materials (Exposure); • High proportion of buildings which are dilapidated in condition (Exposure); • High proportion of structures not employing SLR mitigation design (Sensitivity); • Willingness to relocate among informal settler families (Adaptive Capacity); • Alternative sites can be identified by the local government, ability of the LGU to seek assistance from other agencies and private entities for the provision of housing (Adaptive Capacity);	• Permanent submergence and possible isolation of informal settler families; • Retaining informal settler areas will be costly to manage and maintain; • Increase in mean sea level may change tidal patterns and magnitude of sudden onset hazards (i.e. coastal flooding, storm surges) affecting structures; • There is an immediate need to identify relocation sites to accommodate informal settler families;	• Manage retreat of informal settler areas by 2025 • Designating areas for wetland and mangrove restoration; • Encourage sustainable resource production activities within the area; • Provision of alternative livelihood to potentially affected families; • Identification of 9.29 hectares of residential areas to accommodate displaced families; • Establish EWS and formulation of contingency plans to prevent fatalities and injuries due to potential changes in tidal pattern during sudden onset hazards;
Bonbon - residential areas	• 4.30 hectares of residential areas exposed to 1 meter SLR representing 38% of the residential areas in the barangay (Exposure); • High proportion of buildings with light to salvageable materials and no protection infrastructure coverage (Sensitivity); • Majority of structures do not have property insurance (or the capacity to afford) (Adaptive Capacity); • Alternative sites can be identified by the local government, ability of the LGU to seek assistance from other agencies and private entities for the provision of housing (Adaptive Capacity); • There is willingness to relocate if provided assistance by the government (Adaptive Capacity);	• Permanent submergence of residential areas; • Potential backlog of 4.30 hectares of residential areas; • Need to identify residential sites to accommodate existing families; • Establishing, upgrading and maintaining access/utility systems may be costly in the long term; • Increase in mean sea level may change tidal patterns and magnitude of sudden onset hazards (i.e. coastal flooding, storm surges) affecting structures; • structural mitigation of buildings and construction of sea walls will be very costly;	• Manage retreat of residential areas by 2025; • Reclassify areas for protection land uses; • Encourage sustainable resource production activities; • Land swapping for legitimate land owners; • Provision of tax incentives to encourage managed retreat and relocation; • Establish EWS and formulation of contingency plans to prevent fatalities and injuries due to potential changes in tidal pattern during sudden onset hazards;

Table 3.4.9d Sample Climate Change Vulnerability Assessment Summary Matrix for Critical Point Facilities, Sea Level Rise

Decision Area/s	Technical Findings	Implications	Policy Interventions
A	B	C	D
Luyong Bonbon Health Center	• 75 sq. meters exposed to SLR (Exposure); • Building considered mixed wood and concrete (Sensitivity); • Structure does not employ hazard mitigation design (Sensitivity); • No property insurance coverage (Adaptive Capacity); • LGU will have available funds to establish new health centers in the future (Adaptive Capacity);	• Potential submergence of the facility due to SLR; • Potential reduction in the quality provision of health services in the barangay; • Relocating the health center will be a better strategy in the long-term compared to rehabilitation/ retrofitting; • There is a need to identify an additional 75 sq. meters for the relocation of the facility; • Surrounding areas accessing the facility will also be submerged due to SLR making it difficult and expensive to maintain/ensure accessibility;	• Retain facility but discourage further expansion and improvement; • Construction of additional health centers in safer areas to anticipate potential disruption or reduction in service capacity for health related services;
Igpit Day Care Center	• 50 sq. meters exposed to SLR (Exposure); • Building is concrete but in poor condition (Sensitivity); • Structure does not employ hazard mitigation design (Sensitivity); • No property insurance coverage (Adaptive Capacity); • LGU will have available funds to establish new day care centers in future (Adaptive Capacity);	• Potential submergence of the facility due to SLR; • Potential reduction in the quality provision of social welfare services in the barangay; • Relocating the facility will be a better strategy in the long-term compared to rehabilitation/ retrofitting; • Surrounding areas accessing the facility will also be submerged due to SLR making it difficult and expensive to maintain/ensure accessibility;	• Retain facility but discourage further expansion and improvement; • Construction of additional social welfare buildings to cater to senior citizens in safer areas to anticipate potential disruption or reduction in service capacity.

Table 3.4.9e Sample Climate Change Vulnerability Assessment Summary Matrix for Lifeline Utilities, Sea Level Rise

Decision Area/s	Technical Findings	Implications	Policy Interventions
A	B	C	D
Malingin Road	• Approximately 467 meters exposed and the primary transportation access of informal settler families along the Igpit coastal area (Exposure); • Currently dirt road and poorly maintained (Sensitivity); • No other alternative access systems leading to the area (Sensitivity); • Government resources are limited (Adaptive Capacity);	• Permanent submergence of transportation access system; • Isolation of communities during extreme weather events (i.e. coastal flooding, storm surges) • Upgrading and maintenance will be very costly in the long term; • Further upgrading of transport system may lead to unregulated growth of informal settlements in the Malingin Area; • Cost for upgrading can be used for other priority transportation systems;	• Minimal upgrading of the Malingin Road; • Strategic location of new roads to limit access and discourage further settlement growth in SLR impact areas; • Provide EWS and contingency plans to minimize potential isolation and encourage pre-emptive evacuation due to sudden onset hazards;
Luyong Bonbon Road	• Approximately 260 meters of barangay road exposed (Exposure); • Only access system connecting the settlement areas of Luyong bonbon to the national road (Exposure); • Currently concrete but in poor condition and in need of major repairs (Exposure); • No other alternative access systems leading to the area (Sensitivity); • Government resources are limited (Adaptive Capacity);	• Potential isolation of certain areas of Luyong Bonbon residential areas; • There is a need to establish redundant transportation system/s to link Luyong Bonbon and the Poblacion further west (parallel to the national road); • Linkage systems should also be established for the purposes of evacuation in the event of sudden onset hazards such as storm surges or coastal flooding;	• Minimal upgrading of the Luyong Bonbon Road to discourage further settlement growth in the area; • Strategic construction of redundant systems to redirect urban growth in relatively safer areas in coordination with regional line agencies; • Provide EWS and contingency plans to minimize potential isolation and encourage pre-emptive evacuation due to sudden onset hazards;

Step 5. Disaster Risk Assessment (DRA)

Objectives

- To determine the risk areas
- To be able to analyze adaptive capacities of identified risk areas

Outputs

- DRA summary decision areas and issues matrix
- Risk maps

Process

Task 5.1 Assign the likelihood of occurrence
Task 5.2 Determine Exposed Elements
Task 5.3 Consequence Analysis
Task 5.4 Risk Estimation
Task 5.5 Analyze Adaptive Capacities
Task 5.6 Identify the Decision Areas and prepare a summary Disaster Risk Assessment Matrix
Task 5.7 Identify Policy Interventions to reduce risks to acceptable levels

Task 5.1 Assign the likelihood of occurrence

The likelihood of the hazard is an estimate of the period of time a hazard event is likely to repeat itself, expressed in years. For simplification purposes, and when certainty is hard to determine from records, this may be estimated by the likely occurrence of the natural event. This broadly defines a return period of a hazard. Knowing the time interval for a hazard event to occur again is important because it gives an idea on how often a threat from a hazard may be expected.

From the hazard inventory matrix prepared in Step 2, assign an indicative likelihood occurrence score relative to the recurrence period of the hazard. Table 3.5.1a below provides a description of the likelihood, the corresponding return period in years, and the corresponding score. The ranges describe an ordered but descriptive scale which can be assigned to real or assumed hydro-meteorological or geophysical events. The likelihood score ranges from 1 to 6. A score of 1 is given to very rare events (>200-300 or more years; for example, volcanic eruptions, very strong ground shaking) while a score of 6 is given to frequently recurring or very likely recurring hazards (every 1 to 3 years; for example, recurring floods). The higher the likelihood of occurrence score, the more frequent the hazard may occur.

Table 3.5.1a Indicative Likelihood of Occurrence Scores

Measure of Likelihood	Return Period in Years	Likelihood Score
Frequent	Every 1-3 years	6
Moderate	Every >3-10 years	5
Occasional	Every >10-30 years	4
Improbable	Every >30-100 years	3
Rare event	Every >100-200 years	2
Very rare event	Every >200 years	1

Source: Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans Report, NEDA-HLURB-UNDP,2012

When preparing the hazard maps, the attribute information can contain the estimated flood depth/s and likelihood of occurrence per susceptibility area. Additional columns can be added to accommodate field observations/data on the flood duration, flow velocity, and speed of onset (i.e. slow, sudden). The additional hazard information should provide a more comprehensive description of the hazard which shall be considered in the succeeding steps (i.e. consequence analysis and risk estimation). Similar Tables can be prepared for other hazards (refer to Table 3.5.1b).

Table 3.5.1b Sample Flood Hazard Inventory, Municipality of Opol

Flood Susceptibility	Estimated Flood Depth	Likelihood of Occurrence	Likelihood of Occurrence Score
High	≥1 meter	One meter flood in the area will be equaled or exceeded every 10 to 30 years considered occasional in likelihood	4
Moderate to Low	<1 meter	Flood depth of <1 meter are triggered by Rare Event of >100-200 years	2

Task 5.2 Determine the extent/number of exposed elements

Determining exposure involves the estimation of the number of affected individuals, structures or the extent of area located within hazard-susceptible areas. This can be done by overlaying the hazard and the population exposure map. Based on the map overlaying, the estimated exposed elements can be computed and summarized, including the vulnerability attributes of the elements exposed. These vulnerability attributes will be the basis for estimating the severity of consequence in succeeding tasks. Note that all hazard information (such as susceptibility level, flood depths, and likelihood of occurrence are included in the processed exposure table).

Sub-task 5.2.1 Determine Population Exposure

Overlay the population exposure map with the hazard map. The map overlying will determine the extent of area exposed per hazard susceptibility, where the number of exposed individuals can be computed. Determining exposure can be facilitated using GIS or overlay mapping using paper maps and transparencies (refer to Figure 3.5.1a). The overlying will append the information from the hazard map which contains the hazard descriptors (i.e. flood susceptibility, flood depths, likelihood of occurrence) to the population exposure database map and table.

- Compute for the residential area to population density by dividing the total barangay population with the total estimated residential areas (Column G);
- Estimate the flooded areas per barangay, per susceptibility level in hectares (Column H);
- Compute for the affected population by multiplying the estimated flooded area by the residential area to population density (Column I);
- Determine the exposure percentage of affected population, relative to the total barangay population by dividing the affected population and the total barangay population (Column J);
- A sample computation of exposure is presented below (refer to Table 3.5.2a).

Figure 3.5.1a Sample Population Flood Exposure Mapping

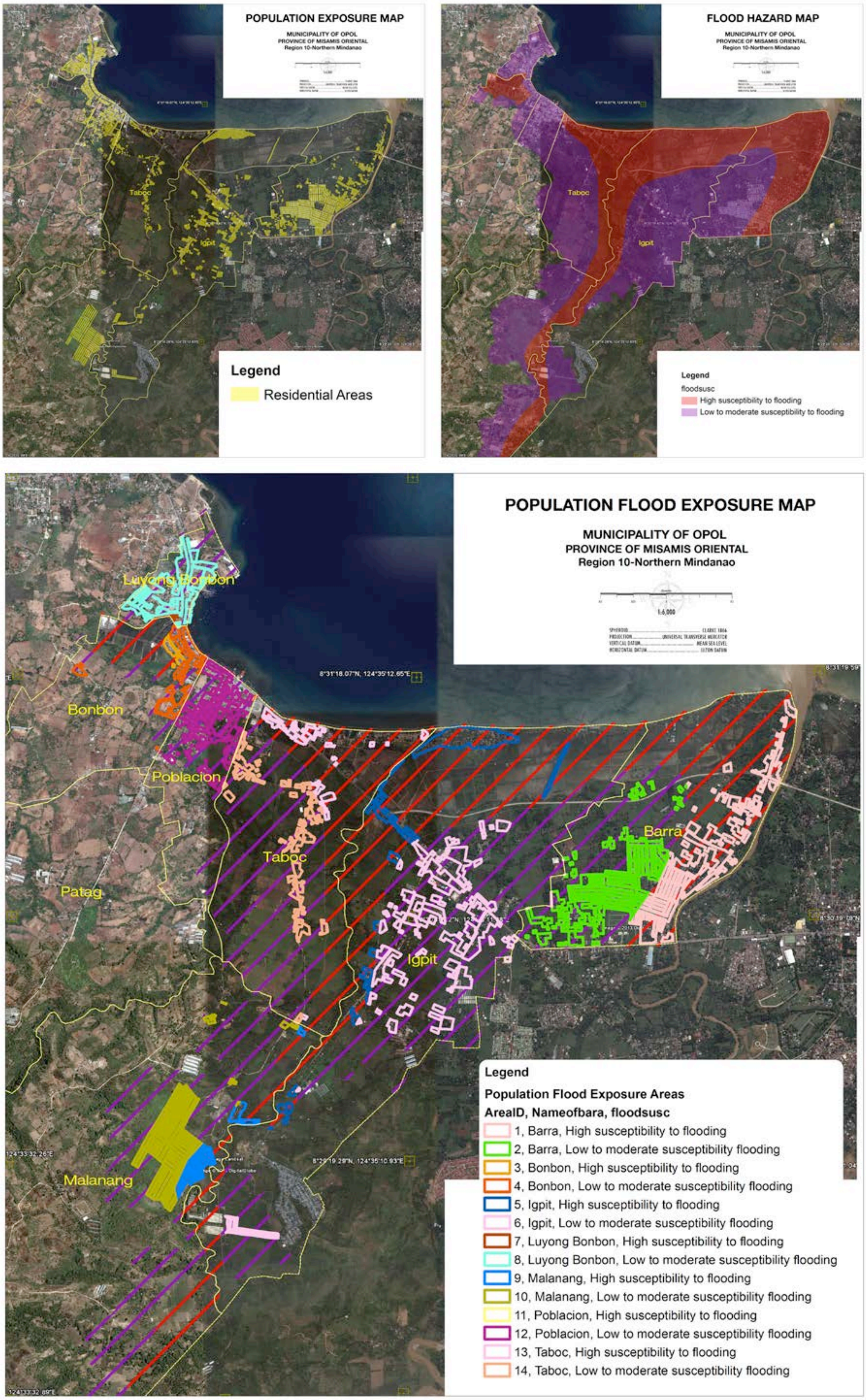


Table 3.5.2a Sample Population Flood Exposure Estimation, Municipality of Opol

A	B	C	D	E	F	G	H	I	J
	HAZARD			EXPOSURE					
Barangay	Flood Susceptibility	Likelihood of Occurrence Score	Flood depth	Barangay Population	Estimated Residential Area (Hectares)	Residential Area to Population Density (Persons/ Hectare)[1]	Affected Area (Hectares)[2]	Exposed Population[3]	Exposure Percentage
						E/F		GxH	I/E
Barra	HSA	4	≥1 meter	14,334	185.26	77.37	88.38	6,838	47.71%
Barra	MLSA	2	<1 meter	14,334	185.26	77.37	92.43	7,152	49.89%
Bonbon	MLSA	2	<1 meter	2,698	17.18	157.04	10.02	1,573	58.30%
Bonbon	HSA	4	≥1 meter	2,698	17.18	157.04	2.29	360	13.35%
Igpit	MLSA	2	<1 meter	10,123	252.20	40.14	175.02	7,025	69.40%
Igpit	HSA	4	≥1 meter	10,123	252.20	40.14	56.95	2,286	22.58%
Luyong Bonbon	HSA	4	≥1 meter	3,491	28.09	124.28	0.68	85	2.42%
Luyong Bonbon	MLSA	2	<1 meter	3,491	28.09	124.28	26.19	3,254	93.22%
Malanang	HSA	4	≥1 meter	3,593	102.07	35.20	13.77	485	13.49%
Malanang	MLSA	2	<1 meter	3,593	102.07	35.20	68.28	2,404	66.90%
Poblacion	HSA	4	≥1 meter	3,690	58.28	63.32	0.28	18	0.49%
Poblacion	MLSA	2	<1 meter	3,690	58.28	63.32	40.63	2,572	69.71%
Taboc	HSA	4	≥1 meter	2,918	63.68	45.82	31.49	1,443	49.45%
Taboc	MLSA	2	<1 meter	2,918	63.68	45.82	32.19	1,475	50.55%

[1]Residential Area Population Density derived by dividing the estimated population and residential areas.
[2] Estimated exposed areas expressed in hectares are GIS derived.
[3] Estimated affected population derived from multiplying the exposed areas by the estimated Residential area to population Density.

Sub-task 5.2.2 Determine Natural Resource-based Production Area Exposure

Similar to population exposure, overlay the natural resource production area exposure map prepared in Step 3. The hazard map will be used to determine the extent of area exposure per hazard susceptibility by type of natural resource production area (refer to Figure 3.5.1b). Based on the map overlaying, the estimated exposed elements can be computed and summarized, including the vulnerability attributes of the elements exposed. These vulnerability attributes will be the bases for estimating the severity of consequence in succeeding tasks. Note that all hazard information such as susceptibility level, flood depths, and likelihood of occurrence are embedded in the exposure table.

- Estimate the flooded natural resource-based production areas per barangay, per susceptibility level in hectares (Column G);
- Determine the exposure percentage of exposed natural resource production area relative to the total barangay allocation by dividing the exposed area and the barangay area allocation by dominant crop (Column H);
- Compute for the exposed value by multiplying the estimated flooded area by the estimated average annual output per hectare (Column I);
- Sample computation is presented below (refer to Table 3.5.2b).

Figure 3.5.1b Sample Natural Resource-based Production Area Flood Exposure Mapping

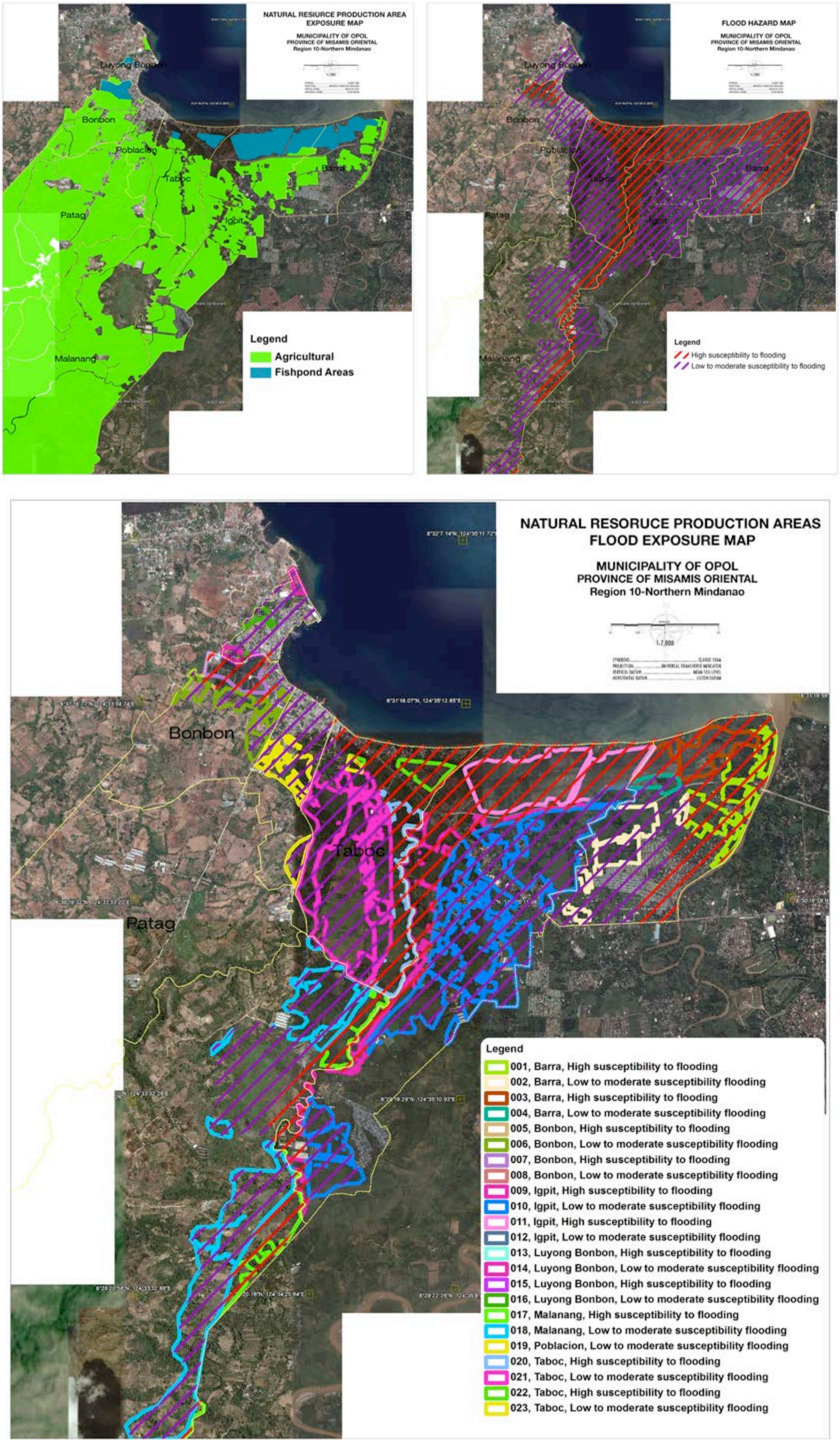


Table Table 3 .5.2 b Sample Natural Resource-based Production Area Flood Exposure Estimation, Municipality of Opol

A	B	C	D	E	F	G	H	I	J
HAZARD				EXPOSURE					
Barangay	Flood Susceptibility	Likelihood of Occurrence Score	Flood Depth	Area by Dominant Crop (Hectares)	Dominant Crop	Exposed Area[1] (Hectares)	Exposure Percentage[2]	Average potential income per hectare per year (PHP)	Exposed Value (Php)[3]
							G/E		GxI
Barra	HSA	4	>1 Meter	58.66	vegetable	29.83	50.85%	150,000	4,474,500
Barra	MLSA	2	<1 Meter	58.66	vegetable	28.58	48.72%	150,000	4,287,000
Barra	HSA	4	>1 Meter	30.67	Tilapia/Bangus	26.20	85.44%	32,843	860,605
Barra	MLSA	2	<1 Meter	30.67	Tilapia/Bangus	5.09	16.61%	32,843	167,302
Bonbon	HSA	4	>1 Meter	108.93	rice	4.86	4.46%	91,605	445,200
Bonbon	MLSA	2	<1 Meter	108.93	rice	15.60	14.32%	91,605	1,429,038
Igpit	HSA	4	>1 Meter	281.75	rice	51.03	18.11%	91,605	4,674,603
Igpit	MLSA	2	<1 Meter	281.75	rice	170.53	60.53%	91,605	15,621,401
Igpit	HSA	4	>1 Meter	281.75	Tilapia/Bangus	73.63	26.13%	32,843	2,418,276
Igpit	MLSA	2	<1 Meter	281.75	Tilapia/Bangus	0.62	0.22%	32,843	20,256

[1] Estimated exposed areas expressed in hectares based on hazard overlay is GIS derived
[2] Exposure percentage derived by dividing the affected area by the total barangay allocation
[3] Estimated affected value derived by multiplying average output per hectare with the affected area.

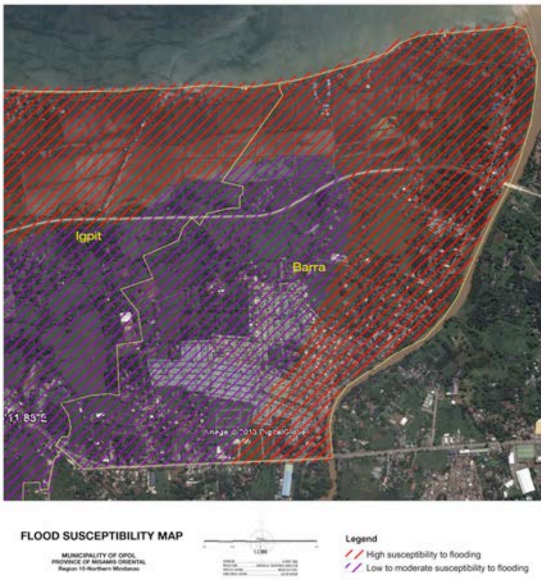
Sub-task 5.2.3 Determine Urban Use Area Exposure

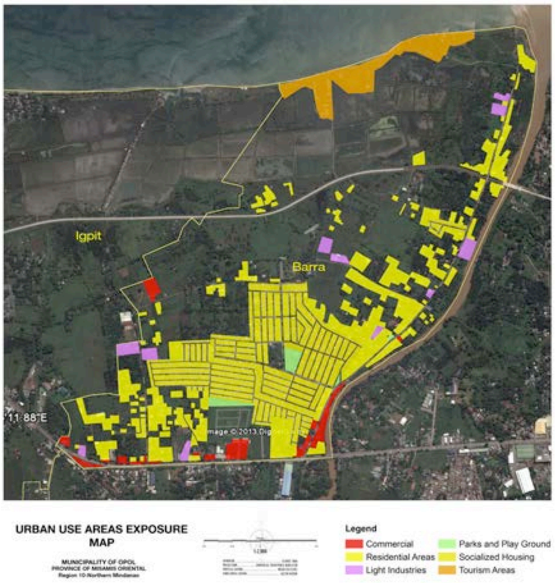
Overlay the urban use area exposure map prepared in Step 3 with the hazard map to determine the extent of area exposure per hazard susceptibility by type of land use category. Based on the map overlaying, the estimated exposed area can be determined including other exposure statistics, and summarized, including the vulnerability attributes of the elements exposed (refer to Figure 3.5.1c).

Proceed and compute for the estimated exposed area and value, including the exposure percentage:

- Estimate the flooded urban areas per barangay, per susceptibility level in hectares (Column H);
- Determine the exposure percentage of exposed urban use area relative to the total barangay allocation by dividing the affected area and the urban use area allocation (Column I);
- Compute for the exposed value by multiplying the estimated flooded area by the estimated replacement cost per square meter, multiplied by 10,000 (Column K);
- Sample computation is presented below (refer to Table 3.2.1c).

Figure 3.5.1c Sample Urban Use Areas Flood Exposure Mapping





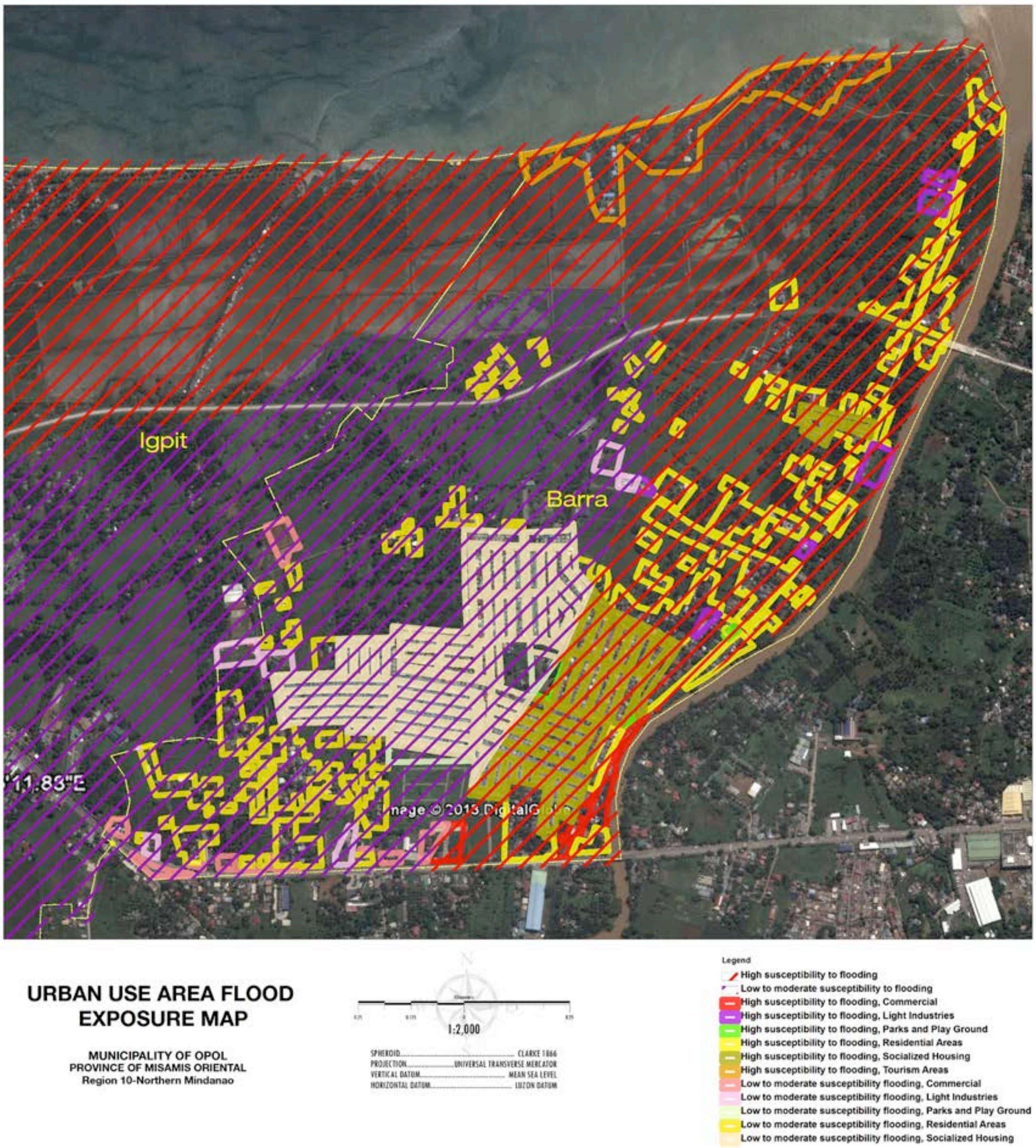


Table 3.5.2c Sample Urban Use Areas Flood Exposure Estimation, Barangay Barra, Municipality of Opol

A	B	C	D	E	G	H	I	J	K
HAZARD				EXPOSURE					
Barangay	Flood Susceptibility	Expected Flood Depth	Likelihood of Occurrence Score	Land Use Category (Specific Use)	Area per land use description in Hectares	Exposed Area in Hectares [1]	Exposure Percentage[2]	Replacement Cost per Sq. Meter(PHP)	Exposed Value (PHP) [3]
							H/G		HxJx10000
Barra	HSA	>1 Meter	4	Commercial	3.32	1.69	51%	8,672	146,558,997
Barra	HSA	>1 Meter	4	Residential	27.79	17.24	62%	5,400	930,894,488
Barra	HSA	>1 Meter	4	Light Industries	3.06	1.32	43%	8,672	114,472,116
Barra	HSA	>1 Meter	4	Residential Areas - Socialized Housing	24.16	9.08	38%	5,400	490,285,496
Barra	HSA	>1 Meter	4	Tourism Areas	7.20	7.20	100%	8,672	624,393,360
Barra	MLSA	<1 Meter	2	Commercial	3.32	1.57	47%	8,672	136,152,441
Barra	MLSA	<1 Meter	2	Residential Areas	27.79	10.38	37%	5,400	560,480,556
Barra	MLSA	<1 Meter	2	Light Industries	3.06	1.74	57%	8,672	150,895,062
Barra	MLSA	<1 Meter	2	Residential Areas - Socialized Housing	24.16	15.08	62%	5,400	814,262,696

[1] Estimated exposed areas expressed in hectares based on hazard overlay is GIS derived
[2] Exposure percentage derived by dividing the affected area by the total barangay allocation
[3] Estimated exposed value derived by multiplying replacement cost per square meter and the estimated exposed area in hectares multiplied by 10000 (one hectare = 10000 sq. meters).

Sub-task 5.2.4 Determine Critical Point Facility Exposure

Overlay the critical point facility exposure map prepared in Step 3 with the hazard map to determine the hazard susceptibility of each critical point facility. Based on the map overlaying, the estimated exposed area can be computed and summarized, including the vulnerability attributes of the elements exposed (refer to Figure 3.5.1d and Table 3.5.2d).

Figure 3.5.1d Sample Critical Point Facilities Flood Exposure Mapping

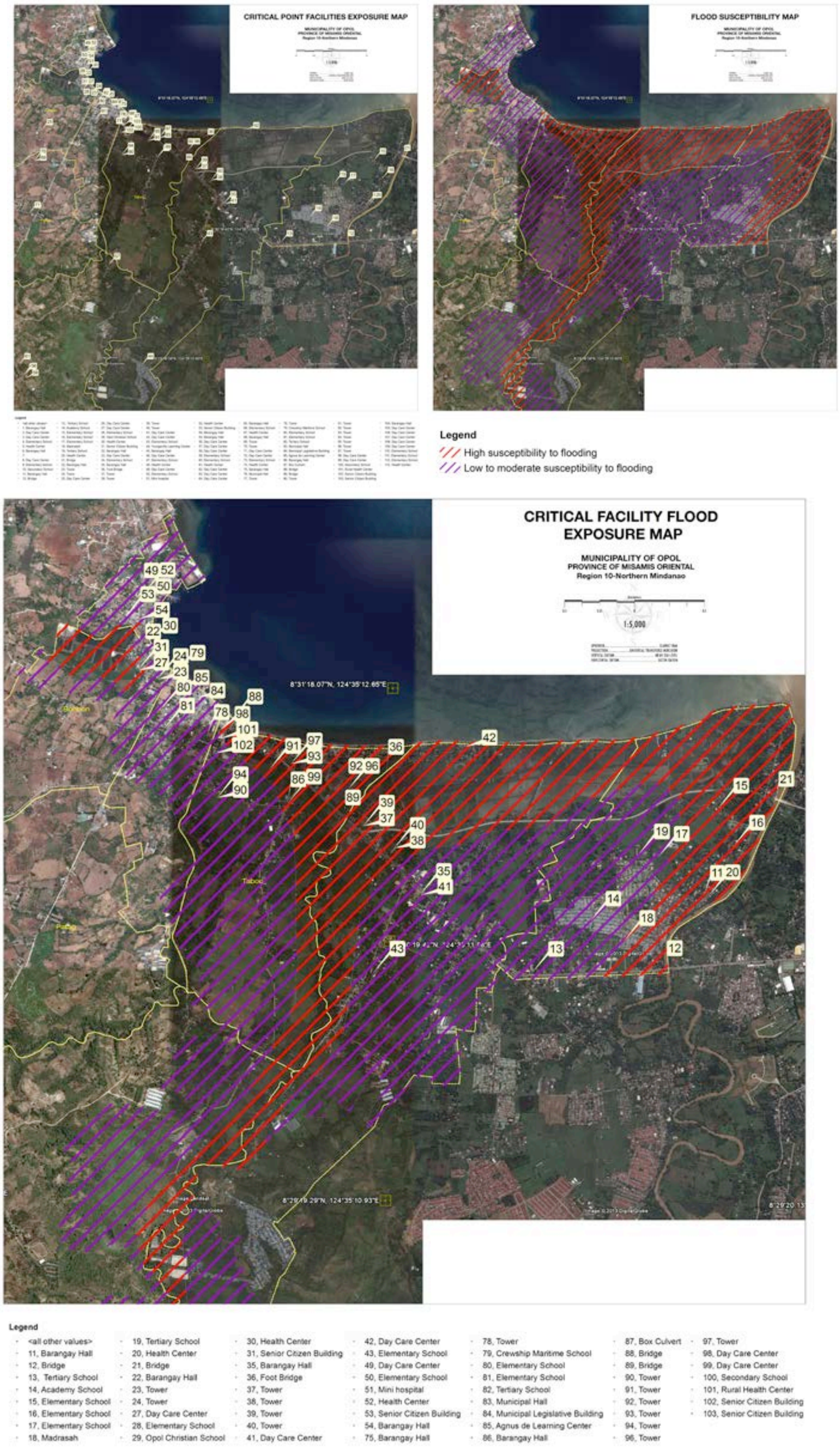


Table 3.5.2d Sample Critical Point Facilities Flood Exposure, Municipality of Opol

A	B	C	D	E	F	G	H
	HAZARD			EXPOSURE			
Barangay	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Facility Type	Storey	Exposed Area	Number of Classrooms/Rooms/ Bed Capacity
Barra	HSA	4	>1 Meter	Health Center	2	75 sq. meters	4 Bed Capacity
Barra	HSA	4	>1 Meter	Elementary School	1	6404 sq. meters	15 Classrooms
Barra	HSA	4	>1 Meter	Bridge	N/A	N/A	20 Tons
Bonbon	HSA	4	>1 Meter	Senior Citizen Building	2	50 sq meters	
Bonbon	MLSA	2	<1 Meter	Health Center	1	75 sq. meters	4 Bed Capacity
Bonbon	HSA	4	>1 Meter	Elementary School	1	10000 sq meters	6 Classrooms
Bonbon	HSA	4	>1 Meter	Day Care Center	2	50 sq meters	
Igpit	HSA	4	>1 Meter	Foot Bridge	N/A	N/A	3 Tons
Igpit	MLSA	2	<1 Meter	Elementary School	1	23986 sq. meters	8 Classrooms
Igpit	HSA	4	>1 Meter	Day Care Center	1	50 sq meters	
Luyong Bonbon	MLSA	2	<1 Meter	Health Center	1	75 sq. meters	4 Bed Capacity
Luyong Bonbon	MLSA	2	<1 Meter	Day Care Center	1	50 sq meters	
Poblacion	MLSA	2	<1 Meter	Municipal Legislative Building	2	250 sq.meters	
Poblacion	MLSA	2	<1 Meter	Municipal Hall	2	400 sq meters	
Taboc	MLSA	2	<1 Meter	Senior Citizen Building	1	50 sq meters	
Taboc	MLSA	2	<1 Meter	Rural Health Center	1	150 sq meters	6 Bed Capacity
Taboc	HSA	4	>1 Meter	Day Care Center	1	100 sq meters	
Taboc	HSA	4	>1 Meter	Bridge	N/A	N/A	15 Tons

Sub-task 5.2.5 Lifeline Utilities

Lifeline utilities cover the transportation, water distribution, drainage, and power distribution networks. These are also important municipal/city assets which should be assessed to ensure the delivery of lifeline-related services (refer to Figure 3.5.1e). Exposure can be expressed in the linear kilometers exposed, and the construction cost or replacement values. At the minimum, LGUs can limit exposure to major or significant access/distribution networks.

- Estimate the exposed length per segment, per susceptibility level in kilometers (Column G);
- Determine the exposure percentage of exposed length relative to the total length of the segment (Column H);
- Compute for the exposed value by multiplying the estimated exposed segment with the estimated replacement cost per linear kilometer (Column J);
- Sample computation is presented below (refer to table 3.5.2e).

Figure 3.5.1e Sample Lifeline Utilities Flood Exposure Mapping

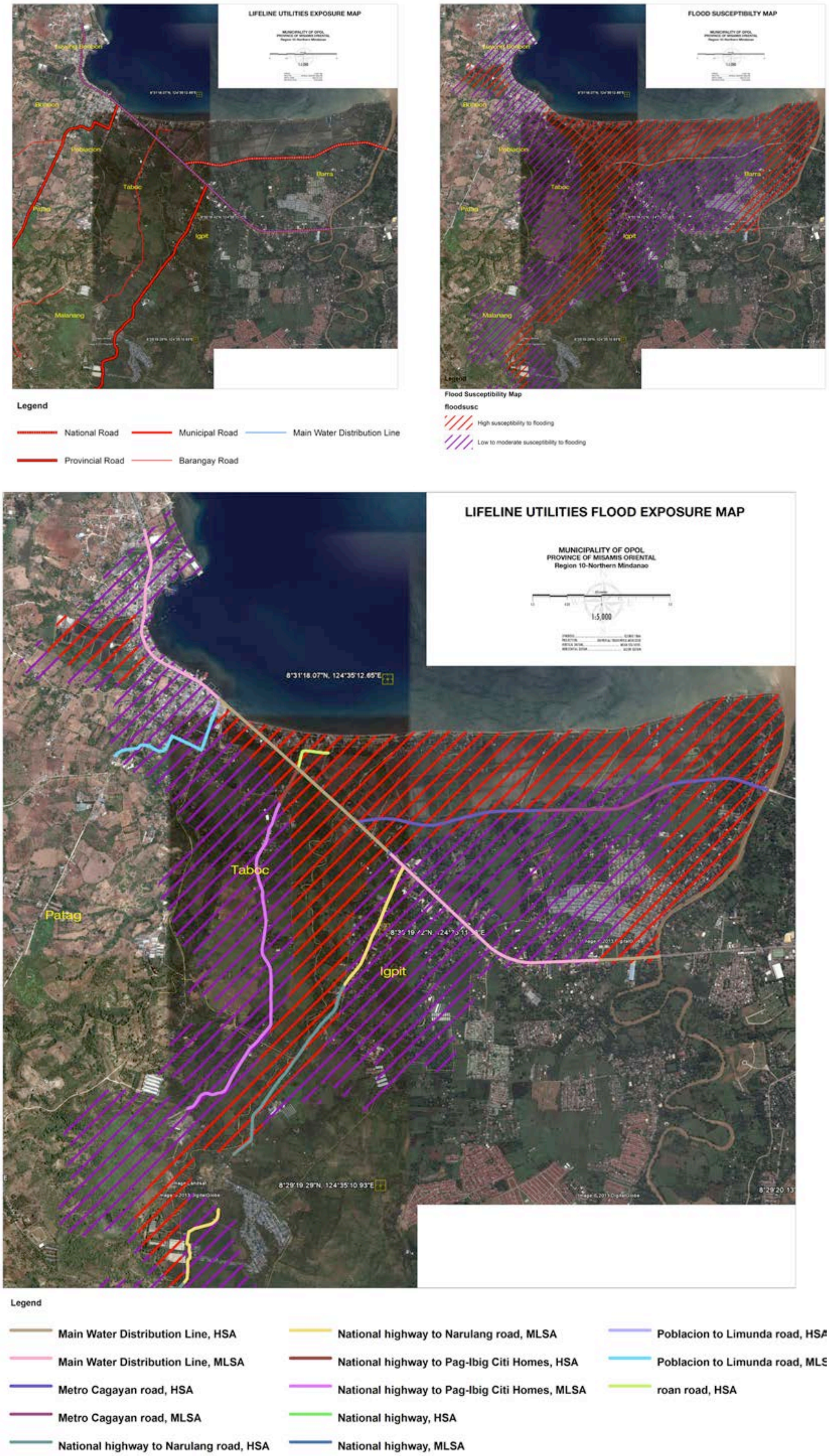


Table 3 .5.2e Sample Lifeline Utilities Flood Exposure Estimation, Municipality of Opol

A	B	C	D	E	F	G	H	I	J
	HAZARD			EXPOSURE					
Name	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Classification	Length (Km.)	Exposed length (Linear Kilometers)[1]	Exposure Percentage[2]	Replacement Cost	Value of exposed Lifeline[3]
							G/C		G*I
National highway to Pag-Ibig Citi Homes	MLSA	2	<1 Meter	Barangay Road	2.84	2.55	89.9%	11,036,000	28,192,566
National highway to Pag-Ibig Citi Homes	HSA	4	>1 Meter	Barangay Road	2.84	0.29	10.1%	11,036,000	3,180,575
National highway to Narulang road	HSA	4	>1 Meter	Provincial road	3.73	1.62	43.5%	18,000,000	29,165,400
National highway to Narulang road	MLSA	2	<1 Meter	Provincial road	3.73	1.64	43.9%	18,000,000	29,469,600
National highway	HSA	4	>1 Meter	National road	5.40	1.66	30.8%	23,000,000	38,288,100
National highway	MLSA	2	<1 Meter	National road	5.40	2.81	52.1%	23,000,000	64,692,100
Metro Cagayan road	HSA	4	>1 Meter	National road	3.08	2.11	68.4%	23,000,000	48,424,200
Metro Cagayan road	MLSA	2	<1 Meter	National road	3.08	0.92	29.8%	23,000,000	21,107,100
Main Water Distribution Line	HSA	4	>1 Meter	-	5.40	2.10	38.9%	N/A	N/A
Main Water Distribution Line	MLSA	2	<1 Meter	-	5.40	3.29	60.9%	N/A	N/A

[1] Estimated exposed lifelines expressed in linear kilometers are GIS derived.
[2] % Exposure derived by dividing the exposed segment length with the total segment length.
[3] Estimated affected value derived by multiplying replacement cost per linear kilometer and affected linear distance.

Task 5.3 Consequence Analysis

Assigning the severity of consequence score shall be based on expected magnitude of the hazard (hazard characterization), the extent of exposure (determined through hazard exposure mapping), and the vulnerabilities of the exposed elements (compiled in the exposure database), the combination of which will be the basis for determining the severity of consequence rating (refer to Table 3.5.3). Although the indicators selected for the vulnerability analysis are likely to be interrelated, it has been assumed for the purposes of these guidelines that each indicator can contribute dependently or independently to the vulnerability of an individual, community, structures, and natural resource-based production areas.

LGUs can organize workshop sessions and seek the participation of local stakeholders, members of the Planning and Development Council (C/MPDC), representatives/experts from mandated hazard mapping related agencies, and representatives from the Disaster Risk Reduction and Management Office. Participants shall be asked to give their subjective opinion on the severity of consequence scores (Table 3.5.2a-5.2e) per exposure unit, guided by the information generated from the hazard characterization, exposure mapping, and vulnerability analysis steps. Estimating the degree of damage can be qualitatively assigned using the degree of damage score matrix. The final composite severity of consequence score will be the average of scores derived from the participants.

Table 3.5.3 Severity of Consequence Score Matrix

Category	Severity of Consequence Score	Population	Urban Use Areas	Natural Resource based Production Areas	Critical Point Facilities	Lifeline Utilities
Very High	**4**	≥20% of the population are affected and in need of immediate assistance	≥40% of non-residential structures are severely damaged or ≥20% of residential structures are severely damaged	≥ 40% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged;	Damages may lead to the disruption of services which may last one week or more	Disruption of service by lasting one week or more (for Municipalities) and one day for Highly Urbanized Areas
High	**3**	>10 - <20% of affected population in need of immediate assistance	>20 to <40% of non-residential structures are severely damaged or >10-20% of residential structures are severely damaged	20 to <40% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged;	Damages lead may to the disruption of services which may last three days to less than a week	Disruption of service by approximately five days for municipalities and less than 18 hour disruption for highly urbanized areas
Moderate	**2**	>5%-10% of affected population in need of immediate assistance	>10 to 20% of non-residential structures are severely damaged or >5 to10% of residential structures are severely damaged	10 to <20% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged;	Damages may lead to the disruption of service lasting for one day to less than three days	Disruption of service by approximately three days for municipalities and less than six hour disruption for highly urbanized areas
Low	**1**	≤5% of the affected population in need of immediate assistance.	≤10% of non-residential structures are severely damaged or ≤5% of residential structures are severely damaged	<10% and below of of exposed production areas/ means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged;	Damages may lead to the disruption of service lasting less than one day	Disruption of service by approximately one day for municipalities and less than six hour disruption for highly urbanized areas

Sub-task 5.3.1 Determine factors contributing to Population vulnerability and estimate the severity of consequence score

Before proceeding to the degree of damage scoring, organize the exposure and vulnerability matrix. The matrix shall provide a brief description of the hazard (i.e. magnitude, susceptibility levels), the extent or number of exposed elements (i.e number of individuals or households), and the attributes/characteristics of the exposed elements which contribute to their vulnerabilities (i.e. number of households below the poverty threshold, number of persons with disabilities, proportion of informal settlers, access to post-disaster economic protection) relative to the expected magnitude of the hazard.

- Organize workshops with local stakeholders, policymakers, and local experts to assist in the assigning of the severity of consequence. To facilitate the assigning of the severity of consequence score, please refer to Table 3.5.3 (Population) for the severity score and description.

- When assigning the severity of consequence score, consider the expected magnitude of the hazard and relate it to the extent of exposure and the various vulnerability conditions.

- These can be scored by the participants or focus groups (i.e. stakeholders, TWG-LGU, Hazard/ Disaster Specialists/Experts). Representatives from the mandated hazard mapping agencies can be invited to participate such as PAGASA, DOST-NOAH, and MGB for floods; PAGASA for storm surges; MGB for rain-induced landslides; and PHIVOLCS for seismic and volcanic related hazards.

- The average of the various qualitative severity of consequence scores as assessed by the various participants can be used as the estimated severity of consequence.

- Please refer to Table 3.5.3a for a sample working table for the estimation of the severity of consequence. (Note: This is a continuation of Table 3.5.2a).

Sub-task 5.3.2 Determine factors contributing the Natural Resource-based Production Area vulnerability and estimate the severity of consequence score

Similar to population vulnerability, organize the exposure and vulnerability matrix for natural resource-based production areas (from the exposure database). The matrix should provide a comprehensive baseline information regarding the expected magnitude of the hazard, the extent of areas exposed (i.e. expressed in area and/or value), and the various vulnerability attributes that would contribute to damage (crop types, access to insurance, hazard control measures coverage, access to early warning systems, and climate proofed production techniques).

Provide a qualitative severity of consequence score based on the expected hazard magnitude, extent of exposure and the various vulnerability indicators. To facilitate the assigning of the severity of consequence score, please refer to Table 3.5.3 for the severity score and description. The average of the various qualitative severity of consequence scores as assessed by the various participants can be used as the estimated severity of consequence; Please refer to Table 3.5.3b for a sample working table for the estimation of the severity of consequence. (Note: This is a continuation of Table 3.5.2b)

Table 3.5.3a Sample Population Severity of Consequence Estimation for Floods

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
	HAZARD			EXPOSURE						VULNERABILITY						SEVERITY OF CONSEQUENCE SCORE			
Barangay	Flood Susceptibility	Likelihood of Occurrence Score	Flood depth	Barangay Population	Estimated Residential Area (Hectares)	Residential Area to Population Density (Persons/ Hectare)[1]	Affected Area (Hectares)	Affected Population	Exposure Percentage	Percentage of Informal Settlers	Percentage of Population Living in Dwelling Units with Walls Made from Light to Salvageable Materials	Percentage of Young and Old Dependents	Percentage of Persons with Disabilities	Percentage of Households Living Below the Poverty Threshold	Percentage Malnourished Individuals	Group 1	Group 2	Group 3	Average
						E/F		GxH	I/E										= (Q+R+S)/3*
Barra	HSA	4	≥1 meter	14,334	185.26	77.37	88.38	6,838	48%	1.06%	0.84%	33.58%	0.70%	14.55%	0.61%	3	3	3	3.00
Barra	MLSA	2	<1 meter	14,334	185.26	77.37	92.43	7,152	50%	1.06%	0.84%	33.58%	0.70%	14.55%	0.61%	3	3	3	3.00
Bonbon	MLSA	2	<1 meter	2,698	17.18	157.04	10.02	1,573	58%	3.13%	5.06%	34.31%	1.01%	35.86%	2.20%	1	1	1	1.00
Bonbon	HSA	4	≥1 meter	2,698	17.18	157.04	2.29	360	13%	3.13%	5.06%	34.31%	1.01%	35.86%	2.20%	1	1	1	1.00
Igpit	MLSA	2	<1 meter	10,123	252.20	40.14	175.02	7,025	69%	7.27%	1.75%	36.30%	0.70%	27.16%	1.06%	3	3	3	3.00
Igpit	HSA	4	≥1 meter	10,123	252.20	40.14	56.95	2,286	23%	7.27%	1.75%	36.30%	0.70%	27.16%	1.06%	3	3	3	3.00
Luyong Bonbon	HSA	4	≥1 meter	3,491	28.09	124.28	0.68	85	2%	2.00%	8.55%	35.43%	0.40%	41.51%	1.80%	1	3	2	2.00
Luyong Bonbon	MLSA	2	<1 meter	3,491	28.09	124.28	26.19	3,254	93%	2.00%	8.55%	35.43%	0.40%	41.51%	1.80%	1	3	2	2.00
Malanang	HSA	4	≥1 meter	3,593	102.07	35.20	13.77	485	13%	1.06%	0.79%	36.37%	0.84%	26.65%	0.32%	1	3	2	2.00
Malanang	MLSA	2	<1 meter	3,593	102.07	35.20	68.28	2,404	67%	1.06%	0.79%	36.37%	0.84%	26.65%	0.32%	1	1	1	1.00
Poblacion	HSA	4	≥1 meter	3,690	58.28	63.32	0.28	18	0%	4.06%	6.08%	32.25%	2.23%	21.30%	1.50%	1	1	1	1.00
Poblacion	MLSA	2	<1 meter	3,690	58.28	63.32	40.63	2,572	70%	4.06%	6.08%	32.24%	2.23%	21.29%	1.50%	1	1	1	1.00
Taboc	HSA	4	≥1 meter	2,918	63.68	45.82	31.49	1,443	49%	4.45%	8.74%	35.67%	0.89%	31.29%	0.59%	3	1	2	2.00
Taboc	MLSA	2	<1 meter	2,918	63.68	45.82	32.19	1,475	51%	4.45%	8.74%	35.67%	0.89%	31.29%	0.59%	1	3	2	2.00

*Depending on the number of groups

Table 3.5.3b Sample Natural Resource-based Production Area Severity of Consequence Estimation for Floods

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
	HAZARD			EXPOSURE						VULNERABILITY							SEVERITY OF CONSEQUENCE SCORE			
Barangay	Flood Suscept ibility	Likelihood of Occurrence Score	Flood Depth	Total Barangay Area Allocation (Hectares)	Dominant Crop	Average output per hectare (PHP)	Affected Area [1] (Hectares)	Affected Value (Php) [2]	Exposure Percentage [3]	Number of Farming Families who attended climate field school	Proportion of Farming Families using sustainable production techniques	Number of Famers with access to hazard information	Number of production areas with flood infrastructure coverage	% Areas with Irrigation Coverage	% Areas with Water Impoundment	Number of farming families with access to Early warning system	Group 1	Group 2	Group 3	Average
								GxH	H/E											= (R+S+T)/3
Barra	HSA	4	>1 Meter	58.66	vegetable	150,000	29.83	4,474,500	50.85%	NONE	0.00%	26.77%	NONE	0.00%	0.00%	26.77%	4	4	4	4
Bonbon	HSA	4	>1 Meter	108.93	rice	91,605	4.86	445,200	4.46%	NONE	0.00%	100.00%	NONE	0.00%	0.00%	100.00%	1	1	1	1
Igpit	HSA	4	>1 Meter	281.75	rice	91,605	51.03	4,674,603	18.11%	NONE	4.07%	20.33%	NONE	40.00%	20.00%	20.33%	4	2	3	3
Malanang	HSA	4	>1 Meter	1,750.28	rice	91,605	41.76	3,825,425	2.39%	NONE	1.52%	34.55%	NONE	36.00%	0.00%	34.55%	2	4	3	3
Taboc	HSA	4	>1 Meter	149.28	rice	91,605	33.38	3,057,775	22.36%	NONE	15.00%	35.00%	NONE	35.00%	30.00%	35.00%	4	4	4	4
Barra	MLSA	2	<1 Meter	58.66	vegetable	150,000	28.58	4,287,000	48.72%	NONE	0.00%	26.77%	NONE	0.00%	0.00%	26.77%	1	2	3	2
Bonbon	MLSA	2	<1 Meter	108.93	rice	91,605	15.60	1,429,038	14.32%	NONE	0.00%	100.00%	NONE	0.00%	0.00%	100.00%	1	1	1	1
Igpit	MLSA	2	<1 Meter	281.75	rice	91,605	170.53	15,621,401	60.53%	NONE	4.07%	20.33%	NONE	40.00%	20.00%	20.33%	2	4	3	3
Malanang	MLSA	2	<1 Meter	1,750.28	rice	91,605	131.07	12,006,667	7.49%	NONE	1.52%	34.55%	NONE	36.00%	0.00%	34.55%	3	3	3	3
Poblacion	MLSA	2	<1 Meter	53.26	rice	91,605	16.71	1,530,720	31.37%	NONE	0.00%	100.00%	NONE	25.00%	0.00%	100.00%	1	2	3	2
Taboc	MLSA	2	<1 Meter	149.28	rice	91,605	112.51	10,306,479	75.37%	NONE	15.00%	35.00%	NONE	35.00%	30.00%	35.00%	4	4	4	4
Barra	HSA	4	>1 Meter	30.67	Tilapia/Bangus	32,843	26.20	860,605	85.44%	NONE	0.00%	26.77%	NONE	100.00%	0.00%	26.77%	1	3	2	2
Igpit	HSA	4	>1 Meter	281.75	Tilapia/Bangus	32,843	73.63	2,418,276	26.13%	NONE	0.00%	20.33%	NONE	100.00%	20.00%	20.33%	3	3	3	3
Taboc	HSA	4	>1 Meter	149.28	Tilapia/Bangus	32,843	7.65	251,279	5.13%	NONE	0.00%	35.00%	NONE	100.00%	30.00%	35.00%	4	4	4	4
Barra	MLSA	2	<1 Meter	30.67	Tilapia/Bangus	32,843	5.09	167,302	16.61%	NONE	0.00%	26.77%	NONE	100.00%	0.00%	26.77%	3	1	2	2
Igpit	MLSA	2	<1 Meter	281.75	Tilapia/Bangus	32,843	0.62	20,256	0.22%	NONE	0.00%	20.33%	NONE	100.00%	20.00%	20.33%	2	1	3	2

Sub-task 5.3.3 Determine factors contributing to Urban Use Area vulnerability and estimate the severity of consequence score

Damage to structures or the building stock can be attributed to several factors namely: strucutral design, construction materials used, age of the structure, current condition (i.e. dilapidated, condemened), approved building and zoning permits, and insurance coverge. These can be gathered and presented at the barangay level depending on the availability of local data and fund availability for conducting building surveys. At the minimum, a description of the building characteristics should be presented to inform and guide the estimation of the severity of conseqeunce.

Provide a qualitative severity of consequence score based on the expected hazard magnitude, extent of exposure, and the various vulnerability indicators. To facilitate the assigning of the severity of consequence score, please refer to Table 3.5.3 for the severity score and description. The average of the various qualitative severity of consequence scores, as assessed by the various participants, can be used as the estimated severity of consequence. Please refer to Table 3.5.3c for a sample working table for the estimation of the severity of consequence. (Note: This is a continuation of Table 3.5.2c).

Sub-task 5.3.4 Determine factors contributing to Critical Point Facilities Vulnerability and estimate the severity of consequence score

Vulnerability conditions for critical point facilities should focus mainly on the structural design characteristics of buildings and structures. LGUs should comprehensively describe the vulnerability of the structure to damage and look into the existing structural condition, insurance coverage, wall/roof construction materials, and hazard-specific design employed (i.e. building designed to withstand a 100-year flood, storm surge, potential earthquake, intensity/ground acceleration, tsunami, etc.).

Provide a qualitative severity of consequence score based on the expected hazard magnitude, extent of exposure and the various vulnerability indicators. To facilitate the assigning of the severity of consequence score, please refer to table 3.5.3 for the severity score and description. The average of the various qualitative severity of consequence scores as assessed by the various participants can be used as the estimated severity of consequence. Please refer to Table 3.5.3d for a sample working table for the estimation of the severity of consequence. (Note: This is a continuation of Table 3.5.2d)

Table 3.5.3c Sample Urban Use Area Severity of Consequence Estimation for Floods

A	B	C	D	E	F	G	H	I	J	K	L	M	O	P	Q	R	S
		HAZARD			EXPOSURE					VULNERABILITY				SEVERITY OF CONSEQUENCE SCORE			
Barangay	Land Use Category	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Total Barangay area Allocation in Hectares	Replacement Cost per Sq. Meter(PHP)	Affected Area in Hectares (GIS Derived)	Affected Value (PHP)	% Exposure	Proportion of Buildings with Walls with Light to Salvageable Materials	Proportion of Buildings in Dilapidated/ Condemned Condition	Structure Not Employing Hazard-Resistant Building Design	No Access/Area Coverage to Infrastructure-Related Hazard Mitigation Measures	Group 1	Group 2	Group 3	Average
								HxGx10000	H/F								= (P+Q+R)/3
Barra	Commercial	HSA	4	>1 Meter	3.32	8,672	1.69	146,558,997	50.90%	Very Low	Very Low	Moderate	Moderate	2	2	2	2
Barra	Residential	HSA	4	>1 Meter	27.79	5,400	17.24	930,894,488	62.04%	Low	Very Low	Very High	Moderate	2	4	3	3
Barra	Light Industries	HSA	4	>1 Meter	3.06	8,672	1.32	114,472,116	43.14%	Low	Low	Moderate	Moderate	3	1	2	2
Barra	Parks and Play Ground	HSA	4	>1 Meter	1.24	3,254	0.39	12,690,600	31.45%	Residual	Residual	Residual	Moderate	0	0	0	0
Barra	Socialized Housing	HSA	4	>1 Meter	24.16	5,400	9.08	490,285,496	37.58%	Low	Very Low	Very High	Moderate	4	2	3	3
Barra	Tourism Areas	HSA	4	>1 Meter	7.20	8,672	7.20	624,393,360	100.00%	Moderate	Moderate	Low	Moderate	1	1	1	1
Barra	Commercial	MLSA	2	<1 Meter	3.32	8,672	1.57	136,152,441	47.29%	Low	Low	Moderate	Moderate	1	3	2	2
Barra	Residential Areas	MLSA	2	<1 Meter	27.79	5,400	10.38	560,480,556	37.35%	Low	Very Low	High	Low	2	1	3	2
Barra	Light Industries	MLSA	2	<1 Meter	3.06	8,672	1.74	150,895,062	56.86%	Low	Low	Low	Low	1	3	2	2
Barra	Parks and Play Ground	MLSA	2	<1 Meter	1.24	3,254	0.84	27,333,600	67.74%	Residual	Residual	Residual	Low	0	0	0	0
Barra	Socialized Housing	MLSA	2	<1 Meter	24.16	5,400	15.08	814,262,696	62.42%	Low	Very Low	High	Low	2	2	2	2

Table 3.5.3d Sample Critical Point Facilities Severity of Consequence Estimation for Floods

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
		HAZARD			EXPOSURE			VULNERABILITY			SEVERITY OF CONSEQUENCE SCORE			
Barangay	Facility Type	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Storey	Area	Number of Classrooms/ Rooms/Bed Capacity	Wall Materials Used	Existing Condition	Structure Employing Hazard Resistant Design	Group 1	Group 2	Group 3	Average
														= (L+M+N)/3
Bonbon	Senior Citizen Building	HSA	4	>1 Meter	2	50 sq meters		Mixed	Poor/needs major repair	No	2	4	3	3
Taboc	Senior Citizen Building	MLSA	2	<1 Meter	1	50 sq meters		Concrete	Needs repair	No	1	1	1	1
Taboc	Rural Health Center	MLSA	2	<1 Meter	1	150 sq meters	6 Bed Capacity	Concrete	Good	Yes	1	1	1	1
Poblacion	Municipal Legislative Building	MLSA	2	<1 Meter	2	250 sq.meters		Concrete	Good	Yes	1	1	1	1
Poblacion	Municipal Hall	MLSA	2	<1 Meter	2	400 sq meters		Concrete	Good	Yes	1	1	1	1
Barra	Health Center	HSA	4	>1 Meter	2	75 sq. meters	4 Bed Capacity	Concrete	Good	Yes	1	1	1	1
Bonbon	Health Center	MLSA	2	<1 Meter	1	75 sq. meters	4 Bed Capacity	Concrete	Good	No	1	3	2	2
Luyong Bonbon	Health Center	MLSA	2	<1 Meter	1	75 sq. meters	4 Bed Capacity	Wood	Poor	No	2	2	2	2
Igpit	Foot Bridge	HSA	4	>1 Meter	N/A	N/A	3 Tons	Steel Centered Cable Wire	Needs minor repair	No	2	4	3	3
Bonbon	Elementary School	HSA	4	>1 Meter	1	10000 sq meters	6 Classrooms	Wood	needs repair	No	4	2	3	3
Barra	Elementary School	HSA	4	>1 Meter	1	6404 sq. meters	15 Classrooms	Concrete	Good	No	2	4	2	3
Igpit	Elementary School	MLSA	2	<1 Meter	1	23986 sq. meters	8 Classrooms	Mixed	needs repair	No	2	2	2	2
Igpit	Day Care Center	HSA	4	>1 Meter	1	50 sq meters		Concrete	Poor	No	3	4	2	3
Taboc	Day Care Center	HSA	4	>1 Meter	1	100 sq meters		Concrete	Good	No	3	3	3	3
Bonbon	Day Care Center	HSA	4	>1 Meter	2	50 sq meters		Mixed	Poor/needs major repair	No	3	1	2	2
Luyong Bonbon	Day Care Center	MLSA	2	<1 Meter	1	50 sq meters		Wood	Poor	No	2	2	2	2
Barra	Bridge	HSA	4	>1 Meter	N/A	N/A	20 Tons	Concrete	Good	Yes	1	1	1	1
Taboc	Bridge	HSA	4	>1 Meter	N/A	N/A	15 Tons	Concrete	Good	Yes	1	1	1	1

Sub-task 5.3.5 Determine factors contributing to Lifeline Utilities vulnerability and estimate the severity of consequence score

Vulnerability conditions pertain to the structural design characteristics of the lifeline asset/s. For roads, vulnerability can be described and limited to surface type, current condition, and whether these roads have unique hazard resistant design specifications. Similar to transportation, water-related distribution lifelines can also be described depending on its current condition, pipe materials used, and the unique hazard resistant design specifications employed. These vulnerability parameters should guide the estimation of the severity of consequence and determine whether hazards will significantly affect the water and power distribution and access/linkages systems of the city/municipality.

Provide a qualitative severity of consequence score based on the expected hazard magnitude, extent of exposure and the various vulnerability indicators. To facilitate the assigning of the severity of consequence score, please refer to table 3.5.3 for the severity score and description. The average of the various qualitative severity of consequence scores as assessed by the various participants can be used as the estimated severity of consequence. Please refer to Table 3.5.3e for a sample working table for the estimation of the severity of consequence. (Note: This is a continuation of Table 3.5.2e).

Table 3.5.3e Sample Lifeline Utilities Severity of Consequence Estimation for Floods

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
		HAZARD			EXPOSURE			VULNERABILITY			SEVERITY OF CONSEQUENCE SCORE			
Name	Classification	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Replacement Cost	Affected Distance (Linear Kilometers)[1]	Affected Value[2]	Surface Type	Existing Condition	Hazard Resistant Design	Group 1	Group 2	Group 3	Average
							G*F							= (L+M+N)/3
National highway to Narulang road	Provincial road	HSA	4	>1 Meter	18,000,000	1.62	29,165,400	Concrete/ Gravel	Needs minor repair	No	2	4	3	3.00
National highway to Pag-Ibig Citi Homes	Barangay Road	MLSA	2	<1 Meter	11,036,000	2.55	28,192,566	Concrete/ Gravel	Poor	No	2	2	2	2.00
Metro Cagayan road	National road	HSA	4	>1 Meter	23,000,000	2.11	48,424,200	Concrete	Good	Yes	1	1	1	1.00
Metro Cagayan road	National road	MLSA	2	<1 Meter	23,000,000	0.92	21,107,100	Concrete	Good	Yes	1	1	1	1.00
National highway	National road	HSA	4	>1 Meter	23,000,000	1.66	38,288,100	Concrete	Good	Yes	1	1	1	1.00
National highway	National road	MLSA	2	<1 Meter	23,000,000	2.81	64,692,100	Concrete	Good	Yes	1	1	1	1.00
National highway to Narulang road	Provincial road	MLSA	2	<1 Meter	18,000,000	1.64	29,469,600	Concrete	Good	Yes	1	1	1	1.00
National highway to Pag-Ibig Citi Homes	Barangay Road	HSA	4	>1 Meter	11,036,000	0.29	3,180,575	Concrete	Needs minor repair	Yes	3	3	3	3.00
Poblacion to Limunda road	Provincial road	HSA	4	>1 Meter	18,000,000	0.09	1,699,200	Concrete	Good	Yes	1	1	1	1.00
Poblacion to Limunda road	Provincial road	MLSA	2	<1 Meter	18,000,000	1.03	18,511,200	Concrete	Good	Yes	1	1	1	1.00
roan road	Barangay Road	HSA	4	>1 Meter	11,036,000	0.31	3,467,511	Concrete	Good	Yes	1	1	1	1.00
Main Water Distribution Line	Government	HSA	4	>1 Meter	N/A	2.10	N/A	Steel	Good	Yes	1	1	1	1.00
Main Water Distribution Line	Government	MLSA	2	<1 Meter	N/A	3.29	N/A	Steel	Good	Yes	1	1	1	1.00

Task 5.4 Risk Estimation

Estimate the risks for the various exposure units. Risk is operationalized using the function:

Risk = Likelihood of Occurrence x Severity of Consequence

The risk estimation for the various exposure units involves three major steps namely:

1. Computation of the risk score
2. Reclassifying risk scores into risk categories
3. Preparation of risk maps

The resulting risk score/categories, and risk maps will provide a qualitative index of the various location of high risk areas in the locality. Using the computed risk score/s, reclassify them into risk categories using the Risk Score Matrix below (refer to Table 3.5.4). Risk scores reflect three possible scenarios:

High Risk Areas - Areas, zones or sectors may be considered "high risk" if hazard events have very high to moderate severity of consequence, given the scale of exposure, vulnerability to the potential impacts of the hazards, and the level of adaptive capacity to endure direct and indirect impacts of the hazard and likelihood of occurrence ranging from frequent to improbable events. The range of risk score for this scenario is 12 to 24.

Moderate Risk - Areas, zones or sectors may be considered a "moderate risk" if the likelihood of occurrence of a hazard event is improbable to rare with a very high to moderate severity of consequence. These may also pertain to areas where the severity of consequence is "moderate to minor" but with a likelihood of occurrence that is frequent. The range of risk score for this scenario is 5 to <12.

Low Risk - Areas, zones or sectors may be considered "low risk" for very rare hazard events with very high to high severity of consequences. It may also pertain to moderate to low severity of consequence from an occasional to a very rare event. Risk scores for this scenario is <5.

The suggested risk score matrix adopts the probabilistic risk estimation approach where the combination of the frequency (likelihood of occurrence) of the hazard and its resulting damage (severity of consequence) are used as basis for identifying and prioritizing risk areas for immediate implementation of risk management options under the notion that resources are often limited and should be allocated to address chronic hazards and its impacts. Available resources can be initially allocated for addressing priority areas (or high risk areas) in need of immediate interventions characterized by areas where the estimated damage will be very high to high and the likelihood of occurrence of the hazard is within 10-100 years. However, in a land use planning perspective, areas considered as low risk areas where the expected damage is very high/ catastrophic but are triggered by rare to extremely rare events (>100 years) can and should also be addressed within the short term to medium term when available resources permit.

Table 3.5.4 Risk Score Matrix

Indicative Likelihood of Occurrence	Likelihood of Occurrence Score	Severity of Consequence Score			
		Very High	High	Moderate	Low
		4	3	2	1
Frequent (1-3 Years)	6	24	18	12	6
Moderate (4-10 Years)	5	20	15	10	5
Occasional Slight Chance (11-30 Years)	4	16	12	8	4
Improbable (31-100 Years)	3	12	9	6	3
Rare (101-200 Years)	2	8	6	4	2
Very rare (>200 years)	1	4	3	2	1

Source: Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans Report, NEDA-UNDP-HLURB,2012

Sub-task 5.4.1 Derive the Population Risk Score

Taking off from the severity of consequence table (Table 3.5.3a) add two columns that will contain the risk scores and risk categories. Multiply the likelihood occurrence with the average severity of consequence score derived from the previous step (refer to Table 3.5.4a). The risk score will provide an indicative index of risk.

Sub-task 5.4.1.1 Reclassify the risk scores into risk categories

Based on the derived risk scores and corresponding risk categories (Table 3.5.4), reclassify the risk scores into risk categories (refer to table 3.5.4a).

Sub-task 5.4.1.2. Prepare Risk Maps

Prepare a population risk map indicating the spatial extent and distribution of risk (i.e. High, Moderate Low). The map should guide the identification of decision areas for a particular hazard, where site/area issues and concerns can be articulated and the general policy directions and options can be identified and enumerated (refer to figure 3.5.2a).

Figure 3.5.2a Flood Risk to Population Map

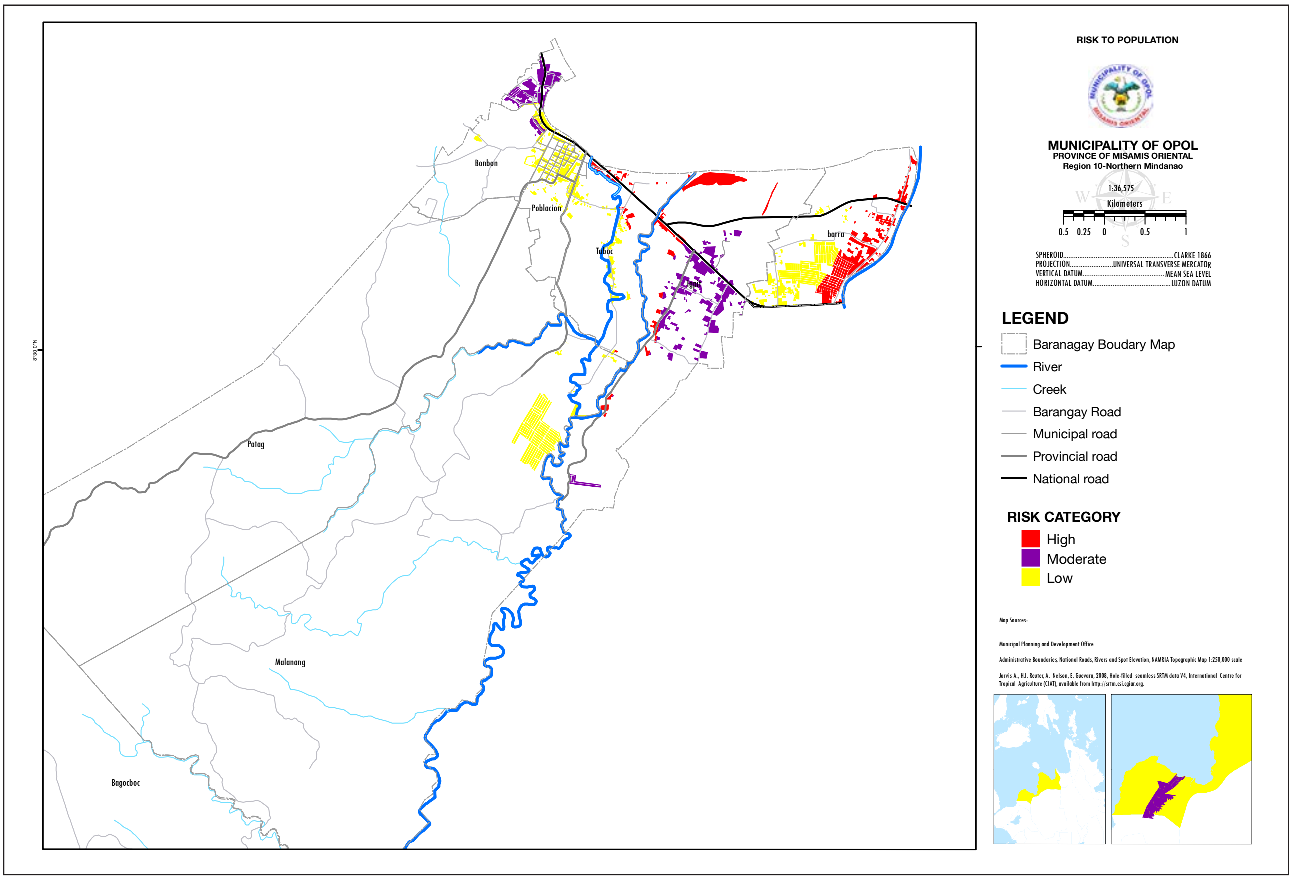


Table 3.5.4a Sample Population Risk to Floods

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	T	U	V
	HAZARD			EXPOSURE						VULNERABILITY						SEVERITY OF CONSEQUENCE SCORE	RISK	
Barangay	Flood Susceptibility	Likelihood of Occurrence Score	Flood depth	Barangay Population	Estimated Residential Area (Hectares)	Population Density per Hectare of Residential Area[1]	Affected Area (Hectares)[2]	Affected Population[3]	Exposure Percentage	Percentage of Informal Settlers	Percentage of Population Living in Dwelling Units with Walls Made from Light to Salvageable Materials	Percentage of Young and Old Dependents	Percentage of Persons with Disabilities	Percentage of Households Living Below the Poverty Threshold	Percentage Malnourished Individuals		Risk Score	Risk Category
						E/F		GxH	I/E								=C x T	
Barra	HSA	4	≥1 meter	14,334.00	185.26	77.37	88.38	6,838	47.71%	1.06%	0.84%	33.58%	0.70%	14.55%	0.61%	3	12	High
Barra	MLSA	2	<1 meter	14,334.00	185.26	77.37	92.43	7,152	49.89%	1.06%	0.84%	33.58%	0.70%	14.55%	0.61%	3	6	Moderate
Bonbon	MLSA	2	<1 meter	2,698.00	17.18	157.04	10.02	1,573	58.30%	3.13%	5.06%	34.31%	1.01%	35.86%	2.20%	1	2	Low
Bonbon	HSA	4	≥1 meter	2,698.00	17.18	157.04	2.29	360	13.35%	3.13%	5.06%	34.31%	1.01%	35.86%	2.20%	1	4	Low
Igpit	MLSA	2	<1 meter	10,123.00	252.20	40.14	175.02	7,025	69.40%	7.27%	1.75%	36.30%	0.70%	27.16%	1.06%	3	6	Moderate
Igpit	HSA	4	≥1 meter	10,123.00	252.20	40.14	56.95	2,286	22.58%	7.27%	1.75%	36.30%	0.70%	27.16%	1.06%	3	12	High
Luyong Bonbo	HSA	4	≥1 meter	3,491.00	28.09	124.28	0.68	85	2.42%	2.00%	8.55%	35.43%	0.40%	41.51%	1.80%	2	8	Moderate
Luyong Bonbo	MLSA	2	<1 meter	3,491.00	28.09	124.28	26.19	3,254	93.22%	2.00%	8.55%	35.43%	0.40%	41.51%	1.80%	2	4	Low
Malanang	HSA	4	≥1 meter	3,593.00	102.07	35.20	13.77	485	13.49%	1.06%	0.79%	36.37%	0.84%	26.65%	0.32%	2	8	Moderate
Malanang	MLSA	2	<1 meter	3,593.00	102.07	35.20	68.28	2,404	66.90%	1.06%	0.79%	36.37%	0.84%	26.65%	0.32%	1	2	Low
Poblacion	HSA	4	≥1 meter	3,690.00	58.28	63.32	0.28	18	0.49%	4.06%	6.08%	32.25%	2.23%	21.30%	1.50%	1	4	Low
Poblacion	MLSA	2	<1 meter	3,690.00	58.28	63.32	40.63	2,572	69.71%	4.06%	6.08%	32.24%	2.23%	21.29%	1.50%	1	2	Low
Taboc	HSA	4	≥1 meter	2,918.00	63.68	45.82	31.49	1,443	49.45%	4.45%	8.74%	35.67%	0.89%	31.29%	0.59%	2	8	Moderate
Taboc	MLSA	2	<1 meter	2,918.00	63.68	45.82	32.19	1,475	50.55%	4.45%	8.74%	35.67%	0.89%	31.29%	0.59%	2	4	Low

Sub-task 5.4.2 Derive the Natural Resource Areas Risk Score

Taking off from the severity of consequence table (Table 3.5.3b) add two columns that will contain the risk scores and risk categories. Multiply the likelihood occurrence with the average severity of consequence score derived from the previous step (refer to Table 3.5.4b). The risk score will provide an indicative index of risk.

Sub-task 5.4.2.1 Reclassify the risk scores into risk categories

Based on the recommended risk scores and corresponding risk categories (Table 3.5.4), reclassify risk scores into risk categories (refer to Table 3.5.4b).

Sub-task 5.4.2.2 Prepare risk maps

Prepare a natural resource-based production area risk map indicating the spatial extent and distribution of risk (i.e. High, Moderate Low). This should guide the identification of decision areas for a particular hazard where site/area issues and concerns can be articulated and the general policy directions and options can be identified and enumerated (refer to Figure 3.5.2b).

Figure 3.5.2b Flood Risk to Natural Resource-based Production Areas Map

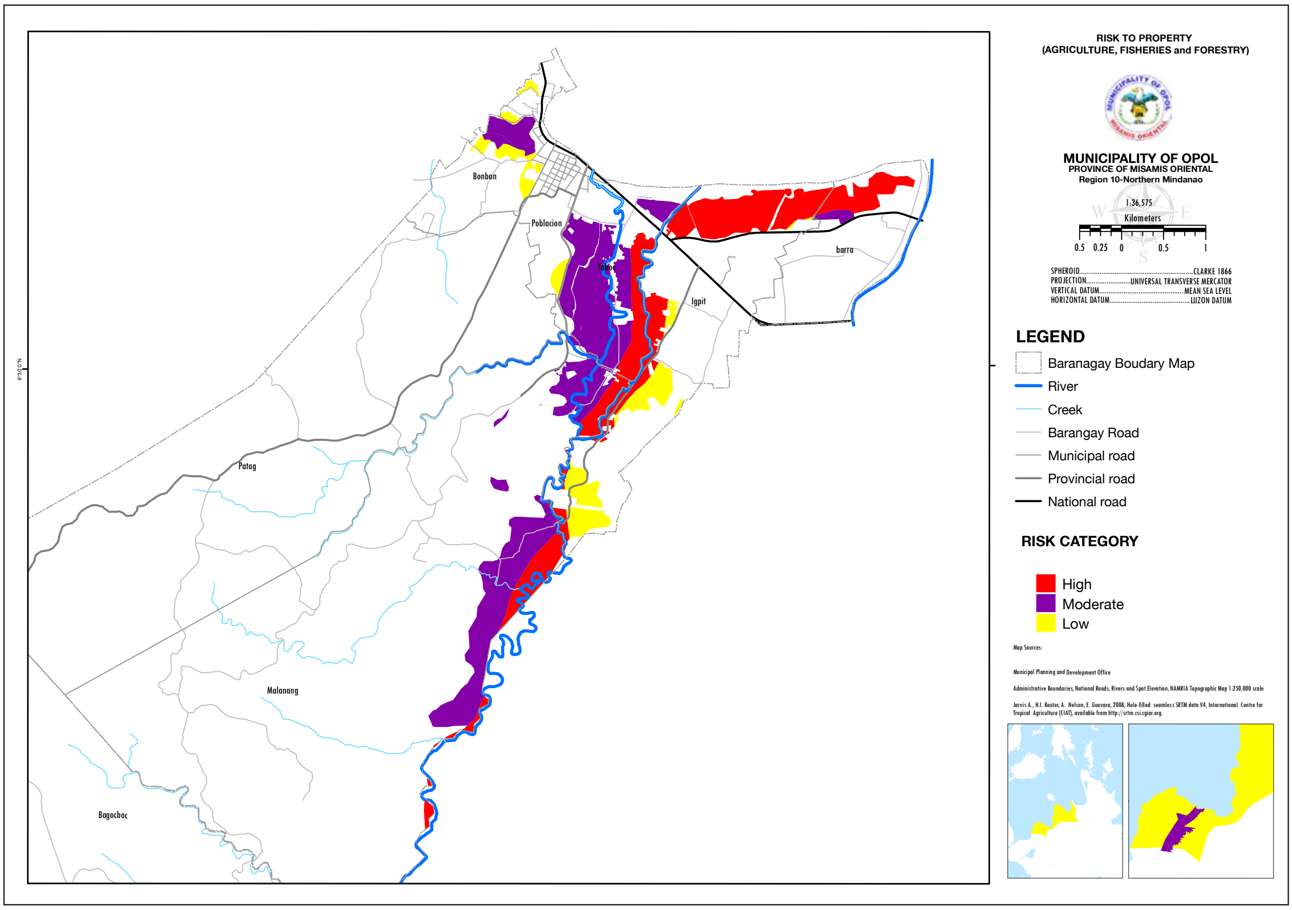


Table 3.5.4b Sample Flood Risk to Natural Resource Production-based areas

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	U	V	W
	HAZARD			EXPOSURE						VULNERABILITY								RISK	
Barangay	Flood Susceptibility	Likelihood of Occurrence Score	Flood Depth	Total Barangay Area Allocation	Dominant Crop	Average output per hectare (PHP)	Affected Area [1] (Hectares)	Affected Value (Php) [2]	Exposure Percentage [3]	Number of Farming Families who Attended Climate Field School	Proportion of Farming Families Using Sustainable Production Techniques	Number of Famers with Access to Hazard Information	Number of Production Areas with Infrastructure Coverage	% Areas with Irrigation Coverage	% Areas with Water Impoundment	Number of farming families with access to Early warning system	SEVERITY OF CONSEQUENCE SCORE	Risk Score	Risk Category
								GxH	H/E									=C x U	
Barra	HSA	4	>1 Meter	58.66	vegetable	150,000	29.83	4,474,500	50.85%	NONE	0.00%	26.77%	NONE	0.00%	0.00%	26.77%	4	16	High
Bonbon	HSA	4	>1 Meter	108.93	rice	91,605	4.86	445,200	4.46%	NONE	0.00%	100.00%	NONE	0.00%	0.00%	100.00%	1	4	Low
Igpit	HSA	4	>1 Meter	281.75	rice	91,605	51.03	4,674,603	18.11%	NONE	4.07%	20.33%	NONE	40.00%	20.00%	20.33%	3	12	High
Malanang	HSA	4	>1 Meter	1,750.28	rice	91,605	41.76	3,825,425	2.39%	NONE	1.52%	34.55%	NONE	36.00%	0.00%	34.55%	3	12	High
Taboc	HSA	4	>1 Meter	149.28	rice	91,605	33.38	3,057,775	22.36%	NONE	15.00%	35.00%	NONE	35.00%	30.00%	35.00%	4	16	High
Barra	MLSA	2	<1 Meter	58.66	vegetable	150,000	28.58	4,287,000	48.72%	NONE	0.00%	26.77%	NONE	0.00%	0.00%	26.77%	2	4	Low
Bonbon	MLSA	2	<1 Meter	108.93	rice	91,605	15.60	1,429,038	14.32%	NONE	0.00%	100.00%	NONE	0.00%	0.00%	100.00%	1	2	Low
Igpit	MLSA	2	<1 Meter	281.75	rice	91,605	170.53	15,621,401	60.53%	NONE	4.07%	20.33%	NONE	40.00%	20.00%	20.33%	3	6	Moderate
Malanang	MLSA	2	<1 Meter	1,750.28	rice	91,605	131.07	12,006,667	7.49%	NONE	1.52%	34.55%	NONE	36.00%	0.00%	34.55%	3	6	Moderate
Poblacion	MLSA	2	<1 Meter	53.26	rice	91,605	16.71	1,530,720	31.37%	NONE	0.00%	100.00%	NONE	25.00%	0.00%	100.00%	2	4	Low
Taboc	MLSA	2	<1 Meter	149.28	rice	91,605	112.51	10,306,479	75.37%	NONE	15.00%	35.00%	NONE	35.00%	30.00%	35.00%	4	8	Moderate
Barra	HSA	4	>1 Meter	30.67	Tilapia/Bangus	32,843	26.20	860,605	85.44%	NONE	0.00%	26.77%	NONE	100.00%	0.00%	26.77%	2	8	Moderate
Igpit	HSA	4	>1 Meter	281.75	Tilapia/Bangus	32,843	73.63	2,418,276	26.13%	NONE	0.00%	20.33%	NONE	100.00%	20.00%	20.33%	3	12	High
Taboc	HSA	4	>1 Meter	149.28	Tilapia/Bangus	32,843	7.65	251,279	5.13%	NONE	0.00%	35.00%	NONE	100.00%	30.00%	35.00%	4	16	High
Barra	MLSA	2	<1 Meter	30.67	Tilapia/Bangus	32,843	5.09	167,302	16.61%	NONE	0.00%	26.77%	NONE	100.00%	0.00%	26.77%	2	4	Low
Igpit	MLSA	2	<1 Meter	281.75	Tilapia/Bangus	32,843	0.62	20,256	0.22%	NONE	0.00%	20.33%	NONE	100.00%	20.00%	20.33%	2	4	Low

Sub-task 5.4.3.1 Derive the Urban Use Areas Risk Score

Taking off from the severity of consequence table (Table 3.5.3c) add two columns that will contain the risk scores and risk categories. Multiply the likelihood occurrence with the average severity of consequence score derived from the previous step (refer to Table 3.5.4c). The risk score will provide an indicative index of risk .

Sub-task 5.4.3.2. Reclassify the risk scores into risk categories

Based on the recommended risk scores and corresponding risk categories (Table 3.5.4), reclassify risk scores into risk categories (refer to Table 3.5.4c).

Sub-task 5.4.3.3. Prepare risk maps

Prepare an urban use area risk map indicating the spatial extent and distribution of risk (i.e. High, Moderate Low). This should guide the identification of decision areas for a particular hazard where site/area issues and concerns can be articulated and the general policy directions and options can be identified and enumerated (refer to figure 3.5.2c).

Figure 3.5.2c Flood Risk to Urban Use Areas Map

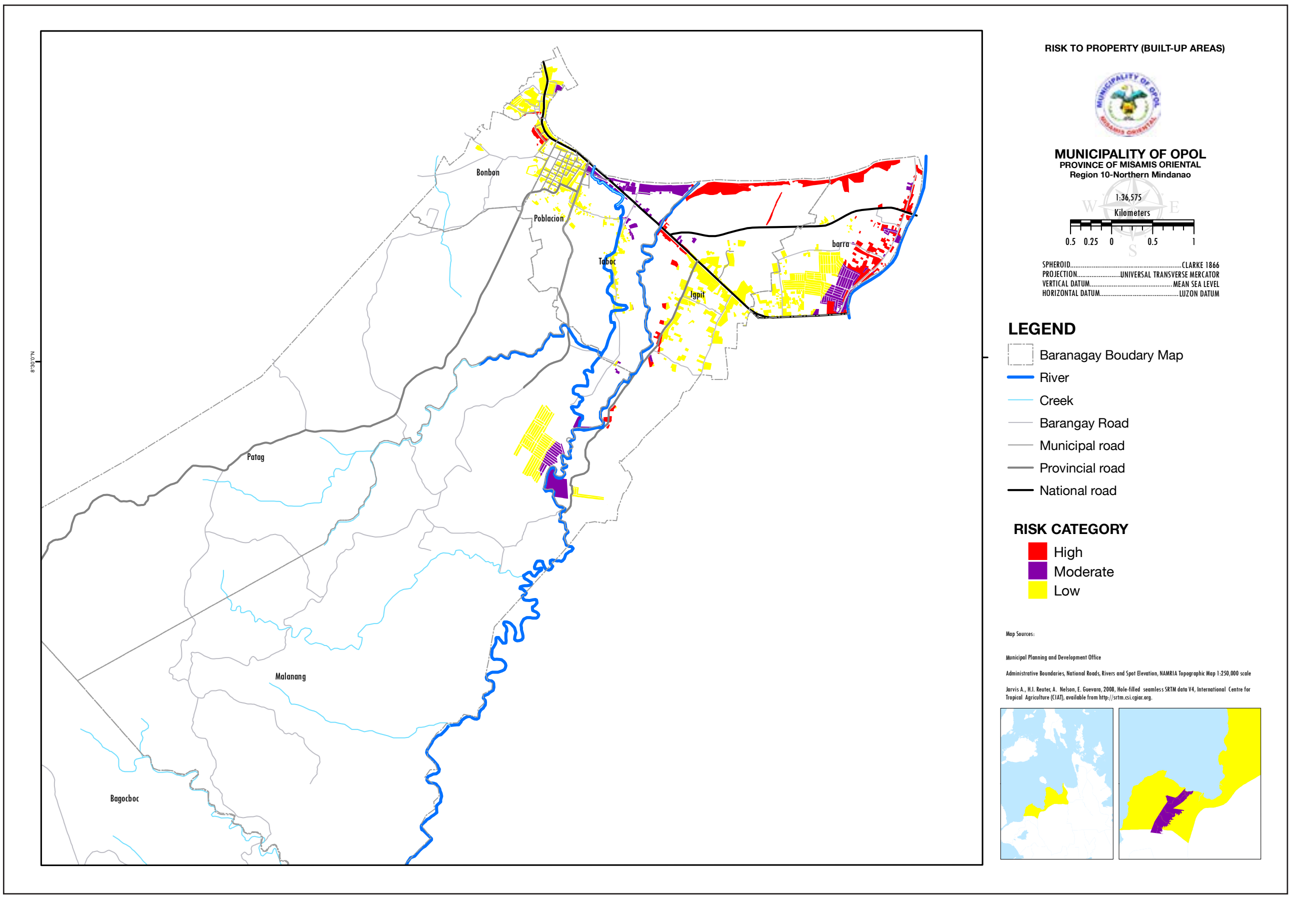


Table 3.5.4c Flood Risk to Urban Use Areas

A	B	C	D	E	F	G	H	I	J	K	L	M	O	S	T	U
		HAZARD			EXPOSURE					VULNERABILITY					RISK	
Barangay	Land Use Category	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Total Barangay area Allocation in Hectares	Replacement Cost per Sq. Meter(PHP)	Affected Area in Hectares (GIS Derived)	Affected Value (PHP)	% Exposure	Proportion of buildings with walls with light to salvageable materials	Proportion of Buildings in dilapidated/ condemned Condition	Structure not employing hazard resistant building design	Structures with no access/area coverage to infrastructure related mitigation measures	SEVERITY OF CONSEQUENCE SCORE	Risk Score	Risk Category
								HxGx10000	H/F						=S x D	
Barra	Commercial	HSA	**4**	>1 Meter	3.32	8,672	1.69	146,558,997	50.90%	Very Low	Very Low	Moderate	Moderate	**2**	**8**	**Moderate**
Barra	Residential	HSA	**4**	>1 Meter	27.79	5,400	17.24	930,894,488	62.04%	Low	Very Low	Very High	Moderate	**3**	**12**	**High**
Barra	Light Industries	HSA	**4**	>1 Meter	3.06	8,672	1.32	114,472,116	43.14%	Low	Low	Moderate	Moderate	**2**	**8**	**Moderate**
Barra	Parks and Play Ground	HSA	**4**	>1 Meter	1.24	3,254	0.39	12,690,600	31.45%	Residual	Residual	Residual	Moderate	**0**	**0**	**None**
Barra	Socialized Housing	HSA	**4**	>1 Meter	24.16	5,400	9.08	490,285,496	37.58%	Low	Very Low	Very High	Moderate	**3**	**12**	**High**
Barra	Tourism Areas	HSA	**4**	>1 Meter	7.20	8,672	7.20	624,393,360	100.00%	Moderate	Moderate	Low	Moderate	**1**	**4**	**Low**
Barra	Commercial	MLSA	**2**	<1 Meter	3.32	8,672	1.57	136,152,441	47.29%	Low	Low	Moderate	Moderate	**2**	**4**	**Low**
Barra	Residential Areas	MLSA	**2**	<1 Meter	27.79	5,400	10.38	560,480,556	37.35%	Low	Very Low	High	Low	**2**	**4**	**Low**
Barra	Light Industries	MLSA	**2**	<1 Meter	3.06	8,672	1.74	150,895,062	56.86%	Low	Low	Low	Low	**2**	**4**	**Low**
Barra	Parks and Play Ground	MLSA	**2**	<1 Meter	1.24	3,254	0.84	27,333,600	67.74%	Residual	Residual	Residual	Low	**0**	**0**	**None**
Barra	Socialized Housing	MLSA	**2**	<1 Meter	24.16	5,400	15.08	814,262,696	62.42%	Low	Very Low	High	Low	**2**	**4**	**Low**

Sub-task 5.4.4 Derive the Critical Facilities Risk Score

Taking off from the severity of consequence table (Table 3.5.3d) add two columns that will contain the risk scores and risk categories. Multiply the likelihood occurrence with the average severity of consequence score derived from the previous step (refer to Table 3.5.4d). The risk score will provide an indicative index of risk .

Sub-task 5.4.4.1 Reclassify the risk scores into risk categories

Based on the recommended risk scores and corresponding risk categories (Table 3.5.4), reclassify risk scores into risk categories (refer to Table 3.5.4d).

Sub-task 5.4.4.2 Prepare risk maps

Prepare a critical point facility risk map indicating the risk level (i.e. High, Moderate Low) per facility. This should guide the identification of facilities for a particular hazard where issues and concerns can be articulated and the general policy directions and options can be identified and enumerated (refer to Figure 3.5.2d).

Figure 3.5.2d Flood Risk to Critical Point Facilities Map

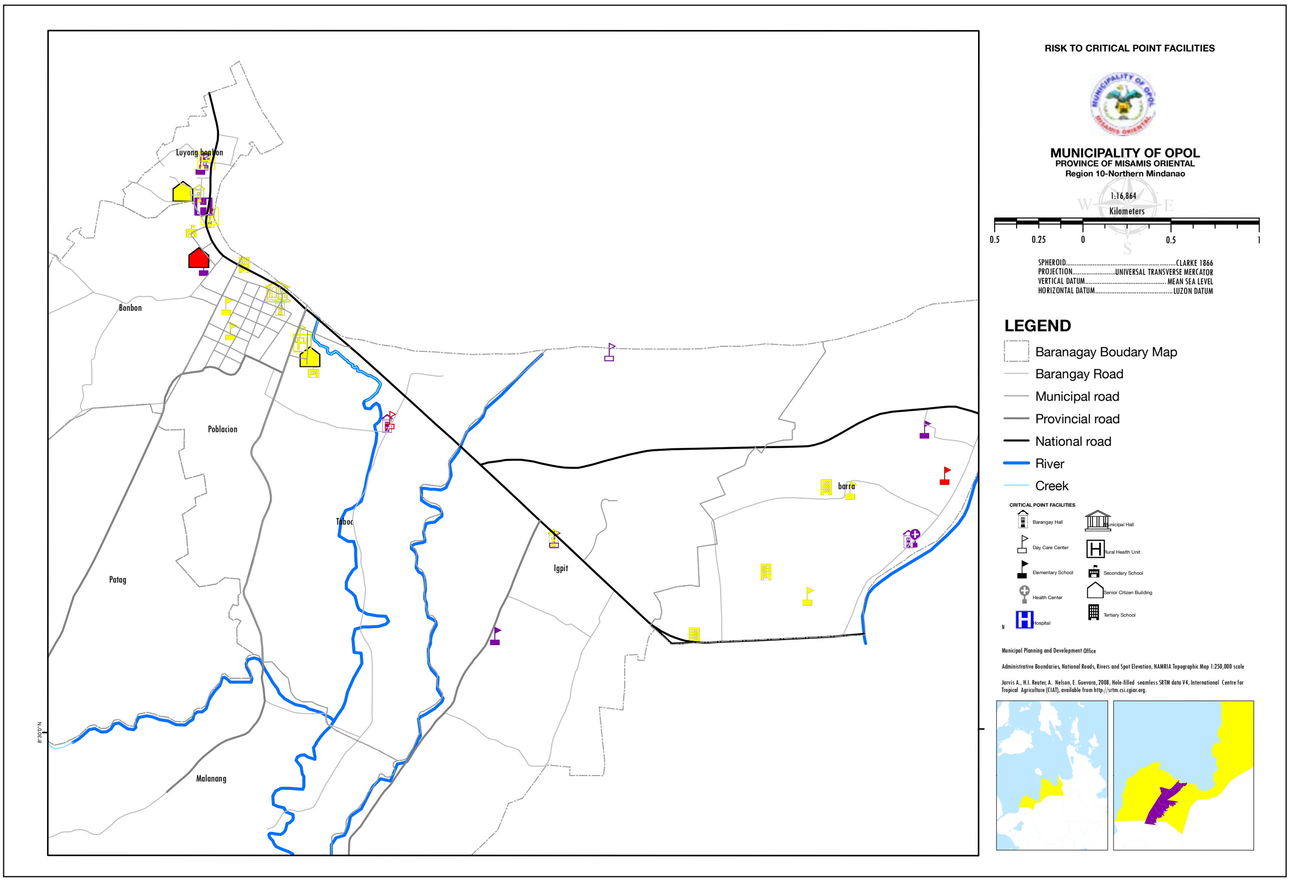


Table 3.5.4d Flood Risk to Critical Point Facilities

A	B	C	D	E	F	G	H	I	J	K	O	P	Q
		HAZARD			EXPOSURE			VULNERABILITY			SEVERITY OF CONSEQUENCE SCORE	RISK	
Barangay	Facility Type	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Storey	Area	Number of Classrooms/ Rooms/Bed Capacity	Wall Materials	Existing Condition	Employing Hazard Resistant Design		Risk Score	Risk Category
												=D x O	
Barra	Health Center	HSA	4	>1 Meter	2	75 sq. meters	4 Bed Capacity	Concrete	Good	Yes	1	4	Low
Barra	Elementary School	HSA	4	>1 Meter	1	6404 sq. meters	15 Classrooms	Concrete	Good	No	3	11	Moderate
Barra	Bridge	HSA	4	>1 Meter	N/A	N/A	20 Tons	Concrete	Good	Yes	1	4	Low
Bonbon	Senior Citizen Building	HSA	4	>1 Meter	2	50 sq meters		Mixed	Poor/needs major repair	No	3	12	High
Bonbon	Health Center	MLSA	2	<1 Meter	1	75 sq. meters	4 Bed Capacity	Concrete	Good	No	2	4	Low
Bonbon	Elementary School	HSA	4	>1 Meter	1	10000 sq meters	6 Classrooms	Wood	needs repair	No	3	12	High
Bonbon	Day Care Center	HSA	4	>1 Meter	2	50 sq meters		Mixed	Poor/needs major repair	No	2	8	Moderate
Igpit	Foot Bridge	HSA	4	>1 Meter	N/A	N/A	3 Tons	Steel Centered Cable Wire	Needs minor repair	No	3	12	High
Igpit	Elementary School	MLSA	2	<1 Meter	1	23986 sq. meters	8 Classrooms	Mixed	needs repair	No	2	4	Low
Igpit	Day Care Center	HSA	4	>1 Meter	1	50 sq meters		Concrete	Poor	No	3	12	High
Luyong Bonbon	Health Center	MLSA	2	<1 Meter	1	75 sq. meters	4 Bed Capacity	Wood	Poor	No	2	4	Low
Luyong Bonbon	Day Care Center	MLSA	2	<1 Meter	1	50 sq meters		Wood	Poor	No	2	4	Low
Poblacion	Municipal Legislative Building	MLSA	2	<1 Meter	2	250 sq.meters		Concrete	Good	Yes	1	2	Low
Poblacion	Municipal Hall	MLSA	2	<1 Meter	2	400 sq meters		Concrete	Good	Yes	1	2	Low
Taboc	Senior Citizen Building	MLSA	2	<1 Meter	1	50 sq meters		Concrete	Needs repair	No	1	2	Low
Taboc	Rural Health Center	MLSA	2	<1 Meter	1	150 sq meters	6 Bed Capacity	Concrete	Good	Yes	1	2	Low
Taboc	Day Care Center	HSA	4	>1 Meter	1	100 sq meters		Concrete	Good	No	3	12	High
Taboc	Bridge	HSA	4	>1 Meter	N/A	N/A	15 Tons	Concrete	Good	Yes	1	4	Low

Sub-task 5.4.5 Derive the Lifeline Utilities Risk Score

Taking off from the severity of consequence table (Table 3.5.3e) add two columns that will contain the risk scores and risk categories. Multiply the likelihood occurrence with the average severity of consequence score derived from the previous step (refer to Table 3.5.4e). The risk score will provide an indicative index of risk.

Sub-task 5.4.4.1 Reclassify the risk scores into risk categories

Based on the recommended risk scores and corresponding risk categories (Table 3.5.4), reclassify risk scores into risk categories (refer to Table 3.5.4e).

Sub-task 5.4.4.2 Prepare risk maps

Prepare a critical point facilities risk map indicating the risk level (i.e. High, Moderate Low) per facility. This should guide the identification of lifeline utilities for a particular hazard where issues and concerns can be articulated and the general policy directions and options can be identified and enumerated (refer to Figure 3.5.2e).

Figure 3.5.2e Flood Risk to Lifeline Utilities Map

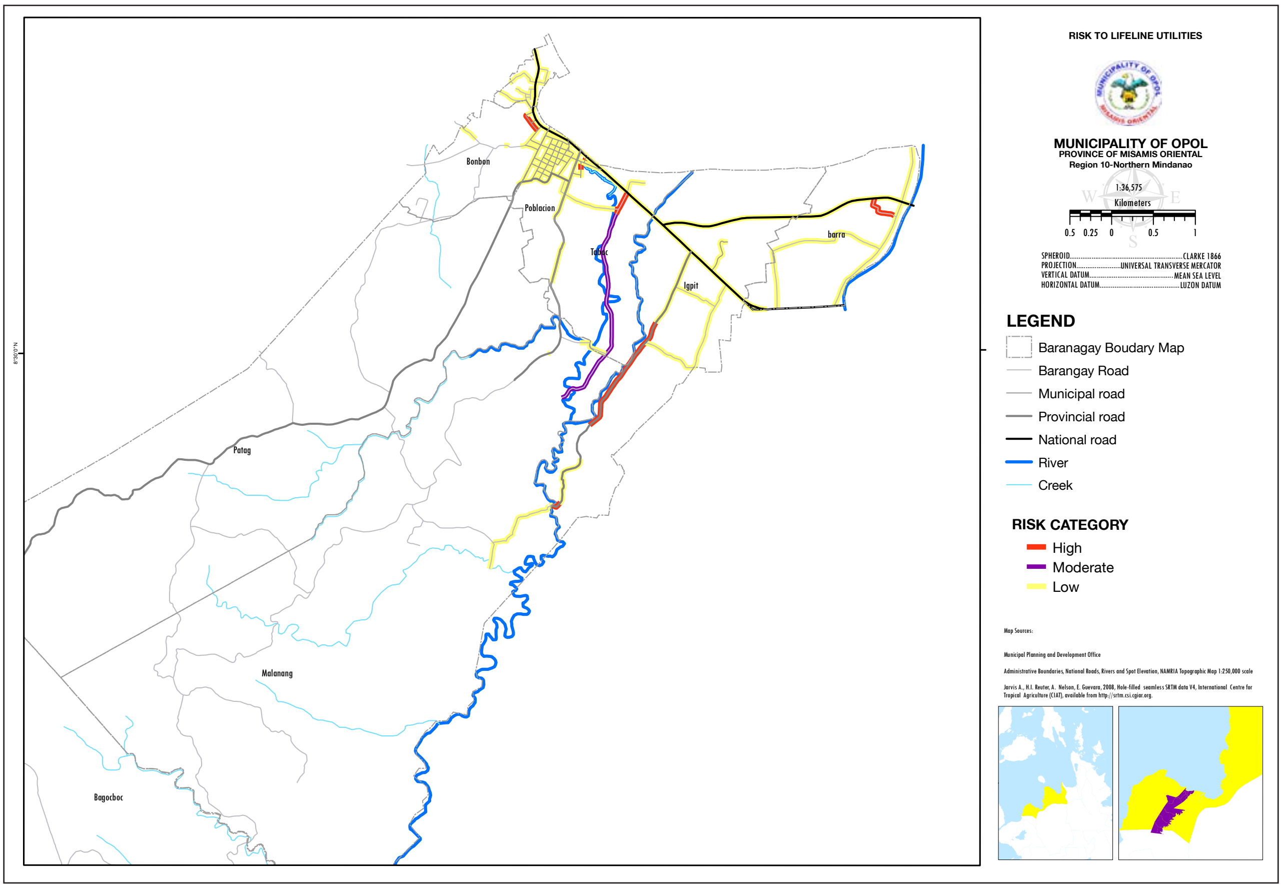


Table 3.5.4e Flood Risk to Lifeline Utilities

A	B	C	D	E	F	G	H	I	J	K	O	P	Q
		HAZARD		EXPOSURE				VULNERABILITY			SEVERITY OF CONSEQUENCE SCORE	RISK	
Name	Classification	Flood Susceptibility	Likelihood of Occurrence Score	Expected Flood Depth	Replacement Cost	Affected Distance (Linear Kilometers)[1]	Affected Value[2]	Surface Type	Existing Condition	Hazard Resistant Design		Risk Score	Risk Category
							G*F					=C X O	
National highway to Narulang road	Provincial road	HSA	**4**	>1 Meter	18,000,000	1.62	29,165,400	Concrete/ Gravel	Needs minor repair	No	**3**	**12**	**High**
National highway to Pag-Ibig Citi Homes	Barangay Road	MLSA	**2**	<1 Meter	11,036,000	2.55	28,192,566	Concrete/ Gravel	Poor	No	**2**	**4**	**Low**
Metro Cagayan road	National road	HSA	**4**	>1 Meter	23,000,000	2.11	48,424,200	Concrete	Good	Yes	**1**	**4**	**Low**
Metro Cagayan road	National road	MLSA	**2**	<1 Meter	23,000,000	0.92	21,107,100	Concrete	Good	Yes	**1**	**2**	**Low**
National highway	National road	HSA	**4**	>1 Meter	23,000,000	1.66	38,288,100	Concrete	Good	Yes	**1**	**4**	**Low**
National highway	National road	MLSA	**2**	<1 Meter	23,000,000	2.81	64,692,100	Concrete	Good	Yes	**1**	**2**	**Low**
National highway to Narulang road	Provincial road	MLSA	**2**	<1 Meter	18,000,000	1.64	29,469,600	Concrete	Good	Yes	**1**	**2**	**Low**
National highway to Pag-Ibig Citi Homes	Barangay Road	HSA	**4**	>1 Meter	11,036,000	0.29	3,180,575	Concrete	Needs minor repair	Yes	**3**	**12**	**High**
Poblacion to Limunda road	Provincial road	HSA	**4**	>1 Meter	18,000,000	0.09	1,699,200	Concrete	Good	Yes	**1**	**4**	**Low**
Poblacion to Limunda road	Provincial road	MLSA	**2**	<1 Meter	18,000,000	1.03	18,511,200	Concrete	Good	Yes	**1**	**2**	**Low**
roan road	Barangay Road	HSA	**4**	>1 Meter	11,036,000	0.31	3,467,511	Concrete	Good	Yes	**1**	**4**	**Low**
Main Water Distribution Line	Government	HSA	**4**	>1 Meter	N/A	2.10	N/A	Steel	Good	Yes	**1**	**4**	**Low**
Main Water Distribution Line	Government	MLSA	**2**	<1 Meter	N/A	3.29	N/A	Steel	Good	Yes	**1**	**2**	**Low**

Task 5.5 Analyze Adaptive Capacities

Analyze indicators to describe the adaptive capacities/characteristics of the exposed elements to implement the necessary interventions and anticipate and reduce risks and/or cope and anticipate potential risks. Also, the level of adaptive capacities would influence the type of risk management and adaptation options in the form of spatial policy interventions such as relocation (minimizing exposure), rezoning of existing urban use areas to production-based, and open space development and strict protection land uses, establishment of structural mitigation measures (flood control, sea wall, slope stabilization) including the debt servicing capacity of the Local Government Unit, and imposition of hazard resistant structural design regulations that would encourage urban resiliency including the potential conformance of proponents and local inhabitants (and the costs associated to conform) to said restrictions/ regulations.

Highlight important adaptive capacity assessment for the various exposure units gathered in the exposure database and include them in the preparation of summary risk assessment matrix to be prepared in the succeeding step. LGUs can further expound on the level of adaptive capacities of specific areas through public consultation.

Task 5.6. Identify the decision areas and prepare a summary disaster risk assessment matrix

Based on the risk maps and risk assessment tables generated for the various exposure units, highlight and identify decision areas or elements. Decision areas can be a specific site in the locality or an area cluster (i.e coastal areas). These can be enumerated in column A (Tables 3.5.5a-3.5.5e) including a description of the area in column A1.

List down the technical findings by describing the area or element in terms of the level of risk and the various contributing factors such as hazard, exposure, vulnerability (severity of consequence), and level of adaptive capacities. The technical findings can be derived from the working tables prepared in the previous steps. These can be listed down in column B. Technical findings can be identified and derived from the working table in the previous steps. The technical findings shall be used in the risk/vulnerability evaluation and guide the identification of the implications when risks are not addressed.

A sample Disaster Risk Assessment Summary Table per exposure unit is presented below (Tables 3.5.5a-3.5.5e). Note that LGUs can limit and focus on important high to moderate risk areas or areas where the severity of consequence range from very high to high regardless of the risk level (mainly applicable for seismic and volcanic related hazards where the severity of consequence are considered catastrophic/ disastrous) when identifying the various decision areas.

Table 3.5.5a Sample Risk Disaster Risk Assessment Summary Matrix for Population, Flood

Decision Area/s	Decision Area Description	Technical Findings
A	A1	B
Barra	Residential areas located along the Iponan River and portions located along the coast/river mouth	• Population risk categorized as high • Around 6,838 individuals are exposed to high susceptibility floods. • Only a portion have access to early warning systems. • Roughly 44% of the population are below the poverty threshold • LGU does not have enough resources to implement flood control works along Iponan River. External assistance from national or regional government agencies will be required. • Imposition of hazard resistant structural design regulations may be difficult considering the income level of the majority of the population. • Relocation of residential areas can be identified within the municipality.. • LGU can pursue land banking to accommodate potential zonal changes from residential to non-residential urban use areas. • Early warning systems and the preparation of flood contingency plans can be pursued by the local government to minimize potential fatalities and injuries.
Bonbon	Low-lying residential areas located along coastal zone of the barangay.	• Roughly 1,934 individuals exposed to floods (360 in high susceptible areas/1574 in moderate to low susceptible areas) • Risk to population categorized as moderate • Approximately 38% of households are below the poverty threshold. • Approximately 587 individuals are living in houses with walls made from light, makeshift, and salvageable materials. • Approximately 60 informal settler individuals (15 households) • LGU does not have enough resources to pursue a total relocation policy. External assistance from national or regional government agencies will be required. • Imposition of hazard-resistant structural design regulations may be difficult considering the income level of the majority of the population. • Relocation of residential areas can be identified within the municipality. • LGU can pursue land banking to accommodate potential zonal changes from residential to non-residential urban use areas. • Existing evacuation sites are enough to accommodate expected severely affected families. However, additional evacuation sites may be needed in the future. • Early warning systems and the preparation of flood contingency plans can be pursued by the local government to minimize potential fatalities and injuries

Table 3.5.5b Sample Risk Disaster Risk Assessment Summary Matrix for Natural Resource Production Areas, Flood

Decision Area/s	Decision Area Description	Technical Findings
A	**A1**	**B**
Barra	Fishpond production areas located adjacent to the coast	• Approximately 19 hectares of fishpond areas exposed to high to moderate floods • Areas categorized as moderate risk to damage • Existing fish pens susceptible to severe damage due to floods • 60% of areas not covered by insurance • No flood control measures in place • Fisherfolks do not practice sustainable/climate proofed fishing techniques
Igpit	Fishpond production areas located adjacent to the coast	• A significant portion of the inland fisheries subsector are classified as high risk areas. • Fisherfolks do not practice sustainable/climate proofed fishing techniques; • Existing fish pens susceptible to severe damage due to floods. • 80% of fish production areas do not have insurance • No flood control measures in place
Taboc	Crop production areas located in the flood plains transected by the Bungcalalan River	• Risk is categorized as high on agricultural crop production • Approximately 32 hectares within high susceptible flood areas, and 103 hectares susceptible to moderate to low floods • Severity of damage considered high • Estimated value in terms of replacement cost is 11.2 million pesos. • Crop types are predominantly cultivated crops. • A significant portion of the population are engaged in farming • Majority of the farmers do not practice climate proofed production techniques. • No early warning systems in place • Majority of the areas are not covered by crop insurance.e

Table 3.5.5c Sample Disaster Risk Assessment Summary Matrix Urban Use Area, Floods

Decision Area/s	Decision Area Description	Technical Findings
A	**A1**	**B**
Barra - Commercial and Residential areas	Existing commercial and residential areas along the Iponan River	• The area is located along the Iponan river. • These are areas within the high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Only a tenth of the structures are made from light to makeshift materials, roughly 153 individuals or 38 structures • Only 20% have property insurance. • Majority of the structures have first floors below the estimated flood depth. • Risk to property damage range from high to moderate. • Hazard resistant restrictions can be imposed to designated non-residential areas but will be difficult to implement for residential areas. • Imposing river easements for lots located adjacent to the river can be pursued.
Igpit - Tourism Areas	The area is located along the coast adjacent to the Macajalar Bay	• These are areas within the high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • The major tourism areas of the municipality are located in this area. • Tourism structures are predominantly made from light materials. • Hazard-resistant design regulations can be pursued in the area.
Igpit - Informal settler settlements	The area is located along the coast adjacent to the Macajalar Bay	• These are areas within the high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Informal settler areas are at high risk to flooding with disastrous consequences. • Potential increase in exposed population will be expected due to unregulated growth of informal settler families. • There is consensus among informal settler families that relocation will be needed. • LGU does not have the capacity to relocate all informal settler families within a short term period. External assistance will be required. • Relocation sites can be identified within the municipality to accommodate affected families.

Table 3.5.5d Sample Disaster Risk Assessment Summary Matrix Critical Point Facilities, Floods

Decision Area/s	Decision Area Description	Technical Findings
A	A1	B
Igpit Day Care Center	Located near the Bungcalalan River	• 50 sq. meters exposed to floods of >1 meter, occurring every 10-30 years (Hazard-Exposure) • Building is concrete but in poor condition (Vulnerability) • Structure does not employ hazard mitigation design (Vulnerability) • No property insurance coverage (Vulnerability) • LGU will have available funds to purchase lots and construct new day care centers in future (Adaptive Capacity)
Bonbon Senior Citizen Building	Flood plains located in Barangay Bonbon	• 50 sq. meters exposed to floods of >1 meter occurring every 10-30 years (Hazard-Exposure) • Building is made from mixed wood and concrete but in poor condition (Vulnerability) • Structure does not employ hazard mitigation design (Vulnerability) • No property insurance coverage (Vulnerability) • LGU will have available funds to purchase lots and construct new senior citizen buildings in future (Adaptive Capacity)
Bonbon Elementary School	Flood plains located in Barangay Bonbon	• Six classrooms with an estimated area of school site area of 10,000 square meters exposed to floods of >1 meter occurring every 10-30 years (Hazard-Exposure) • Made from mixed wood and concrete but requires major repairs • Facility does not employ hazard mitigation design • Facility not covered by insurance • New school sites can be established • Site can be rezoned to commercial uses where proponents will have the financial capacity to conform to hazard mitigation design regulations

Table 3.5.5e Sample Disaster Risk Assessment Summary Matrix Lifeline Utilities

Decision Area/s	Decision Area Description	Technical Findings
A	A1	B
National highway to Narulang Road	Primary access road leading to the Malingin Area	• Categorized as high risk • 1.62 Kilometers exposed to high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Surface type is mixed gravel and concrete; • Disruption of access system may last for five days, affecting settlements and production areas • LGU does not have the capacity to pursue road improvement related projects. External assistance may be required.
National highway to Pag-ilbig Citi Homes	Main access road leading to the Pag-ibig Citi-Homes residential areas and crop production areas	• Categorized as high risk • 0.29 Kilometers exposed to high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Surface type is concrete requiring minor repairs • Disruption of access system may last for five days, affecting settlements and production areas • LGU does not have the capacity to pursue road improvement-related projects. External assistance may be required.

Task 5.7 Identify Policy Interventions to reduce risks to acceptable risks

From the summary risk assessment matrix for the various exposure units prepared in the previous steps, the derived level of risks for each exposure unit/area is a good indication of the level of priority where interventions should be implemented to reduce risks to tolerable or acceptable levels. In these guidelines, the type of risk management options/interventions should seek to achieve the reduction of risks that are below the thresholds for declaring a state of calamity for each exposure type (refer to Table 3.5.6), where the highly unacceptable threshold is based on the NDDRMC criteria for declaring a state of calamity (through the NDCC Memorandum Order No 4. series of 1998, items 4a-b, items a. to b.) covering the minimum percentage of severely affected population, minimum percentage damage to means of livelihood, minimum duration of disruption in the flow of transport and commerce (i.e roads and bridges), minimum percentage damage to agriculture-based products, and duration of disruption of lifeline facilities (i.e electricity, potable water systems, communication). LGUs should be guided by the acceptability ratings and threshold levels to guide land use policy and strategy decisions and ensure that the level of risks is within acceptable or tolerable levels. The policy interventions to be identified shall be in the form of risk management options such risk reduction through elimination/prevention (relocation of at risk elements), risk mitigation (imposing hazard resistant design regulations, hard and soft risk mitigation measures, establishment of redundant systems, and disaster preparedness), and risk transfer (encouraging the use of risk transfer instruments such as property or crop insurance)

Table 3.5.6 Disaster thresholds and level of acceptability per exposure type

Acceptability Rating	Disaster Thresholds/Exposure Unit				
	Population	Natural Resource Production Areas	Urban Use Areas	Critical Point Facilities	Lifeline Utilities
Highly Unacceptable[1]	≥20% of the population are affected and in need of immediate assistance	≥ 40% of exposed production areas/means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	≥40% of non-residential structures are severely damaged ≥20% of residential structures are severely damaged	Damages lead to the disruption of services lasting one week or more	Disruption of service lasting one week or more for municipalities and one day for highly urbanized areas
Highly Intolerable	>10 - <20% of affected population in need of immediate assistance	20-<40% of exposed production areas/ means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	>20 to <40% of non-residential structures are severely damaged >10-20% residential structures are severely damaged	Disruption of services lasting three days to less than a week	Disruption of service lasting approximately five days for municipalities and less than 18 hours for highly urbanized areas
Tolerable	>5%-10% of affected population in need of immediate assistance	5-<20% of exposed production areas/ means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	>10 to 20% non-residential structures are severely damaged >5 to10% of residential structures are severely damaged	Disruption of service lasting for one day to less than three days	Disruption of service lasting approximately three days for municipalities and less than six hours for highly urbanized areas
Acceptable	≤ 5% of the affected population in need of immediate assistance.	≦5% of exposed production areas/ means of livelihood such as fishponds, crops, poultry and livestock and other agricultural/forest products are severely damaged	≤10% of non-residential structures are severely damaged ≤5% of residential structures are severely damaged	Disruption of service lasting less than one day	Disruption of service lasting approximately one day for municipalities and less than six hours for highly urbanized areas

[1]Disaster threshold percentages based on the criteria of declaring a state of calamity, NDCC Memo no. 4, series of 1998.

Sub-task 5.6.1 Identify the development implications

Taking off from the risk and vulnerability evaluation matrix (Tables 3.5.6a-3.5.6e), add two columns for the implications and the policy interventions. Expound on the possible future scenario if the Municipality/City adopts a "business as usual" strategy given the identified risks and vulnerabilities (refer to tables 3.5.6a-3.5.6e). Enumerate the Implications which can be statements related to development issues, concerns and problems which needs to be addressed moving forward (Column C).

Sub-task 5.6.2. Identify the various policy interventions

Based on the implications identified, identify the possible policy interventions that the LGU should pursue to address such the various issues (refer to tables 3.5.6a-3.5.6e). These can be in the form legislation-spatial based policies or programs,projects and activities to reduce exposure, reduce vulnerability and increase adaptive capacity (Column D). Policy interventions should seek to reduce the level of risks to acceptable levels whenever possible or reduce risks to tolerable levels considering the costs, time and effort to implement them. When risk levels can not be significantly reduced to acceptable or tolerable levels, consider relocation or changing the land uses where the cost for mitigation, time and effort needed to implement them are sustainable in the long-term (i.e. residential areas to park and open spaces to reduce exposure, residential to commercial where the costs associated with the imposition of hazard resistant design regulations can be transferred to proponents with higher adaptive capacities).

Table 3.5.6a Sample Issues Matrix for Population for Flood Hazard

Decision Area/ Name	Technical Findings	Implications	Policy Interventions
A	B	C	D
Barra	• Population risk categorized as high • Around 6,838 individuals are exposed to high susceptibility floods. • Only a portion have access to early warning systems. • Roughly 44% of the population are below the poverty threshold • LGU does not have enough resources to implement flood control works along Iponan River. External assistance from national or regional government agencies will be required. • Imposition of hazard resistant structural design regulations may be difficult considering the income level of the majority of the population. • Relocation of residential areas can be identified within the municipality.. • LGU can pursue land banking to accommodate potential zonal changes from residential to non-residential urban use areas. • Early warning systems and the preparation of flood contingency plans can be pursued by the local government to minimize potential fatalities and injuries.	• Potential deaths and injuries due to lack of early warning system, makeshift houses, especially in areas located along the Iponan River and coastal areas • Significant government resources will be allocated for rescue and relief operations • Required post-disaster assistance for affected families/individuals far exceeds available local financial resources • Available livelihood opportunities are not enough to accommodate affected families	• Implement a mandatory relocation policy on structures/ dwellings within the 20 meter coastal and river easements. • Establish open spaces, recreation areas, or parks along the Iponan River • Relocation of informal settlers • Develop regulations with emphasis on hazard resistant design • Mandatory retrofitting of existing structures • Establishment of early warning system • Formulation of flood contingency plan • Provision of comprehensive housing program for affected families • Livelihood program for families below the poverty threshold • Pursue watershed rehabilitation to minimize surface water run-off in low lying areas
Bonbon	• Roughly 1,934 individuals exposed to floods (360 in high susceptible areas/1574 in moderate to low susceptible areas) • Risk to population categorized as moderate • Approximately 38% of households are below the poverty threshold. • Approximately 587 individuals are living in houses with walls made from light, makeshift, and salvageable materials. • Approximately 60 informal settler individuals (15 households) • LGU does not have enough resources to pursue a total relocation policy. External assistance from national or regional government agencies will be required. • Imposition of hazard-resistant structural design regulations may be difficult considering the income level of the majority of the population. • Relocation of residential areas can be identified within the municipality. • LGU can pursue land banking to accommodate potential zonal changes from residential to non-residential urban use areas. • Existing evacuation sites are enough to accommodate expected severely affected families. However, additional evacuation sites may be needed in the future. • Early warning systems and the preparation of flood contingency plans can be pursued by the local government to minimize potential fatalities and injuries	• Potential deaths and injuries due to lack of early warning system, makeshift houses especially in areas located along the Iponan River and coastal areas • Significant government resources will be allocated for rescue and relief operations • Required post-disaster assistance for affected families/individuals far exceeds available local financial resources • Available livelihood opportunities are not enough to accommodate affected families	• Establish open spaces, recreation areas, or parks along the coastal areas • Relocation of informal settlers • Develop regulations with emphasis on hazard resistant design. • Retrofitting of existing structures • Establishment of early warning system. • Formulation of flood contingency plan • Provision of comprehensive housing program for affected families • Livelihood program for families below the poverty threshold • Identify additional residential areas within safer areas • Pursue watershed rehabilitation to minimize surface water run-off in low lying areas. • Change the mix of land use from residential to other uses that would encourage the reduction of exposure

Table 3.5.6b Sample Issues Matrix Natural Resource Production Areas for Flood Hazard

Decision Area/ Name	Technical Findings	Implications	Policy Interventions
A	B	C	D
Bonbon	• Approximately 19 hectares of fishpond areas exposed to high to moderate floods • Areas categorized as moderate risk to damage • Existing fish pens susceptible to severe damage due to floods • 60% of areas not covered by insurance • No flood control measures in place • Fisherfolks do not practice sustainable/climate proofed fishing techniques	• Significant economic losses in the inland fishery sector expected • Increased poverty among inland fishing dependent families also expected • Government resources may be redirected to address the short term needs of affected families • No available alternative livelihood to accommodate expected affected families	• Climate proofing of fish pen areas; • Provision of alternative livelihood • Establishment of mangrove buffers to protect existing fish cages • Encourage insurance • Improve forest cover in the Bungcalalan watershed area • Establishment of early warning system • Extension services for climate sensitive inland fishery production
Igpit	• A significant portion of the inland fisheries subsector are classified as high risk areas. • Fisherfolks do not practice sustainable/climate proofed fishing techniques; • Existing fish pens susceptible to severe damage due to floods. • 80% of fish production areas do not have insurance • No flood control measures in place	• Significant economic losses in the inland fishery sector expected • Increased poverty among inland fishing dependent families also expected • Government resources may be redirected to address the short term needs of affected families • No available alternative livelihood to accommodate expected affected families	• Climate proofing of fish pen areas; • Provision of alternative livelihood • Establishment of mangrove buffers to protect existing fish cages • Encourage insurance • Improve forest cover in the Bungcalalan water shed area • Establishment of early warning system • Include Igpit as the priority area for extension services for climate-sensitive inland fishery production
Taboc	• Risk is categorized as high on agricultural crop production • Approximately 32 hectares within high susceptible flood areas, and 103 hectares susceptible to moderate to low floods • Severity of damage considered high • Estimated value in terms of replacement cost is 11.2 million pesos. • Crop types are predominantly cultivated crops. • A significant portion of the population are engaged in farming • Majority of the farmers do not practice climate proofed production techniques. • No early warning systems in place • Majority of the areas are not covered by crop insurance.e	• The damage to crops is expected to be high due to floods, given current production practices. • Significant portion of the population are dependent on crop production. The lack of alternative livelihood contributes to sensitivity and adaptive capacities of farmers. • Lack of flood control measures, may affect production yields over time. • Existing forest cover of the Bungcalalan and Opol River Watershed is estimated at 40-50%. Lack of forest cover may contribute to low land flooding.	• Extension services for climate sensitive crop production • Encourage the use of flood-resistant crop varieties • Encourage crop insurance • Establishment of early warning system for crop production • Improve forest cover in watershed areas contributing to Bungcalalan and Opol Rivers • Establishment of field demonstration farms to facilitate technology transfer on climate/hazard sensitive crop production. • Provision of alternative livelihoods • Encourage the planting of high value crops

Table 3.5.6c Sample Issues Matrix Urban Use Areas for Flood Hazard

Decision Area/ Name	Technical Findings	Implications	Policy Interventions
A	B	C	D
Barra - Commercial and Residential areas	• The area is located along the Iponan river. • These are areas within the high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Only a tenth of the structures are made from light to makeshift materials, roughly 153 individuals or 38 structures • Only 20% have property insurance. • Majority of the structures have first floors below the estimated flood depth. • Risk to property damage range from high to moderate. • Hazard resistant restrictions can be imposed to designated non-residential areas but will be difficult to implement for residential areas. • Imposing river easements for lots located adjacent to the river can be pursued.	• Significant structural damage to residential areas and informal settler areas are expected. Death and injuries are also expected if no preemptive evacuation is implemented during extreme rainfall events. • Lack of flood-resistant design regulations and increase exposure due to natural expansion may lead to increased risks if not immediately addressed covering residential and commercial areas. • There is a need to identify additional residential areas to accommodate informal settler families for relocation • Increased frequency of extreme rainfall events may result to significant property damage • Potential impacts to the local economy will be severe due to economic disruption affecting commercial and tourism establishments	• Implement a mandatory relocation policy on structures/dwellings within the 20 meter coastal and river easements along the Iponan River. • Set aside areas for open spaces, recreation, or parks. • Relocation of informal settlers • Provision of comprehensive housing program for affected families • Develop regulations with emphasis on hazard resistant design. • Impose a low density development in areas prone to high levels of flooding. • Mandatory Retrofitting of existing structures within a period of 10 years. • Promote property insurance for dwelling units located in highly susceptible areas. • Limit further settlement growth in areas within highly susceptible areas. • Coordinate with Cagayan de Oro City for the rehabilitation of the Iponan River Watershed • Conduct site specific flood hazard mapping as basis for the establishment of structural design regulations
Igpit - Informal settler Settlements	• These are areas within the high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Informal settler areas are at high risk to flooding with disastrous consequences. • Potential increase in exposed population will be expected due to unregulated growth of informal settler families. • There is consensus among informal settler families that relocation will be needed. • LGU does not have the capacity to relocate all informal settler families within a short term period. External assistance will be required. • Relocation sites can be identified within the municipality to accommodate affected families.	• Potential deaths and injuries due to lack of early warning system and makeshift houses especially in zone 1, 2, and 5 • Lack of monitoring may result in increased exposure due to increase in informal settler families in the area • Isolation of families have been observed in the past, • Significant government resources will be allocated for rescue and relief operations • Required post disaster assistance for affected families/individuals far exceeds available local financial resources • Available livelihood opportunities are not enough to accommodate affected families.	• Set aside areas for open spaces, recreation or parks. • Relocation of informal settlers • Provision of comprehensive housing program for affected families • Establishment of early warning systems and formulation of flood contingency plans
Igpit - Tourism Areas	• These are areas within the high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • The major tourism areas of the municipality are located in this area. • Tourism structures are predominantly made from light materials. • Hazard-resistant design regulations can be pursued in the area.	• Damages and disruption of tourism-related facilities • Detrimental impacts to the economy and the property owners	• Mandatory retrofitting of structures within 15 years • Imposition of hazard resistant design standards/regulations within flood susceptible areas. • Promote property insurance located in highly susceptible areas. • Conduct site specific flood hazard mapping as basis for the establishment of structural design regulations • Combine mangrove/wetland rehabilitation/ restoration with eco-tourism development • Minimize exposure through low density tourism development

Table 3.5.6d Sample Issues Matrix Critical Point Facilities for Flood Hazard

Decision Area/ Name	Technical Findings	Implications	Policy Interventions
A	B	C	D
Igpit Day Care Center	• 50 sq. meters exposed to floods of >1 meter, occurring every 10-30 years (Hazard-Exposure) • Building is concrete but in poor condition (Vulnerability) • Structure does not employ hazard mitigation design (Vulnerability) • No property insurance coverage (Vulnerability) • LGU will have available funds to purchase lots and construct new day care centers in future (Adaptive Capacity)	• Significant damage is expected to the Igpit Day Care Center • Possible deaths or injuries expected if The Day Care Center is used as an evacuation center; • Potential inadequacies in the provision of day care services expected in the barangay;	• Establishment of new day care center that will service the Igpit area in a more suitable area. • Property insurance coverage for the existing Igpit Day Care Center • When the Igpit Day Care center is significantly damaged by floods, consider relocating the service to a more suitable site.
Bonbon Senior Citizen Building	50 sq. meters exposed to floods of >1 meter occurring every 10-30 years (Hazard-Exposure) • Building is made from mixed wood and concrete but in poor condition (Vulnerability) • Structure does not employ hazard mitigation design (Vulnerability) • No property insurance coverage (Vulnerability) • LGU will have available funds to purchase lots and construct new senior citizen buildings in future (Adaptive Capacity)	• Significant damage is expected • Potential inadequacies or significant service disruption in the provision of services for senior citizens expected in the barangay • Retrofitting and maintaining the structure may be costly in the long run. Costs can be redirected for the establishment of a new facility	• Establishment of a new senior citizen building that will service the Bonbon area in a more suitable site. • Property insurance coverage for the existing facility • When the building is significantly damaged by floods, consider relocating the service to a more suitable site.
Bonbon Elementary School	• Six classrooms with an estimated area of school site area of 10,000 square meters exposed to floods of >1 meter occurring every 10-30 years (Hazard-Exposure) • Made from mixed wood and concrete but requires major repairs • Facility does not employ hazard mitigation design • Facility not covered by insurance • New school sites can be established • Site can be rezoned to commercial uses where proponents will have the financial capacity to conform to hazard mitigation design regulations	• Moderate damage is expected to the BonBon Elementary School, resulting in the disruption of educational services in the area. • Possible deaths or injuries expected if the Bonbon Elementary School is used as an evacuation center • Potential future inadequacies in the provision of primary level educational services expected in the barangay	• Retrofit the existing school structure • Future expansion should be located in more suitable areas servicing the Bonbon Area.

Table 3.5.6e Sample Issues Matrix Lifeline Utilities for Flood Hazard

Decision Area/ Name	Technical Findings	Implications	Policy Interventions
A	B	C	D
National highway to Narulang Road	• Categorized as high risk • 1.62 Kilometers exposed to high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Surface type is mixed gravel and concrete; • Disruption of access system may last for five days, affecting settlements and production areas • LGU does not have the capacity to pursue road improvement related projects. External assistance may be required.	• Temporary isolation of communities due to long-term disruption of the access system during floods • Poses difficulty in evacuation and response making which may lead to deaths and injuries in isolated areas; • Major disruption in the transportation of agricultural produce resulting in potential losses	• Strategic establishment of alternate/escape routes leading to relatively safer areas • Climate-proofing of existing route through road and drainage upgrading in coordination with NGAs • Preemptive evacuation of areas that will be potentially isolated during floods. • Formulation of flood contingency plans targeting potentially affected communities
National highway to Pag-ilbig Citihomes	• Categorized as high risk • 0.29 Kilometers exposed to high susceptible flood areas, with an estimated flood height of > 1 meter. The estimated likelihood of occurrence is 10-30 years. • Surface type is concrete requiring minor repairs • Disruption of access system may last for five days, affecting settlements and production areas • LGU does not have the capacity to pursue road improvement-related projects. External assistance may be required.	• Temporary isolation of communities due to disruption of the access system during floods; • Poses difficulty in evacuation and response making which may lead to deaths and injuries in isolated areas; • Major disruption in the transportation of agricultural produce resulting in potential losses	• Strategic establishment of alternate routes access systems leading the relatively safer areas; • Climate proofing of existing route through road and drainage upgrading in coordination with NGAs; • Preemptive evacuation of areas that will be potentially isolated during floods. • Formulation of flood contingency plans targeting potentially affected communities

Step 6. Summarize Findings

Objectives

- To identify major decision areas based on the combined risks and vulnerabilities;
- To identify a menu of disaster risk reduction and climate change adaptation options within major decision areas.

Outputs

- Identified major decision areas and list of risk management and adaptation/mitigation measures;

Process

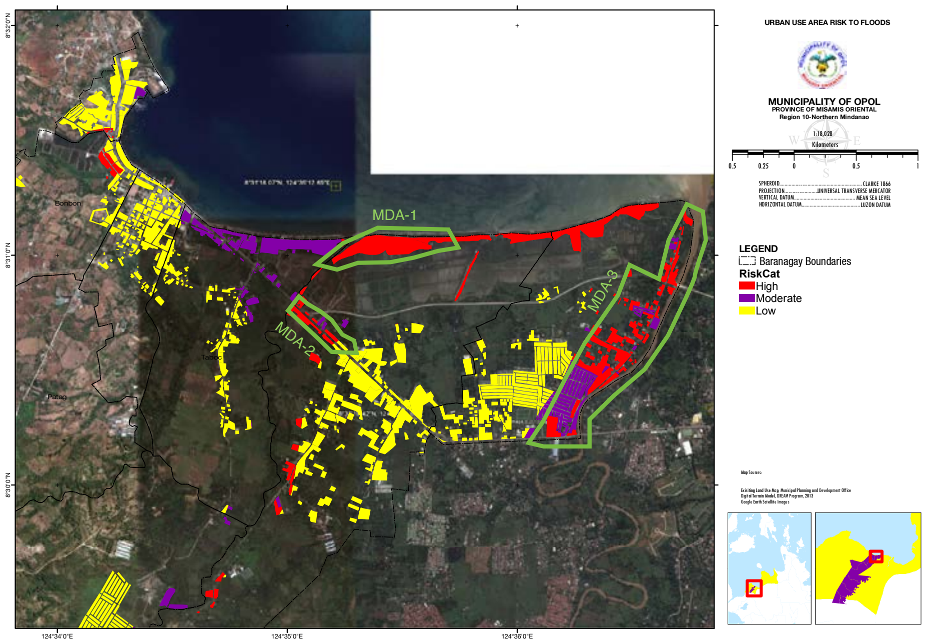
Task 6.1 Identify major decision areas;
Task 6.2 Further detail the identified policy interventions;

Task 6.1 Identify major decision areas

Major decision areas are specific sites within the municipality where level of risks to hazards can be exacerbated by vulnerability to climate change. Identification of major decision areas can be facilitated by overlaying risk and vulnerability maps (refer to figure 3.6.1) or can be tabular in approach especially when certain sites are consistently regarded as decision areas during the disaster risk assessment and climate change vulnerability assessment (table 3.6.1).

Task 6.2 Further detailing of policy interventions

Risk management options identified during the risk and vulnerability assessments may differ in approach. This step will ensure consistency of policy interventions to address a particular major decision area. Based on the identified major decision areas in step 6.1, review and compare the identified policy interventions in the summary risk and vulnerability assessments. Select the appropriate policy interventions using a multi-hazard and climate change perspective to address both risks and vulnerabilities. Refer to Table 3.6.1 for a sample worksheet. Review and compare all hazard specific policy interventions and consolidate and retain the major policy interventions that will be implemented in the specific decision area.



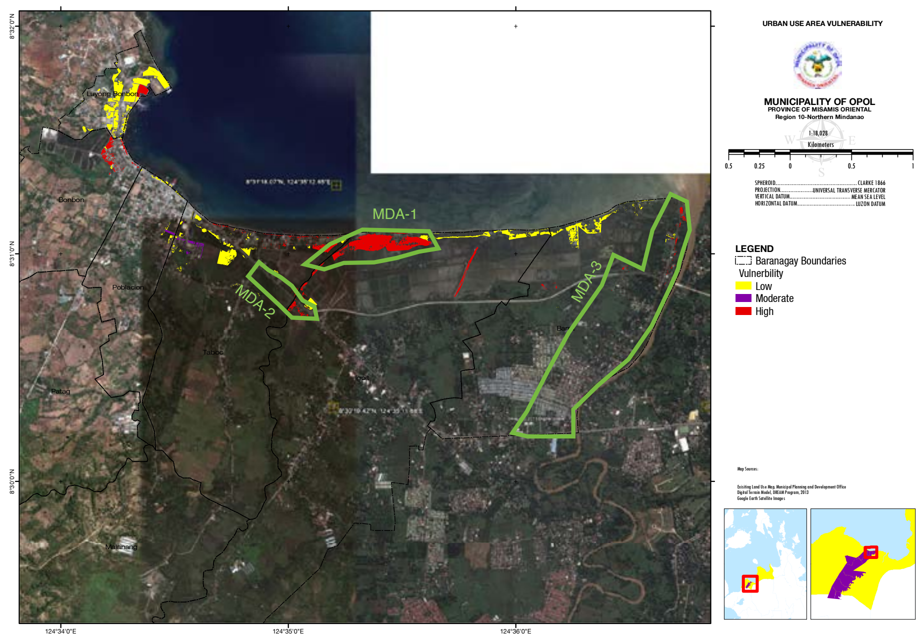


Figure 3.6.1 Detailing of Major Decision Areas

Identification of major decision areas (urban use areas) using the Identified flood risk decision areas (above) and Sea Level Rise vulnerability decision areas (below). In this example MDA-1 was considered a MDA due to risks associated with floods and vulnerability associated with sea level rise. Risk management options and interventions shall be identified to address both the risks to floods and SLR. Risk management options and interventions in MDA-3 will be mainly focused on reducing risks to floods.

Table 3.6.1 Sample Issues Matrix Urban Use Area

Decision Area/s	Description	Problems/Hazards	Impacts/Implications	Policy Interventions
A	B	C	D	E
Igpit - Informal settler areas (MDA-1)	Area located at the mouth of the Bungcalalan River adjacent to the Macalajar Bay	Areas prone to riverine and coastal flooding, potential area submersion due to sea level rise in the long term. Changes in tidal patterns may impact storm surge patterns specifically wave heights and inland inundation. Note: Risks to other hazards can be incorporated to describe the area for a more comprehensive and multi-hazard approach in identifying policy interventions/ recommendations	• Severe potential damages to residential structures due to floods. • Potential submersion of settlements due to sea level rise in the long term. • Potential isolation of communities, injuries and casualties during floods and, storm surges • Establishment of sea walls and mitigation measures to retain current land uses will be costly, costs cannot be shouldered by affected families and the LGU; • Future uncontrolled growth of settlements may increase exposure and risks	• Relocation of informal settler families, employ managed retreat or incremental relocation • Establishment of early warning systems and formulation of flood contingency plans to minimize potential injuries and casualties during the implementation of relocation; • Identification of additional 9.29 hectares of residential land to accommodate potentially affected families and provision of comprehensive housing program for affected families especially the informal settlers • Designating areas for wetland and mangrove restoration and serve as part of the eco-tourism network; • New transportation systems will not be pursued in the area to discourage future settlement growth;
Barra Riverside Settlement areas (MDA-3)	Major growth area with mixed land uses located along the Iponan River	Mainly riverine flooding along the Iponan River with sea level rise near the river mouth	• Potential severe damage to settlement areas and possible deaths and injuries along the riverside areas due to floods • Potential submersion of settlements due to sea level rise in the long term especially along the river mouth • Riverbank erosion and possible failure of riverbank slopes affecting structures; • Future growth in the area may increase exposure and risks if no interventions are implemented	• Establishment of expanded easements along the river side and changing these areas for open space development; • Mandatory relocation of structures within the expanded easements and sea-level rise impact area; • Low density development shall be employed within highly susceptible, prone areas to minimize the level exposure • Change the land use mix from residential to commercial or any land use mix where cost for effective mitigation can be shouldered by proponents/developers • Development of settlement areas shall be subject to development restrictions with emphasis on the imposition of hazard resistant design regulations • Mandatory retrofitting of structures within a period of 10 years • All costs related to the establishment of mitigation measures such as riverbank protection structures shall be shouldered by the property owners through the imposition of special levy taxes • Establishment of early warning systems and formulation of flood contingency plans to minimize potential injuries and casualties • Conduct of site specific flood modeling studies to inform development regulations

4

Formulating a Risk Sensitive Land Use Plan

Integrating climate change and disaster risks to enhance the CLUP formulation process

This chapter shall demonstrate the integration of climate and disaster risks in the various stages of the CLUP formulation process. Risk and vulnerability related information articulated in the climate and disaster risk assessment (CDRA) hopes to enrich the analysis of the planning environment. A better understanding of the potential risks and the vulnerabilities allow decision-makers and stakeholders to make informed and meaningful decisions in goal formulation, strategy generation, and land use policy formulation and development. The integration of the results of the CDRA intends to guide the formulation of a risk-sensitive comprehensive land use plan towards a safer and resilient human settlements through rationalized location of people, assets, economic activities, and sustainable management of resources to effectively manage risks and address the challenges posed by hazards and climate change.

Set the Vision

Mainstreaming climate and disaster risks in the vision statement involves the integration of climate change adaptation and disaster risk reduction concepts/principles in describing the ideal state of locality in terms of the people as individuals and society, local economy, built and natural environment, and local governance. These can either be expressed as vision descriptors or success indicators, benefiting from technical findings derived from the climate and disaster risk assessment.

One of the preferred tools in visioning is the Vision-Reality Gap Matrix, where descriptors are identified for each vision element and a qualitative rating on the current level of achievement is conducted. It has to be noted that the review of the Vision-Reality gap analysis will be better if the information on disaster risks and climate change vulnerabilities are prepared prior to the analysis. Vision descriptors such as a risk resilient population, safe built-environment, proactive local governance, and ecologically balanced natural environment can be used., A list of success indicators to further describe/support the vision descriptors (i.e reduction of exposed population to climate related extreme and slow onset hazards, rate of conformance to risk mitigation structural development regulations, increased level of awareness and proficiency of the population in describing natural hazards affecting their locality, presence of hazard specific mitigation related development regulations, reduction in damages due to hazards to built-up property and production areas) can also be used. The various indicators of exposure, sensitivity/vulnerability, and adaptive capacity can be translated into success indicators to support certain relevant descriptors. Presented below are sample descriptors and success indicators integrating results of the climate and disaster risk profiling.

Table 4.1 Sample Vision Element Descriptors and Success Indicators for Disaster Risk Reduction and Climate Change Adaptation

Element	Descriptor	Success Indicators	Rating
People as individuals and as a society	Safe	Reduction of cases of deaths and injuries related to hazards (i.e. direct/ indirect)	2
	Empowered	Increased provision of special opportunities in employment and training for increased adaptive capacity of the population	2
	Vigilant	Increased level of awareness on areas affected and potential impacts of hazards and climate change, incorporating DRR-CCA in the local educational system	2
	Resilient	Reduced dependence on post-disaster financing/ assistance	2
		Increased % of population employing household level adaptation/mitigation measures	1
Local Economy	Sustainable	Reduction in damages (direct and indirect) in annual local economic output/productivity due to climate-change related hazards	2
		Increase number of economic/productio- based structures/areas employing adaptation and mitigation measures	1
Local Leadership	Firm	High rate of apprehended violators, filed cases/ imposed penalties, sanctioned violators	3
	Progressive	Presence of local legislation in support of risk reduction and climate change adaptation (i.e. incentives and disincentives)	2
		Reduced annual expenditure for disaster response and rehabilitation	2
		Increased financial capacity for disaster and climate change preparedness, adaptation and mitigation	1

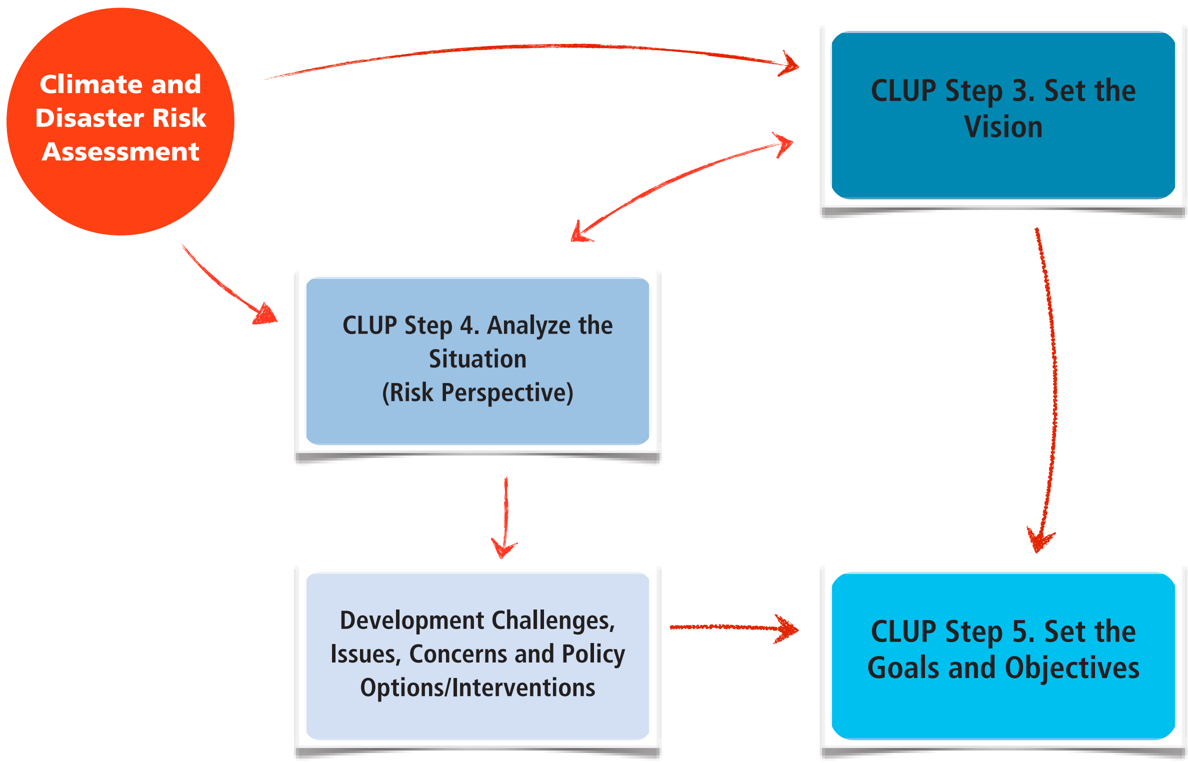
Table 4.1 Sample Vision Element Descriptors and Success Indicators for Disaster Risk Reduction and Climate Change Adaptation

Element	Descriptor	Success Indicators	Rating
Environment Management (Built and Natural Environment)	Clean and Safe	Conformance rate of built related property employing risk mitigation structural/non-structural regulations	1
		Increase area coverage of on/off-site mitigation and adaptation measures targeting vulnerable and risk areas associated with climate change and natural hazards	1
		Increased % of critical point facilities and lifeline infrastructures with climate proofing	1
		Reduction in property damage due to natural hazards and climate change impacts	2
	Balanced	Increased green spaces as carbon sinks	2
		Rehabilitation/protection of key biodiversity and ecologically critical/sensitive areas	2
	Sustainable, ecologically sound	Maximizing and managing supply of potable water resources	1
		Increased use of renewable sources of energy and reduced consumption of energy	1
		Efficient and uninterrupted area access/linkage systems	1
		Uninterrupted provision of basic lifeline utilities (i.e. power, water and communication)	1
		Uninterrupted delivery of basic social services (minimize cases due to damaged facilities as a result of natural hazards and climate change)	2

Situational Analysis

The climate and disaster risk assessment (CDRA) provides the climate and disaster risk perspectives for a deeper analysis of the planning environment. The emphasis will be on the analysis of the implications of climate change and hazards, to the various development sectors/sub-sectors (i.e. demography/social, economic, infrastructure and utilities) and the land use framework. It shall allow climate and disaster risk concerns to be incorporated in the identification of issues, concerns and problems and ensure that identified policy interventions both address current sectoral needs and anticipate future impacts of climate change and disasters. The integration of climate and disaster risks in the sectoral studies shall provide the opportunity for a more integrated approach in formulating the land use plan

Figure 4.1 Mainstreaming Climate and Disaster Risks in the CLUP (Steps 3-5)



Listed below are the expected outputs of the climate and disaster risk profile. Information derived can be used to further enrich the analysis of the planning environment. The profile is intended to analyze how climate change and natural hazards will potentially impact the various sectoral development focus areas and help in the identification of development challenges, planning implications, and possible policy interventions for addressing climate change and natural hazards through proper incremental and long-term adaptation and mitigation in order to reduce or eliminate the impacts of future disasters.

Table 4.2 Steps and expected outputs of the Climate and Disaster Risk Assessment

Steps[1]	Key information
Step. 1 Collect and organize climate and hazard information	• Analysis and discussion of projected climate change variables of the locality; • Description of the various natural hazards that would likely affect the locality (i.e. spatial extent, magnitude, recurrence interval); • Description of the historical damage statistics of past disaster events (amount of damages, affected population and property); • Descriptive observations of impacts from past disaster events
Step 2. Scoping potential impacts of climate change and natural hazards	• Illustration and description of potential sectoral impacts of climate change • Supplemental analysis of potential impacts based on historical experiences.
Step 3. Exposure Database	• Enhanced baseline exposure maps and attribute information on Population, Urban Use Areas, Natural Resource-based Production Areas, Critical Point Facilities and Lifeline Utilities • Indicators of exposure, sensitivity/vulnerability, and adaptive capacity
Step 4.Climate Change Vulnerability Assessment	• Quantitative analysis on the extent of exposure of population, built and production related properties, critical point and lifeline facilities • Understanding of indicators contributing to sensitivity • Qualitative analysis of the degree of impact based on exposure and sensitivity • Qualitative analysis of adaptive capacity, understanding factors contributing to adaptive capacity; • Qualitative assessment on the level of vulnerability, based on the potential degree of impact and existing level of adaptive capacities • Vulnerability maps indicating the spatial variation on the level of vulnerabilities of exposed elements • Decision areas, implications and policy interventions in the form of climate change adaptation and mitigation measures.
Step 5. Disaster Risk Assessment	• Analysis of recurrence interval (likelihood of occurrence) of hazards • Quantitative analysis on the extent of Exposure Population, built and production related properties, Critical Point and Lifeline Facilities • Qualitative analysis of vulnerability (social and inherent) of exposed elements, understanding of indicators contributing to vulnerability • Qualitative analysis of the degree of damage based on exposure and vulnerability • Qualitative analysis of adaptive capacity, understanding factors contributing to adaptive capacity • Qualitative analysis on the severity of consequence, based on the potential degree of impact and existing level of adaptive capacities • Risk maps indicating the spatial variation on the level of risks of exposed elements
Step 6. Summarize findings	• Major decision areas based on the vulnerability and risk maps/ summary tables • Summary of area-based technical findings based on the assessment of risks and vulnerabilities • Prioritization based on the acceptable level of risks and vulnerability • Identification of implications (emphasis on the implication of risks and vulnerabilities to local sectoral development) • Identification of policy interventions (legislation, land management policies, programs/ projects)

[1] CDRA Steps from Chapter 3 of the Supplemental Guidelines

Incorporation of risk and vulnerability information can enrich sectoral and sub-sectoral studies in agriculture, environment, economics, social, and infrastructure and utilities. In general, risks and vulnerabilities can be used to make adjustments in the land demand projections, policy interventions for mitigating risks in identified high risk/vulnerable areas, demand for lifeline utilities, and other cross cutting strategies for CCA-DRR.

Adjustments to land demand projections - Pertains to land demand implications of risks and vulnerabilities associated with the relocation of existing land uses/facilities. It answers the question, "If we are to relocate these land uses in another area, what would be the additional area requirements apart from the estimated requirements based on population projection?" Area estimates, as a result of relocation, are added in the projected land demand covering (but not limited to) the following items:

- Housing;
- Education related facilities (i.e. primary, secondary and tertiary level schools);
- Health related facilities (Hospitals, Municipal Health Stations/Centers)
- Social welfare related facilities (day care centers, senior citizen centers, PWDs and women)
- Government related facilities (i.e. Barangay Halls, Municipal Level Offices;
- Commercial, Industrial, and other production related land uses;

Adjusted demand for lifeline utilities by type - pertains to risk mitigation measures in addressing current risks/vulnerabilities and measures for anticipating potential problems related to the transportation access and utility distribution. These may include:

- Specific routes on where to allocate the estimated ideal road requirement such as evacuation routes, alternative/back-up routes
- Key road segments/routes for climate proofing or rehabilitation
- Demand for key water-related facilities/distribution networks (distribution line, water pumps, water districts, water storage, etc.)
- Demand for power and communication distribution networks and support facilities

Assessing land supply - This pertains to the incorporation of hazard information in the criteria for analyzing the level of suitability of buildable areas for urban expansion. It involves a preparation of a decision matrix which considers the characteristics of the hazard (i.e. susceptibility level, magnitude, return periods) and the required cost and feasibility to sustainably manage risks within identified hazard prone for urban use purposes.

Policy interventions or options for risk reduction and management - This pertain to policies and strategies for risk reduction and management (e.g. mitigation measures that are structural or non-structural in nature) imposed to hazard prone areas to ensure that risks are managed within acceptable levels. These interventions may range from the imposition of building structural design standards and mandatory retrofitting (for identified high risk/vulnerable areas which will be retained); determining relevant projects for disaster prevention/preparedness (priority areas to be targeted by disaster evacuation/preparedness measures that are not structural measures); construction of risk mitigation related infrastructure (i.e. flood control works, sea walls, slope stabilization); establishment of agriculture production support facilities (i.e. water impoundment, irrigation network); programs and projects to reduce population sensitivity/vulnerability and enhance adaptive capacities (i.e. livelihood programs targeting identified highly at risk and vulnerable groups); and rehabilitation and protection of ecological areas, both for enhancing natural adaptive capacities of environments (ensuring ecological stability to reduce impacts of climate stresses to natural environments) and contributing to mitigation of hazards (reforestation in upland areas to mitigate low land floods, establishment of rehabilitating mangrove areas to mitigate storm surges and coastal erosion).

Social Sector

Housing

In the estimation of housing needs, CDRA can identify priority/decision areas for further detailing and validation. This will allow a detailed counting of households/families within hazard-prone areas that are considered high risk/vulnerable, where the preferred mitigation option is through relocation (applying risk reduction through risk elimination and avoidance). Estimated value for relocation shall be added in the number of displaced families item as housing backlogs. Number of housing units considered at risk or vulnerable to hazards where the preferred measure is to retain the residential area/s and mitigate by employing hazard resistant structural retrofitting will be added under estimates for upgrading.

Table 4.3 Adjustments in housing requirements for 2022

Housing Needs	Present/ Future Needs	Future Housing					Total
		2014	2016	2018	2020	2022	
A. Housing Backlog	5,241	1050	1050	1050	1050	1041	5241
Double Occupancy	439	88	88	88	88	87	439
Displaced							
In Danger Areas	2,761	553	553	553	553	549	2761
Affected units due to land earmarked for gov't Infrastructure	1,332	267	267	267	267	264	1332
Evicted/for demolition	371	75	75	75	75	72	372
Homeless	338	68	68	68	68	66	338
B. Household Formation due to increase	6,420	1250	1250	1250	1250	1420	6420
C. Upgrading	405	100	150	155			405
TOTAL	**12,066**	**2,400**	**2,450**	**2,455**	**2,300**	**2,461**	**12,066**
Additional housing needs from CDRA[1]							
New Construction[2]	2,761	553	553	553	553	549	2761
Retrofitting/Upgrading[3]	405	100	150	155			405

[1] Subject to validation for possible inclusion in Items A. and C.
[2] Subject to validation for possible inclusion in item A estimates for displaced housing units in danger areas
[3] Subject to validation for possible inclusion in Item C estimates subject to upgrading with emphasis on structural risk mitigation of housing units

Education

Adjustments in the projected land area requirements for schools will depend on the number of educational facilities which will be relocated from its current location. Specific school structures, where relocation will be the option for risk reduction, shall be added to the projected area requirements (Column G). Educational structures that will be retained in their current locations shall be retrofitted based on hazards affecting the site/structure. Results of the CDRA can be summarized and presented in the sample matrix provided, indicating which structures will be relocated and the estimated area needed.

Table 4.4. Area requirements for educational facilities for 2020

A	B	C	D	E	F	G	H	I
School	Projected Classroom Requirements[1]	Existing Classrooms	Gap	Classrooms For Relocation CDRA[2]	Available classrooms after CDRA	Adjusted Projected Classrooms Requirements	Barangay Classification	Area Requirements (Hectares)[3]
					= C- E	= B - F		
Awang Elem. School	15	7	8	7	0	15	Rural	0.75
Bagocboc Elem. School	17	5	12	0	5	12	Rural	0.75
Barra Elem. School	42	15	27	15	0	42	Urban	2.12
Cauyonan Elem. School	10	3	7	0	3	7	Rural	0.50
Igpit Elem. School	71	8	63	0	8	63	Urban	3.75
Limunda Elem. School	10	4	6	0	4	6	Rural	0.50
Luyong Bonbon Elem. School	53	9	44	9	0	53	Urban	4.42
Malanang Elem. School	11	6	5	0	6	5	Rural	0.50
Binubongan Elem. School	7	4	3	4	0	7	Rural	1.50
Nangcaon Elem. School	11	4	7	4	0	11	Rural	0.75
Patag Elem. School	21	7	14	0	7	14	Rural	4.00
Opol Central School	99	19	80	0	19	80	Urban	10.67
Megdaha Elem. School	5	2	3	2	0	5	Rural	0.50
Tingalan Elem. School	12	3	9	0	3	9	Rural	0.50
Salawaga Elem. School	11	3	8	3	0	11	Rural	0.75
							TOTAL	31.96

[1]Based Sectoral Studies

[2]Based on the CDRA

[3]For Urban Areas: One-half hectare (1/2 ha.) for a central school which has six classes, for a non-central school which has from three to four classes.
One and one half hectare (1 1/2 ha.) for schools which have from seven to ten classes.
Two hectares (2 has.) for schools which have more than 10 classes.

For Rural Areas: One-half hectare (1/2 ha.) for central school with 6 classes and non-central schools with 7-10 classes.
Three fourth of a hectare (3/4 ha.) for eleven to twenty classes.
One hectare (1 ha.) for twenty one or more classes. (Source: ANNEX SE-10, eCLUP Guidebook, page 176)

Social Welfare

Estimation of projected day care centers can be done to determine current backlogs due to hazards. In this example, day care facilities for relocation are indicated in column F (expressed in square meters). Adjustments on the available day care centers after the CDRA can be computed in column G. Net projected area requirements for the planning period can be computed in column H which incorporates the identified backlog. This approach can also be applied to other social welfare related facilities such as senior citizen buildings, and other structures catering to the needs of PWDs and OSY.

Table 4.5 Area requirements for Day Care Centers, 2022

A	B	C	D	E	F	G	H
Barangay & No. DCC	**Projected Households by 2022**	**Projected Day Care Centers[1]**	**Projected Area Requirements (sq. meters)**	**Existing Land Area for Day Care Facilities (sq. meters)**	**Day Care Facilities for Relocation[2]**	**Available Day Care Facilities after CDRA**	**Projected Area Requirements**
						= E-F	= D - G
Awang-	565	2	300	100	0	100	**200**
Bagocboc	640	2	300	250	0	250	**50**
Barra	4,848	10	1500	300	0	300	**1200**
Bonbon	1,051	3	450	150	150	0	**450**
Cauyonan	317	1	150	50	0	50	**100**
Igpit	3,398	7	1050	100	50	50	**1000**
Limonda	225	1	150	50	0	50	**100**
Luyong Bonbon	1,281	3	450	50	50	100	**350**
Malanang	1,773	4	600	300	75	375	**225**
Nangcaon	256	1	150	50	0	50	**100**
Patag	1,111	3	450	350	0	350	**100**
Poblacion	1,234	3	450	100	0	100	**350**
Taboc	1,020	3	450	100	100	200	**250**
Tingalan	581	2	300	150	75	225	**75**
Total		45	6750	2100	100	2200	**4550**

[1]Based Sectoral Studies
[2]Based on the CDRA, day care centers identified for relocation
[3]One Day Care Center per 500 families, One Day Care Center 150 sq. meters, Opol Municipal Social Welfare Department

Health

This covers critical point facilities such as public and private Hospitals, Barangay Health Stations, clinics, and other health services related facilities. The risk/vulnerability evaluation should be able to identify structures to be retained and relocated. Structures to be relocated shall be considered as current backlogs and will be added in the projected area requirements.

Table 4.6 Adjustments in area requirements for Health related facilities

A	B	C	D	E	F	G	H
BHS/MHS	Projected Population	Projected BHS Requirements[1]	Current Facilities	Health related Facilities for Relocation[1]	Available Health related Facilities after CDRA	Adjusted Projected Requirements	Area Requirements (Sq. Meters) [2]
					= D-E	= C-F	
Barra	21,816	5	1	0	1	4	**0.060**
Bonbon	4,730	1	1	1	0	1	**0.015**
Igpit	15,291	3	1	1	0	3	**0.045**
Luyongbonbon	5,765	1	1	1	0	1	**0.015**
Poblacion	5,553	1	1	0	1	0	**0.000**
Taboc	4,590	1	1	0	1	0	**0.000**
Patag	5,000	1	1	0	1	0	**0.000**
Malanang	7,979	2	1	0	1	1	**0.015**
Awang	2,543	1	1	0	1	0	**0.000**
Bagocboc	2,880	1	1	0	1	0	**0.000**
Cauyonan	1,427	1	1	0	1	0	**0.000**
Limonda	1,013	1	1	0	1	0	**0.000**
Nangcaon	1,152	1	1	0	1	0	**0.000**
Tingalan	2,615	1	1	0	1	0	**0.000**
Total	82,354	15	8	3	5	10	**0.150**

[1]Based on the CDRA, identified existing facilities for relocation
[2]Based on 1:5,000 population per BHS. MHS shall cover the whole municipality. BHS space requirement is 150 sq.meter per facility. (Planning Standard)

Other facilities

The same approach can be done for other social support facilities such as protective services (i.e. police, fire protection, jail), governance (brgy. halls, municipal hall), and sports and recreation (gymnasiums. indoor sports facilities, etc.), The risk/vulnerability evaluation shall identify what structures will be relocated and retained. All identified structures for relocation shall be added in the end of planning period projected area requirements.

Economic Sector

This shall cover lands currently allocated for production such as commercial, industrial, tourism, agriculture and fisheries. However, separate analysis should be done for built up production areas such as commercial, industrial and tourism related facilities and areas devoted to natural resource production (i.e. crop, forestry, livestock, inland fisheries production).

Urban Use Areas

CDRA provides the information on non-residential urban use areas which will be relocated due to risks and vulnerability. This can be used to fine tune the projected estimated land area requirements with emphasis on the adjusted land area requirements on cases where some of the urban use areas will be relocated. When relocating urban areas, these will be added in the projected end of planning period land demand. Areas to be retained will be subject to risk mitigation measures either through the structural regulations, mandatory retrofitting or higher property taxes to fund hazard mitigation infrastructure. A sample urban use area projection is presented below:

Table 4.7 Adjustments in area requirements for Urban Use Areas

A	B	C	D	E	F
Land Use Category	Existing Areas	Projected Land Requirements	For Relocation[4]	Available Urban Use Areas	Adjusted Land Requirements
				= B - D	= C - E
Commercial[1]	13.13	15.65	8.831	4.299	11.351
Light Industries[2]	63.17	66	0.538	62.632	3.368
Tourism[3]	3.2	12	1.372	1.828	10.172

[1] 1.5-3% of Total Urban Use Areas
[2] 0.8 Hectares per 1,000 Population
[3] Private Sector Commitments
[4] Estimated urban use areas for relocation based on the CDRA

Natural Resource Production Areas

When dealing with natural resource production areas (i.e crop production areas, fisheries, production forests), the CDRA provides the information on the major decision areas in need of mitigation (adaptation). Mitigation measures can be structural (establishment of flood control works, slope stabilization, construction of water impoundment and irrigation facilities, establishment of extension services field offices, retrofitting production support infrastructure, establishment of warehouses for farm implements and harvests) and non-structural (i.e. use of hazard resistant varieties, climate sensitive production techniques, improving farmers access to extension services, crop insurance). Specific measures for mitigation targeting identified production areas can be guided by the various indicators of sensitivity/vulnerability and adaptive capacity. These can be reflected in the issues matrix and policy interventions can be those that would reduce sensitivities/vulnerabilities or enhance adaptive capacities. These can be further translated into programs, projects, and, in certain cases, regulation (i.e. requiring farmers to secure crop insurances, higher property taxes to fund adaptation/ mitigation options).

Table 4.8 Sample summary of Risk Management Options for Natural Resource Production Areas

Major Decision Areas	Area Description	Area Allocation (Hectares)	Risk Management Options
Awang	• Interventions needed to address lack of irrigation and water impoundment facilities • Extension services sorely lacking • Farmers not familiar with crop insurance	883.56	• Establishment of irrigation facilities and water impoundment facilities to sustain 884 hectares of rice production areas • Use of drought resistant varieties and/or those with reduced water requirements • Improve extension services with emphasis on climate and hazard resilient production techniques
Bagocboc	• Mostly rain-fed rice production areas • No available irrigation and water impoundments facilities • Far flung barangay with no immediate access to extension services and access to early warning systems • Among the highest contributor of rice produce in the Municipality	3,273.04	• Establishment of irrigation facilities and water impoundment facilities to sustain 3,273 hectares of rice production areas • Establishment of early warning system for agricultural crop production • Encourage the use of risk transfer instruments (i.e. crop insurance) • Use of drought resistant varieties and/or those with reduced water requirements • Provision of forestry based alternative livelihood opportunities
Barra	• High value vegetable crops being produced. • Farmers not familiar with climate sensitive crop scheduling	58.66	• Changing crop and/or use of flood resistant varieties can be pursued • Use of drought and flood resistant varieties and/or those with reduced water requirements • Establishment of early warning system for agricultural crop production • Crop insurance can also be encouraged • Provide non-agriculture based livelihood opportunities • Establishment of warehouses for temporary storage • Reduce surface water run-off through upland watershed reforestation • Further expansion of agricultural areas in other upland areas
Igpit	• Flood plain portion of the Barangay • No flood control and water impoundment facilities • Use of drought tolerant varieties can be pursued • Look into possible utilization of ground water sources for irrigation during droughts	281.75	• Establishment of warehouses for temporary storage • Establishment of irrigation facilities and water impoundment facilities to sustain 884 hectares of rice production areas • Use of drought resistant varieties and/or those with reduced water requirements • Improve extension services with emphasis on climate and hazard resilient production techniques • Further expansion of agricultural areas in other upland areas • Reduce surface water run-off through upland watershed reforestation
Limonda	• Upland barangay with minimal irrigation and water impoundment facilities • Corn areas mostly rain fed. Among the biggest contributor of corn in the area • Very minimal Irrigation and water impoundment facilities present • possible extension services on climate sensitive production can be pursued	1,063.60	• Establishment of Irrigation and water impoundment facilities • Crop diversification • Provision of alternative forest production based livelihood

Infrastructure and Utilities Sector

The CDRA would be able to identify existing transportation, power, water and, communication related point facilities or distribution networks that would need either rehabilitation or climate proofing mainly to ensure the uninterrupted delivery of power, communication, and water services and efficient linkages between the various key settlement growth areas/ functional areas of the locality.

Transportation

A summary risk/vulnerability evaluation can be presented in a way that key road segments in need of immediate action are identified. These important road/access segments are key to prevent the isolation of communities and ensure efficient movement of supplies and emergency service during disasters. A sample list of road segments based on the risk/ vulnerability evaluation is presented below which also includes the identification of possible mitigation measures like upgrading/rehabilitating, existing road facilities, and/or establishing redundant/alternate routes.

Bridges can also be assessed and evaluated. This can be done through element-based risk/ vulnerability assessment. These are also important access systems which can be damaged by hazards resulting in major to minor interruptions in linking functional areas in the locality. Through the CDRA, priority bridges in need of immediate action can be identified so proper mitigation measures can be identified and implemented.

Table 4.9 Sample Risk Management Options for Priority Bridges

Name	Type	Location	Risk Management Options[1]
Iponan Bridge	Concrete	Barra	• Establishment of alternate route systems connecting the Municipal Growth Center of Opol to CDO to ensure uninterrupted linkage of the two growth areas • Retrofitting of existing bridge to accommodate 100 years of floods
Igpit Bridge	Concrete	Igpit	• Establishment of alternate route systems connecting Poblacion-Igpit/Barra to ensure uninterrupted linkage within the municipality • Retrofitting of existing bridge to accommodate 100 years of floods
Taboc Bridge 2	Concrete	Taboc	• Establishment of alternate route systems connecting Barangay Taboc to Igpit • Retrofitting of existing bridge to accommodate high 100 years of floods
Tulay ng Pangulo	Steel	Tapurok, Malanang	• Establishment of alternate route systems connecting upland barangays with Poblacion • Retrofitting of existing bridge to accommodate 100 years of floods;

[1]Retrofitting works to mitigate embankment scour, lateral spreading and pilie driving of bridge support columns.

Table 4.10 Summary Risk Management Options for Road Network

Major Decision Area (Road Segment)[1]	Classification	Linear Kilometers	Remarks	Risk Management Options
Highway-Junction Tulahon Road	Provincial road	1.0145	Main road access going to upper Poblacion from Brgy Taboc/Lower Poblacion. Short interruption expected due to severe flood events	Road concreting, and increase road elevation above the flood height. Establish road embankment protection.
Metro Cagayan Road	National road	2.1054	Diversion road parallel to the national highway near the coastal areas. Unpassable during extreme flood events leading to isolation of settlements along the coast.	Improve drainage to allow flood waters to flow underneath through box culverts. Establish road embankment protection.
National Highway	National road	1.6647	Main road access/linkage to Cagayan de Oro to the Municipal Center is often unpassable during extreme events. Isolation of the municipal center to the western part growth areas of the municipality is expected.	Improve drainage to allow flood waters to flow underneath through box culverts. Establish road embankment protection. Establishment of alternate route transecting Igpit Malanang Patag
National Highway to Narulang Road	Provincial road	1.6203	Only road access leading to Youngsville Subdivision from the national road. Possible isolation of Youngsville Subdivision during moderate to extreme flood events.	Road concreting, and increase road elevation above the flood height. Establish road embankment protection. Improve drainage to allow flood waters to flow underneath through box culverts.
National Highway to Pag-ibig Citi Homes	Barangay road	2.5546	Only road access leading to Pag-ibig Citi Homes subdivision from the national road. Possible isolation of Pag-ibig Citi Homes during extreme flood events.	Road concreting, and increase road elevation above the flood height. Establish road embankment protection. Improve drainage to allow flood waters to flow underneath through box culverts.
National Highway to Zone 1 Road	Barangay road	2.1897	Main road access parallel to the Iponan River. Possible isolation of communities during moderate to extreme flood events.	Establish riverside embankment protection. Establishment of alternate route parallel to Zone 1 Road.
Tulahon to Tapurok Road	Barangay road	0.3803	Main route accessing upper Brgy. Patag from Brgy. Malanang, and Igpit. Unpassable during extreme flood events.	Road concreting, and increase road elevation above the flood height. Establish road embankment protection. Improve drainage to allow flood waters to flow underneath through box culverts.

[1] Major road segments for mitigation can be derived from the identified decision areas in the CDRA (lifeline Utilities)

The various risk management options identified can be used as added considerations in refining and designing the transportation network plan of the area with the intention of ensuring the uninterrupted inter and intra area linkages of various functional areas.

Water/Communication and Power

A risk/vulnerability assessment of power, water, and communication facilities can also be done to determine impacts of hazards on the uninterrupted provision of water, power, and communication facilities. However, assessment can be limited to element-based structures such as power substations, water pumping/storagerelated facilities, and communication towers. These can be presented similar to bridge risk/vulnerability evaluation listing down the unique facility indicating the risk/vulnerability evaluation category (high, moderate, low priority). Point facilities considered high are those in need of immediate action. Risk mitigation can be done through retrofitting of the structure where the design specifications are dependent on the hazards affecting the structure, and/or establishment of redundant/ back-up systems. If time and available data permits, an assessment of the utility networks (where segments rather than point facilities are assessed) can also be done. This is to identify important key utility segments that need to be mitigated, either through hazard resistant design specifications/climate proofing, or establishment of redundant/looping systems to ensure uninterrupted delivery of utility services.

Land Demand and Supply Analysis

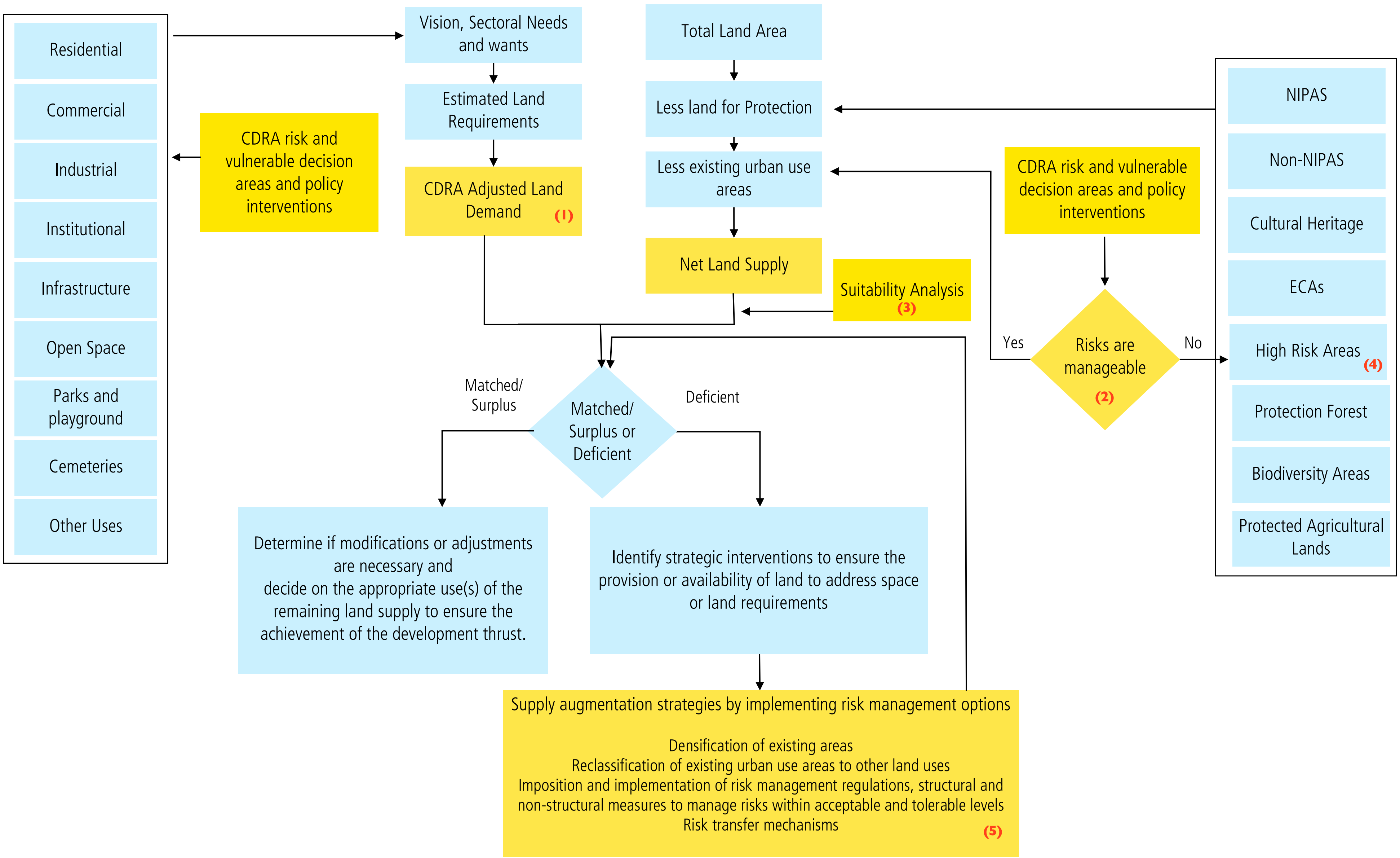
Results of the CDRA can be used as valuable inputs in land demand and supply analysis, accounting for the existing urban use areas which will be retained subject to the implementation of risk management strategies. The results can also be used to inform decision makers on priority areas for urban expansion by analyzing the suitability of sites considering susceptibility to hazards and the cost and effort to sustainably develop and maintain urban areas in the long run; and facilitate the identification of necessary supply augmentation strategies through the implementation of risk management options as may be needed (refer to Figure 4.2).

1. CDRA Adjusted Land Demand - Potential backlogs are associated with the planned relocation of facilities or urban use areas (i.e. housing units and critical point facilities for relocation) due to risk and vulnerability considerations, which were analyzed during the sectoral/sub-sectoral studies. Areas to be relocated shall be incorporated in the final land demand and they may pertain to residential areas; economic based structures/establishments; social support infrastructures considered highly at risk and/or vulnerable with emphasis on the possible structural damage or high possibility of deaths due to their current location relative to the expected changes in the area; and extent, magnitude, and recurrence of natural hazards due to climate change (i.e. floods and storm surges being more severe and frequent, coastal area inundation due to sealevel rise). Areas for relocation are also associated with areas where interventions (structural and nonstructural) are not feasible and/or unsustainable (i.e. flood control works, sea walls, reclamation, potential cost for response, rehabilitation/recovery, financial capacity for implementing major risk mitigation projects) and areas within prescribed and extended buffer easements (i.e. coastal and river easements). Adjustments in the projected land requirement per use are added to estimate the total future land demand by the end of the planning period.

2. Existing Urban Use Areas - CDRA, through the various risk and vulnerability maps, including the policy interventions to address them, can provide a distinction between areas/uses which will be relocated (where risks are unmanageable) and areas which will be maintained (where risks can be managed). Areas where risks are unmanageable are either added in areas for protection (expanded river easements, high susceptible landslide areas) or allocated for production type land uses and urban use spaces such as open space, parks, and buffer. Urban use areas to be maintained are identified risk or vulnerable areas/ establishments where measures for mitigation can be pursued (i.e. retrofitting, implementation of major risk mitigation projects) to reduce risks to acceptable levels and are within the capacities of property owners. Urban use areas to be retained are then subtracted from the total available land supply.

3. Areas for Protection - In the context of climate and disaster risks, when estimating land supply for urban use area expansion, it should account for the expected changes in the area extent, magnitude, and recurrence of natural hazards due to climate change. The estimated land supply should consider whether the associated impacts of hazards can be managed over time given current capacities for mitigation/adaptation. A better understanding of the varying degrees of hazard types and level susceptibility in relation to current and future capacities for short to long-term mitigation, are needed so that decisions can be made on whether certain hazard-prone areas will be deducted in the available land supply. Furthermore, the establishment of buffer easements (whether nationally prescribed or extended to account for the projected impacts of climate change to existing hazards) can be deducted in the available land supply. Examples include the extension of coastal easements (from the mandatory 40 meters) to account for the projected inundation of coastal areas due to sea level rise, extension of river easements (urban, agricultural areas) to account for change in the flood extent and magnitude. These high risk areas can be deducted to the available land supply, either allocated for resource production or open/green spaces.

Figure 4.2 Land Demand and Supply Analysis, incorporating results of the Climate and Disaster Risk Assessment



4. Suitability Analysis - Upon determining the available land supply for expansion, a sieve suitability analysis/ mapping can be conducted to rank and prioritize areas within the areas where expansion can occur. When determining suitability, hazards are viewed as constraints where necessary interventions are needed in order to sustain settlements by managing risks within acceptable levels. Managing risks within acceptable levels entails costs (higher development costs associated with mitigating risks) depending on the characteristics of the hazard. Analyzing suitability allows decision makers to prioritize the location of important urban use areas (i.e. residential areas, socialized housing, critical point facilities) in high suitable areas where costs for mitigation will be lower compared to less suitable areas where the cost for employing risk reduction measures is higher. Moderate to low suitability areas can be reserved for uses with propensities to generate revenues/income to offset the cost for mitigation.

    a. Preparation of suitability parameters (hazards) - The sieve mapping technique illustrated in the CLUP HLURB Guidebook (Volume 1) can be enhanced by assigning suitability indexes for hazard prone areas to prioritize areas for urban expansion. A suitability matrix can be prepared to assign the suitability score for each hazard per susceptibility level (or hazard intensities and recurrence when available). Suitability scores can be discussed and assigned depending on the costs for mitigating risks within acceptable/tolerable levels (refer to table 4.11-4.12 Suitability score and sample suitability analysis matrix).

Table 4.11 Suitability score and description

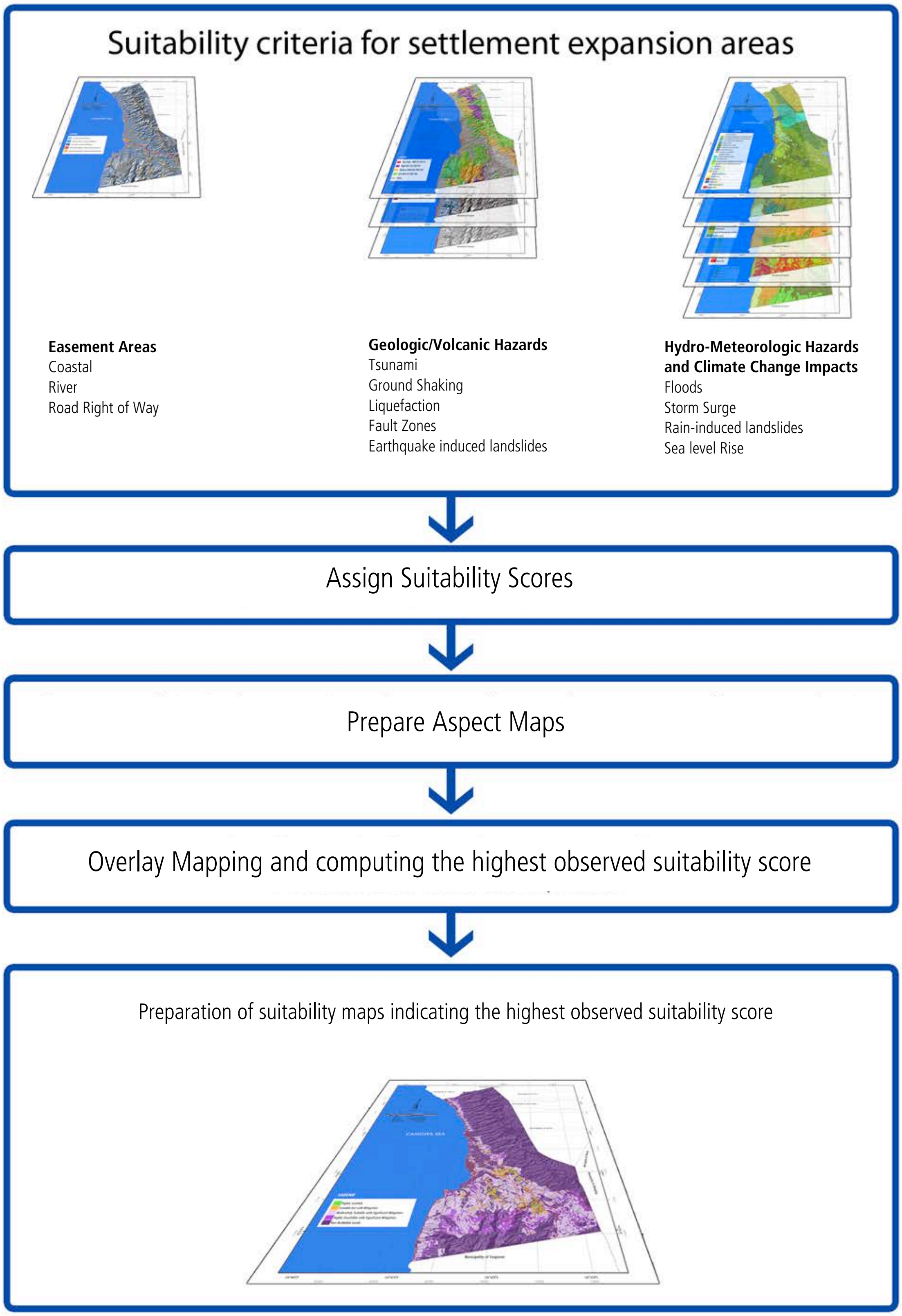
Suitability Category	Description	Suitability Score	Recommended Land Uses for Allocation
Highly Suitable	Areas not susceptible to the hazard	0	All urban use areas. Priority area for residential type land uses, essential facilities, special occupancy structures and hazardous facilities. Densification is recommended to maximize land.
Moderately suitable	Area within low susceptible hazard areas. Required cost for risk mitigation will be low	1	All urban use areas. Priority area for residential type land uses, essential facilities, special occupancy structures and hazardous facilities but subject to regulations on site and hazard resistant design
Low suitability	Area within moderate susceptible hazard areas. Required cost for risk mitigation will be moderate to high	2	Commercial and industrial uses but subject to regulations on hazard resistant site and building design
Highly Unsuitable	Area within high susceptible hazard areas. Required cost for risk mitigation will be very high, infeasible, and impracticable	3	Parks and open spaces, buffer strips and areas devoted for natural resource production
Non-Build able Areas	Areas under strict protection status from existing national laws and issuances such as fault easements, Permanent Danger Zones	100	Protection Land Uses

Table 4.12 Recommended suitability score and description

Hazard/Susceptibility	Suitability Score[1]				
	Highly Suitable	Moderately Suitable	Low Suitability	Highly Unsuitable	Non-Buildable
	0	1	2	3	100
Flood					
None	0				
Low		1			
Moderate			2		
High				3	
Rain-Induced Landslide					
None	0				
Low		1			
Moderate			2		
High				3	
Storm Surge					
None	0				
Low		1			
Moderate			2		
High				3	
Sea Level Rise					
Within >1- 2 meter above mean sea level			2		
Within 1 meter above mean sea level				3	
Liquefaction					
None	0				
Low		1			
Moderate		1			
High		1			
Ground Rupture					
Earthquake Active Fault Zones Easements					100
Ground Shaking					
None	0				
Low		1			
Moderate		1			
High		1			
Lahar Flows				3	
Volcanic Permanent Danger Zone					100

[1] LGUs can assign suitability ratings depending on the current and future capacities of property owners to cover the costs and effort for implementing risk management options. Refer to Table 4.11 on the suitability descriptions and scores

Figure 4.2a Sample Sieve Mapping and Suitability Analysis



b. Overlay mapping - Transparencies can be prepared by translating hazard maps into aspect maps containing the suitability categories. This can also be facilitated by using Geographic Information System and conducting spatial analysis/overlays where suitability ratings can be incorporated in the attribute table per hazard map.

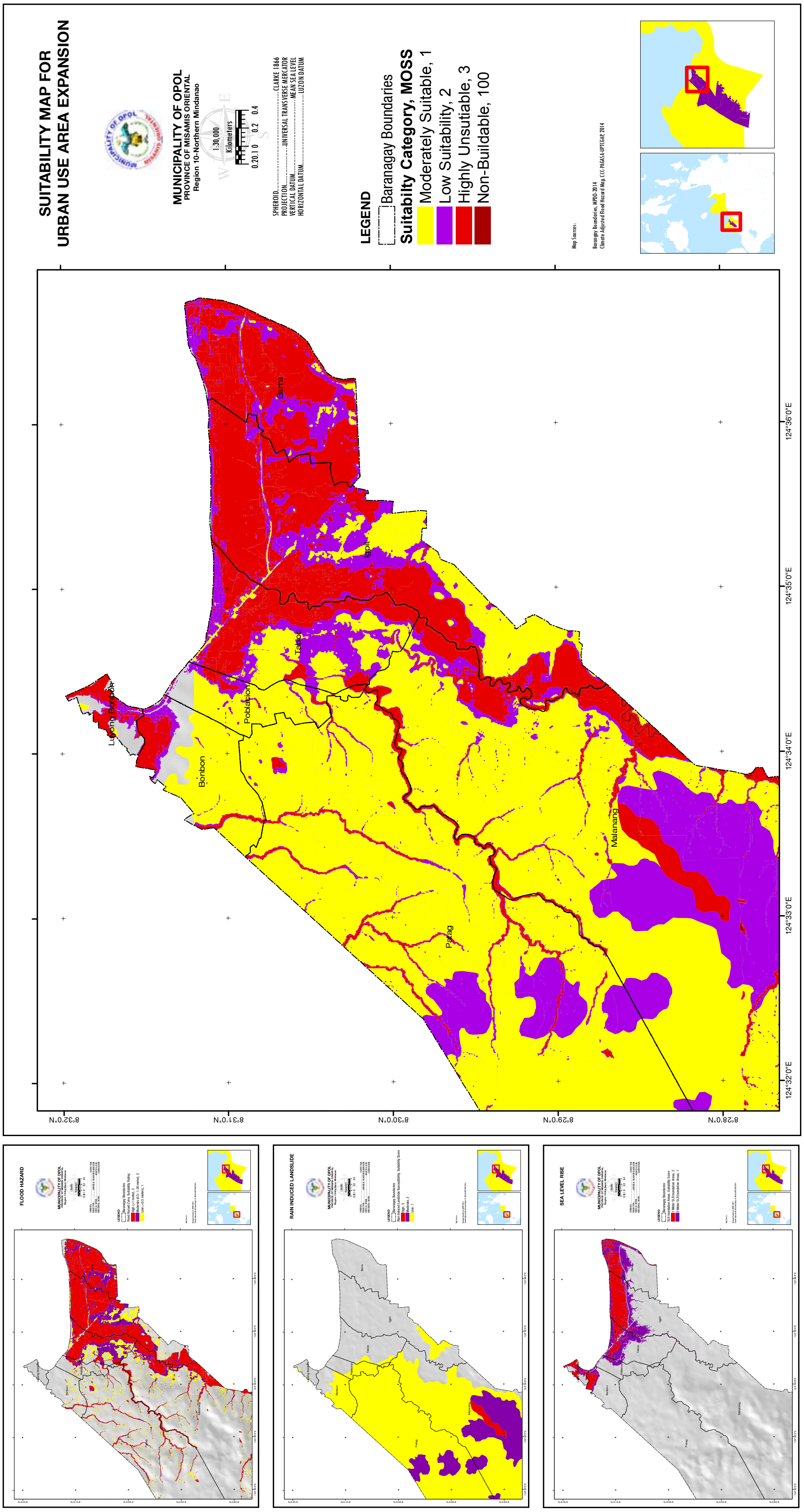
c. Measuring suitability -Suitability can be derived from the sieve mapping analysis. Suitability index can be represented by the maximum observed suitability score (MOSS) based on the combination of aspect suitability maps. This will provide an indication of site suitability. A secondary measure of suitability for further ranking can be derived from the total suitability score (TSS) using the sum of all suitability ratings used to indicate the number of complications (combination of suitability scores) in developing the site. Prioritization can be conducted by sorting values based on the maximum observed suitability score (MOSS) and the total suitability score (TSS). The resulting maps can facilitate the identification of priority areas suitable to accommodate the required land demand and determine areas where possible densification and further risk mitigation can be employed during the demand-supply balancing (refer to Figure 4.2b)

5. Supply augmentation strategies - When balancing land demand and supply, risk mitigation measures can be treated as supply augmentation strategies. Highly susceptible areas, depending on the hazard type, can still be set aside for settlement development provided that the necessary mitigation measures are in place. One example is settlement development within highly susceptible flood areas where structural mitigation measures can be implemented given the capacities of property owners to conform to structural design standards (design considers the base flood elevation and velocity based on modeling and simulation incorporating climate change scenarios) and construction of flood control measures (where costs for implementation are shared by both the LGU and beneficiaries).

   Another example is the development within storm surge areas where storm surge heights and magnitude are clearly projected and understood allowing design standards for structural resilience to be identified and enforced. Another option is through vertical development or densification of settlement areas (either within expansion or existing urban areas) where impacts of hazards are manageable.

   In cases where the expected magnitude and recurrence of hazards exceed current capacities to cope and adapt (landslide prone areas where the cost of mitigation like establishment of slope stabilization works requiring significant financial resources), these areas can be momentarily left in their natural state until such time when level of capacities can sustainably overcome these impacts.

Figure 4.2b Sample Suitability Analysis Map



Sectoral and Cross-sectoral Analysis

Mainstreaming climate and disaster risks in the sectoral analysis provides a risk/vulnerability perspective in generating the technical findings; enriches the identification of development challenges, issues, and problems with emphasis on the impacts of hazards and climate change; the identification of future implications if these issues are not addressed, and the various mitigation and adaptation options to address which can be reflected and articulated in the policy interventions. Presented below are some considerations when conducting a sectoral/cross-sectoral study issues matrix, incorporating the significant findings from the climate and disaster risk profile and risk/vulnerability enhanced situational analysis. Presented is a sample risk-enhanced issues matrix.

Table 4.13 Risk and Vulnerability Information in the Sectoral and Cross-sectoral Analysis

Technical Findings	Implications	Policy Interventions
Incorporate technical findings from the CDRA when discussing sectoral or cross-sectoral analysis: • Risks and vulnerabilities (Priority areas in need of interventions); • Underlying factors contributing to risks and vulnerabilities based on the analysis of exposure, sensitivity/ vulnerability and adaptive capacity; • Impacts of hazards and climate change to the projected land requirements (backlogs) • Important parameters such as Climate Change Projections (extreme weather events, projected seasonal changes in temperature and rainfall), and possible impacts of climate change to existing hazards (frequency and severity) such as floods, landslides, storm surges, drought, etc.	Identify the possible implications and provide statements related to the potential impacts to sectoral development if the development challenges (Problems, issues and concerns) are not addressed. This can be further supplemented by anecdotal accounts derived from the impact chain analysis.	Identify possible policy options and interventions that can address the development challenges/issues and problems with emphasis on interventions related to risk mitigation; and climate change adaptation. These can be in the form of: Specific policies (local legislation, spatial development policies) Specific strategies (Programs, Projects and Activities)

Table 4.14 Risk and Vulnerability considerations in the Sectoral and Cross-sectoral Analysis, Social Sector Housing Sub-sector

Technical Findings	Implications	Policy Interventions
• Increasing number of households in highly susceptible areas to flooding, sea level rise, and storm surge. Provision of adequate and suitable housing units/ areas within the Municipality • Presence of informal settlers within the highly susceptible areas to flooding, sea level rise, and storm surge. • Approximately 2,700 households live in highly vulnerable structures (floods, sea level rise, and storm surge) and need to be relocated, • Approximately 450 structures in flood and storm surge areas which will be retained need to be upgraded/ retrofitted. • Space requirements for approximately 6500 housing units need to be identified and established by 2022 • Behavioral characteristics of vulnerable group (preferring to live within highly susceptible to hazards to be near their place of work) making off-site relocation problematic ineffective; beneficiaries unwilling to stay in existing relocation sites due to lack of income opportunities and lack of on-site basic utilities, • Lack of financial capacities of beneficiaries to participate in relocation, and LGU to provide affordable resettlement housing. • Lack of LGU capabilities for enforcement and monitoring the growth of informal settlements. • Lack of financial capacity among the residential building owners in conforming to structural regulations to mitigate floods. • Lack of clear locational and structural development guidelines in the establishment and construction of residential structures.	• Possible future deaths are expected in identified hazard and climate change hotspots. • Uncontrolled future growth of settlements in identified hotspots increases risk to fatalities and property damage • Redirection of LGU funds for disaster response, relief, and rehabilitation. • Increased poverty incidence especially among highly vulnerable groups	• Identification of future expansion areas within relatively safe areas • Identify suitable relocation sites for settlers in highly susceptible areas to flooding, sea level rise, and storm surge; 445 households need relocation; 405 housing units need retrofitting • Land banking for in-municipality relocation. • Consider multi-storey housing units within relocation sites (as an alternative to row one floor housings). • Provide budget for relocation site development • Social preparation of informal settlers (increase awareness on the potential impacts of hazards and climate change to justify actions for mitigation/ adaptation) • Access funds of National Housing Authority (NHA) • Creation /activation of the local housing board • Establish a system to periodically monitor encroachment on public properties • Generate economic opportunities (Alternative Livelihood) to increase the level of adaptive capacities of the population • Imposition of additional development restrictions/regulations in the location and development of housing units (including other structures) • Discourage the construction of utilities in identified informal settler areas (transportation, water and electricity) to discourage future growth. • Reforestation in the Watershed areas of the Iponan and Bungcalalan River

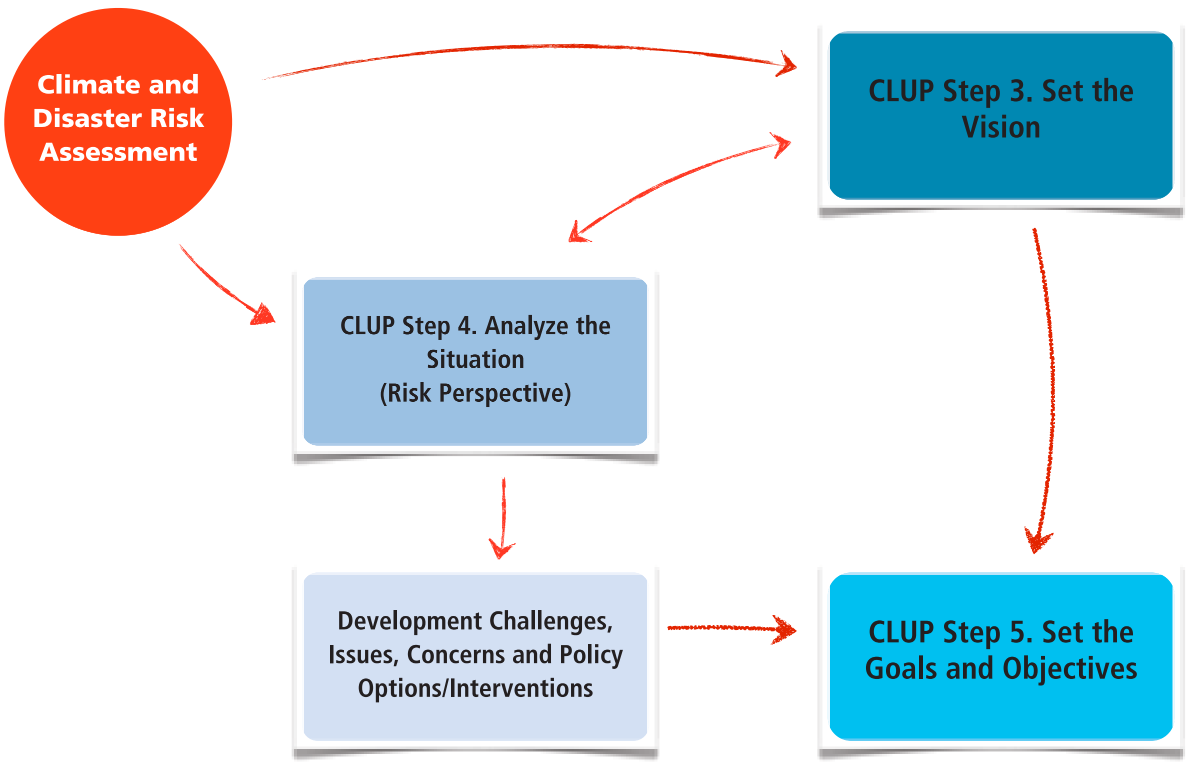
Table 4.15 Risk and Vulnerability considerations in the Sectoral and Cross-sectoral Analysis, Social Sector-Health Sub-sector

Technical Findings	Implications	Policy Interventions
• Increasing demand and ensuring adequate and efficient delivery of quality basic health services • There is a need to provide 10 additional BHS based on the projected population by 2022, including three BHS in need of relocation. • Around 5 existing BHS require retrofitting to mitigate the hazards affecting the structure. • Significant reduction in forest cover in the Iponan and Bungcalalan watershed areas have been observed and may have contributed to low land flooding	• Inadequacies in the provision of BHS in the future to accommodate projected future population. • No assurances that these facilities will be operational during extreme rainfall events which may lead to the deficiencies in the delivery of health related services	• Construction of new BHS within relatively natural hazard safe areas. • Employing structural mitigation/climate proofing of new BHS structures. • Rehabilitation and retrofitting/climate proofing of 5 existing BHS structures vulnerable to damage against flood. • Reforestation in the watershed areas of the Iponan and Bungcalalan River
• Existing municipal health station (12 bed capacity) is within a flood prone area. Past flood occurrences resulted in the transfer of patients to the local public market (Jan 11, 2009, Tail end of the cold front at 200mm). • Cagayan de Oro projections of extreme daily rainfall events (>150mm) suggest that there will be 13 events occurring within the period of 2006-2035 (2020 projection) and nine events occurring within the period of 2036-2065 (2050 projection).	• Possible inadequacies and major disruption of provision of health services • Disaster response may be ineffective and may lead to deaths due to lack of medical/health services	• Retrofitting is possible by extending vertically and using the first floor as parking area. It will entail significant costs but cheaper compared to establishing a new municipal health station. • Establishment of new hospital to accommodate projected future population will be outside flood prone and sea level rise impact areas • Reforestation in the watershed areas of the Iponan and Bungcalalan River

Set the Goals and Objectives

A goal is a broad statement of the desired outcome in support of a long term vision. Goals are typically intersectoral in scope and long to medium term in time scale that seek to address or respond to a general problem. Objectives are more specific statements of medium to short-term targets which seek to address specific sectoral problems that would contribute in the achievement of the identified goal. Informed of the various development challenges, problems, issues, and concerns, and the various policy interventions (through the climate and disaster risk profile incorporated in the sectoral and cross sectoral studies), the municipality/city should be able to enrich its sectoral goals and objectives statements by incorporating principles of disaster risk reduction and climate change adaptation. The integration of climate and disaster risks in the CLUP, recognizes risk reduction and climate change adaptation as pre-requisites to sustainable development and ensures that these will be among the priority long-term agenda of the local government and guide the spatial development locality.

Figure 4.3 Mainstreaming Climate and Disaster Risks in the CLUP (Steps 3-5)



It is assumed that the identified development challenges, issues and concerns derived from the situational analysis are already cognizant of CCA-DRRM. The sectoral studies are already a product of the incorporation of the significant findings from the climate and disaster risk profiling to the various planning sectors. Also, the vision statement already benefits from the incorporation of CCA-DRRM and provides a good description of the ideal state of the locality in the future. Development challenges/issues, including vision descriptors, can be restated as goal statements while policy interventions identified in the sectoral studies can either be restated as objectives. In the context of CCA-DRRM, as it relates to spatial planning, goals and objectives should be able to cover the following development concerns:

- Ensure optimum economic productivity through resilient and well-adapted production systems
- Address vulnerabilities/sensitivities and enhance adaptive capacities of the population
- Ensuring the uninterrupted access to social support services
- Efficient linkage/access, and distribution systems through the establishment of climate proofed and resilient infrastructure and utilities
- More efficient use of public and private investments

Presented below are sample outputs of goals and objectives setting with emphasis on the outputs derived from the CDRA.

Table 4.16 Sample goals and objectives

Vision Statement	Goals	Objectives
A vibrant and sustainable commercial, industrial, and tourism based economy propelled by proactive and self-reliant citizenry living in a water -sufficient, adaptive, and balanced environment with competitive and pro-poor governance.	Ensure the adequate and efficient delivery of basic social support facilities/ services	Establishment of 22 new BHS that are disaster and climate risk resilient by 2023
		Retrofitting and rehabilitation of 6 existing BHS and existing Municipal hospital against potential hazards affecting the structure
		Establishment of additional 139 classrooms that are disaster and climate risk resilient in safe locations and reduce cases of disruption of classes due to structural and equipment damage
		Retrofitting and rehabilitation of 10 existing classrooms to mitigate potential hazards affecting the structure.
	Ensure human security by increasing the level of adaptive capacities of the population and establishment of sustainable and well adapted housing units	Increase allocation for urban use areas; generate jobs in the agri-industrial, tourism industries to cover 1,200 households by 2022
		Increase level of awareness of local population on emerging issues related to disasters and climate change including measures for adaptation and mitigation
		Encourage the retrofitting/upgrading of 405 existing housing structures
		Relocate 445 informal settler households considered highly vulnerable and at risk to flooding, sea level rise and storm surges
		Establish new housing units to accommodate future households (6,420)

Table 4.16 Sample goals and objectives

Vision Statement	Goals	Objectives
A vibrant and sustainable commercial, industrial, and tourism based economy propelled by proactive and self-reliant citizenry living in a water-sufficient, adaptive, and balanced environment with competitive and pro-poor governance.	Ensure local food security and optimum productivity of agriculture and forest-based industries	Increase areas allocated for agricultural production Reduce cases of land conversion of prime agricultural lands to non-agricultural uses Established climate-proofed/risk resilient food warehouses Increase in the average per hectare yield of rice and corn Established climate-proofed/risk resilient post-harvest facilities Reduce damages to farm equipment and post harvest facilities
		Increase in agricultural crop production areas with access to water impoundment facilities Identification of alternative water sources (surface and ground) for irrigation
		Increase in agricultural crop production areas with access to irrigation facilities Decrease amount of damage to crops due to flood, severe winds, drought through sound, and climate-proofed production techniques
		Establish forest production areas and ensure sustainable production/resource extraction techniques

Table 4.16 Sample goals and objectives

Vision Statement	Goals	Objectives
A vibrant and sustainable commercial, industrial and tourism based economy propelled by proactive and self-reliant citizenry living in a water-sufficient, adaptive, and balanced environment with competitive and pro-poor governance.	Establish climate - smart, risk-resilient and environment-friendly industries and services	Increase area allocation for economic-based establishments, tourism, agri-industrial, forestry, and other service related facilities/establishments Increase in locally employed residents Increase number establishments employing structural mitigation measures and/or decrease in the number of business establishments exposed to hazards Decrease production losses due to hazards
		Increase number of establishments employing water augmentation practices Increase number of establishments using on-site renewable energy technologies Enact a local ordinance providing incentives to establishments using eco-efficient production/operation practices
	Enhance the quality and stability of natural environments	Enact a local ordinance designating portions of the Bungcalalan River Watershed as protection forest Enact a local ordinance designating portions of the Iponan River Watershed as protection forest Increase rehabilitation efforts in forest areas
		Increase in mangrove areas rehabilitated Enact a local ordinance designating portions of the coastal areas as protection mangrove forest Enact a local ordinance designating portions of the coastal areas within inland fishery areas as production areas including sustainable resource management regulations in place Resolution of conflicts arising from the conversion of mangrove forests into urban use areas
		Enact a local ordinance designating key aquatic habitats as protection areas Reduction of cases of prohibited resource extraction activities within identified protected areas

Table 4.16 Sample goals and objectives

Vision Statement	Goals	Objectives
A vibrant and sustainable commercial, industrial, and tourism based economy propelled by proactive and self-reliant citizenry living in a water-sufficient, adaptive, and balanced environment with competitive and pro-poor governance.	Establish climate-smart and disaster risk-resilient infrastructure systems	Established alternate route connecting the urban core to the Cagayan de Oro and El Salvador Reduced cases of prolonged isolation of barangays due to floods, landslides, and storm surges Number of highly vulnerable and at-risk road segments, climate-proofed and/or rehabilitated
		Establishment of a local water district Increase volume of locally sourced water Ensure water quality of potable water (point source) Area coverage (or households and establishments) with access to potable drinking water Number of establishments employing water augmentation practices Reduced cases of disruption of water distribution services due to natural hazards Reduced cases of disruption of water distribution services due to lack of water supply Establishment of communal water treatment facilities within major settlement areas Enact a local ordinance providing incentives to establishments using eco-efficient water management practices
		Number of off-grid, decentralized community-based renewable energy systems to generate affordable electricity Amount of energy (KwH) derived from renewable energy sources Reduced cases of disruption of power distribution services due to natural hazards Reduced electricity consumption

Selection of the Preferred Development Thrust

The development thrust identifies the type of development the city/municipality wishes to pursue, which will drive the long term development of the locality. Identification of development options is based on sectoral studies, SWOT analysis, and other analytical studies which establish the inherent potentials and opportunities. LGUs are expected to identify at least three development thrust options (i.e. Agriculture, Industrial, Commercial, Eco-Tourism, Agri-Tourism) and prepare an evaluation criteria to select the preferred thrust. The thrust option/s should be consistent with the predefined vision, goals, and objectives.

In the context of integrating CCA-DRR in the CLUP, climate and disaster risk information give decision makers and stakeholders the opportunity to revisit their current development thrust. They can choose to identify possible alternative development thrusts and evaluate and select the preferred development thrust that accounts for the current and potential implications of climate and disaster risks. In general, items for consideration include:

- Ability of the option to generate social and economic benefits to reduce current and future vulnerabilities/sensitivities and enhance current adaptive capacities of local residents
- Feasibility of pursuing the thrust option/s given the magnitude and spatial extent of natural hazards
- Potential impacts of climate change (i.e. extremes and variability) on the thrust option and its implications to the sustained economic productivity
- Required mitigation and adaptation measures to ensure sustained productivity
- The expected impacts of the development thrust to the stability and ecological balance of the natural environment and its ability to reduce hazards and climate change associated impacts

Tools for evaluating development thrust/strategy options include Social Cost-Benefit Analysis (SCBA), Planning and Budgeting System (PBS), Land Suitability Assessment (LSB), Checklist Criteria, and other innovative techniques. Illustrated below is a sample goal achievement matrix used for evaluating development thrust options.

Table 4.17 Sample Development Thrust Evaluation

	Criteria	Weight	Alternative 1: Intensified Crop Production Development		Alternative 2: Agro-Forestry Tourism Development		Alternative 3: Light to Medium Agri-Industrial Development	
			Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
1	Cost of new support infrastructure (i.e. Transportation, Power, Communication, Irrigation)	10%	3	0.3	4	0.4	4	0.4
2	Is the option consistent with the vision and achievement of identified goals and objectives?	5%	4	0.2	4	0.2	3	0.15
3	Will the option generate enough economic opportunities and improve income levels of the local inhabitants (sensitivities and enhance adaptive capacities of households and individuals)?	15%	2	0.3	4	0.6	3	0.45
4	Will it generate enough local revenues/income in the form of real property taxes and business permits to support/sustain local development?	5%	2	0.1	3	0.15	4	0.2
5	Does the local inhabitants have the necessary skills and capabilities to pursue the option?	5%	4	0.2	4	0.2	4	0.2
6	Does the Local Government have the capacity and capability to support the development thrust in terms of policy, program and project implementation?	5%	4	0.2	4	0.2	4	0.2
7	Will it encourage the sustainable and optimal use of local natural resources?	5%	3	0.15	4	0.2	3	0.15
8	Is the option achievable given the hazard susceptibilities of the Municipality?	15%	3	0.45	3	0.45	3	0.45
9	Is the option achievable given the projected changes in the climate (extremes and variability)?	15%	3	0.45	4	0.6	4	0.6
10	Amount of disaster risk management and climate change adaptation measures required to pursue the development option to be shouldered by the LGU and the private sector	10%	2	0.2	2	0.2	3	0.3
11	Does it promote ecological balance and sustainability?	10%	4	0.4	4	0.4	3	0.3
	Weighted Score	100%	2.95		3.6		3.4	
	Rank		3		1		2	

Scoring System:
1-Low contribution to the achievement of desired goals, very high cost requirements to achieve goals, very limited capacities and/or capabilities of constituents or the government to achieve goals
2-Moderate contribution to the achievement of desired goals, high cost requirements to achieve goals, limited capacities and/or capabilities of constituents or the government to achieve goals
3-High contribution to the achievement of desired goals, moderate cost requirements to achieve goals, existing capacities and/or capabilities of constituents or the government to achieve goals are present
4-Very high contribution to the achievement of desired goals, Low cost requirements to achieve goals, existing capacities and/or capabilities of constituents or the government to achieve goals are highly compatible
Note: The above evaluation tool is for demonstration purposes only. LGUs can develop or adopt their own evaluation tool.

Selection of the Preferred Spatial Strategy

Spatial strategy generation involves the translation of vision, goals, and objectives and the preferred development thrust in spatial terms. The spatial strategy serves as framework to guide the detailed allocation and location of the various land use categories. In the context of climate and disaster risks, the spatial strategy generation provides an opportunity for the LGU to look at alternative options for spatial development with information on issues and concerns related to disasters and climate change. Different options can be generated, depicting the configuration of the built and un-built environments and considering possible spatial management options that municipalities can adopt and pursue to address current risks/vulnerabilities and prevent future ones. Sample risk reduction and management principles (including addressing vulnerabilities to climate change) can be applied in the generation of spatial strategy alternatives/options such as:

1. **Risk Avoidance or Elimination –** This strategy involves removing the risk trigger by locating new expansion areas outside of potential hazard susceptible areas. This can also be achieved by encouraging open spaces and establishment and extension of buffer easements (i.e. coastal, river). However, it has to be noted that nationally prescribed easement regulations can be extended to factor in the possible increase in frequency and severity of hazards due to climate change (i.e. storm surge, floods, sea-level rise).

2. **Risk Reduction through Mitigation –** This strategy can be implemented if the strategy of avoidance/ elimination cannot be applied and/or the spatial strategy involves retaining existing urban use areas and resource production areas in its current location. Measures for mitigation (or adaptation) can be applied to reduce potential risks/vulnerabilities by changing physical characteristics or operations of a system or the element exposed to hazards. It can take on the following subcategories:

    a. **Mitigation -** Imposing building design regulations to enhance structural resistance/resilience to hazards and implementing engineering-based measures (i.e. flood control, sea-wall, slope stabilization). However, such measures (which often entail significant costs) will be dependent on the capacities of the LGU and property owners to implement and conform to such measures. Nonstructural mitigation, to some extent, can also be considered as mitigation measures, such as the rehabilitation of upland and coastal forests to reduce hazards (i.e. renewed upland forest cover can reduce magnitude and extent of floods in low-land areas or rehabilitating coastal mangrove areas to reduce magnitude of storm surges), changing production techniques (climate sensitive agricultural production practices, shift to climate resilient varieties), and constructing production support infrastructure such as water impoundments and irrigation.

b. **Duplication or Redundancy -** Increasing system sustainability by providing back-up support for systems or facilities that may become nonfunctional/operational after a hazard impact. This can be applied by establishing redundantaccess/linkage/ distribution systems (i.e. establishment of alternate transportation routes, looping and back-up systems for water distribution, and establishing alternative critical point facilities such as schools and hospitals).

c. **Spatial separation -** Increasing system capacity and robustness through geographic, physical, and operational separation of facilities and functions through multi-nodal spatial development. It proposes a strategy option of not centrally placing critical services (i.e health, educational, commercial, governance-based facilities/services) in one location.

d. **Preparedness measures -** Mostly non-structural measures that reduce the socio-economic vulnerabilities or improve coping mechanisms of communities at risk by improving capability to rescue, salvage, and recover; installation of early warning systems; increasing level of awareness through information, education, and communication (IEC) programs; and developing contingency/evacuation plans. These measures can be pursued and implemented in areas potentially exposed to hazards.

3. **Risk sharing or risk transfer –** Another option that can be pursued for usrban use areas and natural production areas located in hazard prone areas. It is the shifting of the risk-bearing responsibility to another party, oftentimes involving the use of financial and economic measures particularly insurance systems to cover and pay for future damages. However, this strategy should consider the current and future financial capacities of the exposed elements in accessing these instruments.

4. **Risk retention or acceptance –** This is the “do-nothing” scenario where risks are fully accepted and arrangements are made to pay for financial losses with own resources. However, this strategy can only be applied if current or future exposed elements will have the resource capacity to carry the burden of recovering from risks.

In the context of climate and disaster risks, when evaluating spatial strategy options, the evaluation criteria should be able to assess the various options in terms of the following considerations:

- Reduces current and/or prevent future risks;
- Ensure the uninterrupted delivery of high quality and basic social support services;
- Ensure and maintain inter- and intra area linkages;
- Required risk mitigation measures (through the imposition of zoning regulations and hazard resistant design standards) are within the current and future of the LGU and the private sector;
- Risk can be managed within acceptable thresholds especially when retaining or expanding built-up areas within the hazard prone areas.

Illustrated below is a sample set of criteria for evaluating spatial strategy options with emphasis on climate and disaster risks (refer to Table 4.18)

Upon selection of the preferred development thrust, preparation of the structure plan map can proceed. The structure plan map is a schematic representation of the chosen spatial strategy. It indicates the approximate location of areas for settlement development, location of key production systems, areas for protection and the various linkage systems. In the context of DRR-CCA, in the preparation of the structure plan map, emphasis should be given to:

- Indicative location of new expansion settlement areas in relation to hazard susceptibilities;
- Priority areas where mitigation and adaptation measures should be implemented for current or future settlement (expansion) areas, including production areas identified as highly vulnerable to natural hazards and climate change impacts;
- Key linkage and distribution systems with emphasis on its role for disaster risk reduction and climate change adaptation (redundant transportation routes for improved area access, response and evacuation, back up systems for water distribution);
- Major risk mitigation infrastructure to be established (flood control, sea walls, slope stabilization, etc.);
- Designating highly susceptible hazard areas as protection (buffer easements) or natural resource production areas (where production can be pursued if feasible);
- Indicating key protection areas for rehabilitation and conservation with emphasis on its contribution to management of climate and disaster risks.

Table 4.18 Sample Spatial Strategy Evaluation

	Criteria	Weight	Alternative 1: Trend Extension		Alternative 2: Concentric Development		Alternative 3: Multi-Nodal Development	
			Rating	Weighted Rating	Rating	Weighted Rating	Rating	Weighted Rating
1	Financial capacity of the LGU to realize the spatial option (i.e. infrastructure requirements and available public investments), Including investment requirements for mitigation and adaptation	15%	4	0.6	4	0.6	2	0.3
2	Impact on general image and attractiveness of the municipality	5%	2	0.1	3	0.15	3	0.15
3	Is the efficient access and linkages between the various functional zones feasible (physically and in terms of cost and potential impacts of hazards) ?	10%	3	0.3	4	0.4	2	0.2
4	Will the option encourage the equitable distribution of economic benefits within the municipality?	5%	4	0.2	4	0.2	4	0.2
5	Will it contribute to ecological balance and stability?	10%	3	0.3	4	0.4	4	0.4
6	Will the spatial option significantly reduce exposure and promote long term human security from natural hazards?	15%	2	0.3	2	0.3	4	0.6
7	Potential scale and cost of disaster response, recovery, and rehabilitation, given the potential exposure	5%	2	0.1	4	0.2	4	0.2
8	If the option is pursued, are current and future capacities enough to comply with the required risk reduction and management related land use and structural development regulations (building design, Floor Area Ratio, risk transfer mechanisms) ?	15%	2	0.3	2	0.3	3	0.45
9	Will it encourage the preservation of prime agricultural areas?	5%	3	0.15	4	0.2	3	0.15
10	Does it ensure the uninterrupted delivery of basic social support services?	10%	2	0.2	2	0.2	4	0.4
11	Ability of the LGU to effectively monitor and enforce required development regulations and policies	5%	3	0.15	4	0.2	3	0.15
	Weighted Score	100%	2.7		3.15		3.2	
	Rank		3		2		1	

Scoring System:
1-Low contribution to the achievement of desired goals, very high cost requirements to achieve goals, very limited capacities and/or capabilities of constituents or the government to achieve goals
2-Moderate contribution to the achievement of desired goals, high cost requirements to achieve goals, limited capacities and/or capabilities of constituents or the government to achieve goals
3-High contribution to the achievement of desired goals, moderate cost requirements to achieve goals, existing capacities and/or capabilities of constituents or the government to achieve goals are present
4-Very high contribution to the achievement of desired goals, Low cost requirements to achieve goals, existing capacities and/or capabilities of constituents or the government to achieve goals are highly compatible
Note: The above evaluation tool is for demonstration purposes only. LGUs can develop or adopt their own evaluation tool.

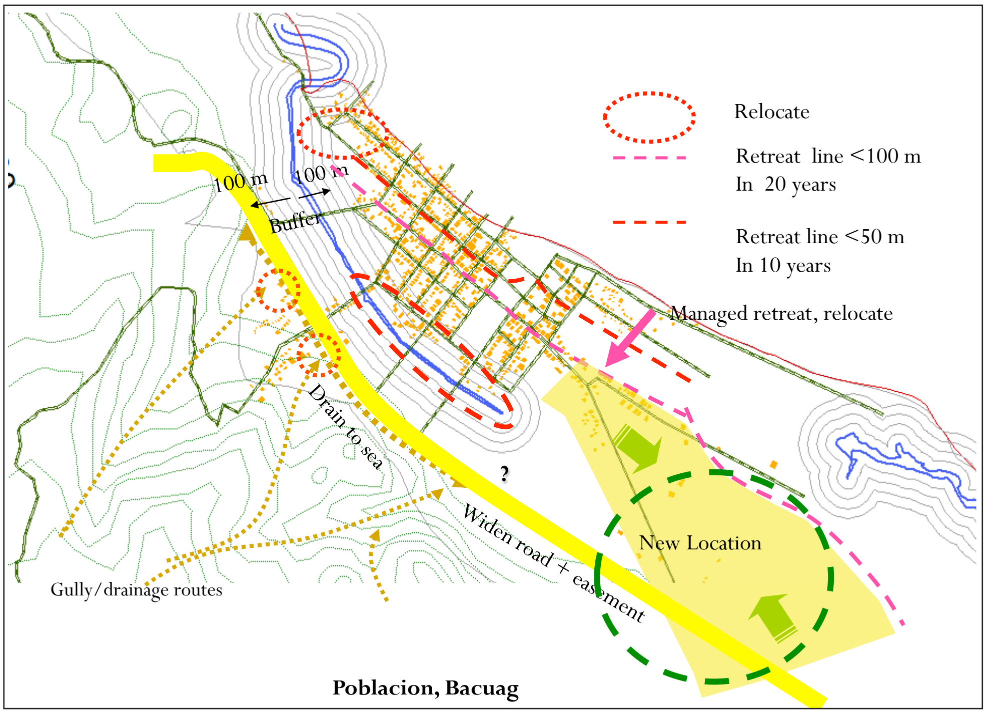


Figure 4.4 Sample Spatial Strategy Option. The Spatial Strategy plan map of the Municipality of Bacuag, Identifies the new expansion areas, establishment of buffer easements along rivers, and its incremental approach to adaptation in addressing current settlement risks along the coast and rivers though managed retreat/relocation. It also indicates the need to widen the road to ensure ease of access during evacuation and response operations (Source: Reference Manual on Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plans Report, NEDA-UNDP-

Climate and Disaster Risk Sensitive Land Use Planning

At this stage in the planning process, the land use plan will translate the development thrust and spatial strategy that both describe how, why, when, and where to build, rebuild, and preserve[20]. It involves four major steps: balancing land demand and supply; designing the land and water uses schemes (covering location and allocation); formulating the policies for land development and resource use management; and identification of priority programs and projects. At this stage, most of the identified planning challenges issues and challenges related to CCA-DRR, and how these will be addressed in terms of inventions (whether spatial and non-spatial in context), have already been articulated in previous steps (i.e. situational analysis, visioning, goals and objectives setting, development thrust, and spatial strategy). This would allow decision makers make necessary adjustments in the land use plan, one that would effectively address the potential impacts of natural hazards and climate change.

Designing the Land Use Scheme and Land Use Policy Options

The land use design scheme deals with the allocation and location of the various land use categories generally based on the projected service requirements, location standards, land suitability studies, costs, aesthetics, accessibility, and other considerations. Land use policies refer to specific guidelines, methods, procedures, rules, and forms that will guide the use of lands. In the context of CCA-DRR, emphasis will be given to design approaches/options for risks reduction and climate change adaptation with emphasis on approaches for reducing exposure and addressing vulnerability/sensitivity, and enhancing adaptive capacities. These mitigation and adaptation approaches shall be incorporated in the area location/allocation and land use policy formulation. Below are some recommended policies in designing the land use scheme/s and policy statements covering the four general land use policy areas.

Urban Use Areas

The land use design scheme deals with the allocation and location of the various land use categories generally based on the projected service requirements, location standards, land suitability studies, costs, aesthetics, accessibility, and other considerations. Land use policies refer to specific guidelines, methods, procedures, rules, and forms that will guide the use of lands. In the context of CCA-DRR, emphasis will be given to design approaches/options for risks reduction and climate change adaptation with emphasis on approaches for reducing exposure and addressing vulnerability/sensitivity, and enhancing adaptive capacities. These mitigation and adaptation approaches shall be incorporated in the area location/allocation and land use policy formulation. Below are some recommended policies in designing the land use scheme/s and policy statements covering the four general land use policy areas.

[20] Housing and Land Use Regulatory Board, CLUP Guidebook: A Guide to Comprehensive Land Use Planning, Volume 1, 2006.

- **Minimize hazard exposure**
  - This policy approach for settlement area development is an application of risk avoidance/elimination. It entails the location of settlements where hazards are not present and/or risks associated with locating within hazard prone areas can be effectively managed over the long-term by minimizing elements exposed.
  - This policy option is pursued under the notion that future risks will be averted which is more sustainable compared to risk reduction through mitigation which may entail costs.
  - Minimizing exposure (within hazard prone areas) can be done by designating such areas as parks and open spaces, buffers, or natural resource production areas.
  - These development control measures restrict new development in order to significantly reduce future elements exposed to hazards.
  - Although in reality, it is widely recognized that very little lands (relatively safe areas) are available to accommodate future demands. In such cases densification of relatively safe areas and mitigation of structures within hazard prone areas should be employed.

- **Densification of identified safe areas**
  - Densification of existing and future expansion areas should be encouraged within identified safe areas (or highly suitable areas where risks can be managed cheaply and effectively) to maximize utilization of lands.
  - This approach can be adopted to prevent future expansion in hazard prone areas, reduce future exposure and/or minimize potential costs for mitigation especially when very little lands are available to accommodate future urban use areas.

- **Reduce risks/vulnerabilities through mitigation measures**
  - When existing and urban expansion settlement areas are within hazard prone areas, necessary mitigation measures should be in place (through structural and non-structural measures) to safeguard structures and the population.
  - To reduce building vulnerabilities/sensitivities, proper building structural design standards (specific to the type or combination of hazard/s), using national and special building and structural codes, should be enforced and monitored.
  - Vulnerabilities can also be reduced through the establishment of off-site risk mitigation structures (flood control, flood water retention ponds, sea wall, wave breakers, slope stabilization) whenever feasible.
  - Enhancing adaptive capacities may involve non-spatial related measures such as increasing level of awareness, improving income levels, improved capacities to access/ afford post disaster economic protection, and disaster preparedness/evacuation plans.
  - Decisions to situate urban use areas within hazard prone areas should consider the feasibility and conformance to the new risk reduction related regulations and whether it can be sustained over the long term.

- **Prioritizing Residential areas, Critical point Facilities, and other Government owned/managed Facilities to be situated in relatively safe areas**
  - This is in support of ensuring human security by prioritizing residential areas over other uses, to be situated within less susceptible hazard prone areas. This is under the notion that nonresidential uses such as commercial and industrial have a higher capacity to conform to building/development restrictions and implement disaster management options.
  - Aside from residential areas, key infrastructure-related point facilities such as those related to water (pumping stations, water treatment plants), power (sub-stations, and power plants) and other institutional facilities (schools, government buildings, evacuation centers) should also be strategically located to minimize major disruptions in the delivery of basic utilities and critical social support facilities.

- **Prioritizing safety over accessibility when it comes to location standards**
  - This pertains to the location of propulsive growth areas or central facilities (i.e. commercial and residential growth centers, schools, hospitals, governance, point utilities,) being located within hazard prone areas due to location standards that favor accessibility (convenience) rather than long term safety (performance).
  - Settlement expansion tends to expand around and in near proximity to these centers which may increase future risks especially when these propulsive centers are within or adjacent hazard prone areas.
  - When locating new propulsive centers/establishments, the overall design should anticipate the associated settlement growth surrounding it.
  - Location should lean more towards safety location standards and not on accessibility standards.
  - Accessibility can be considered over safety provided that risk mitigation measures (i.e hazard resistant design standards, major engineering measures) can be enforced and implemented; and ensuring that current and future private and public capacities can adapt to potential impacts.

- **Mitigation measures should account for the expected changes on the severity and frequency of hazards.**
  - The severity and frequency of rapid (floods, landslides and storm surges) and slow onset hazards (i.e sea level rise) may increase due to climate change.
  - This may entail the anticipation of future spatial extent and magnitude of hazards when deciding to retain or extend existing mandatory easement adjacent to existing and new settlements.
  - This often requires special studies and may require coordination with the mandated agencies.

- **Cost for mitigation should be shared by both the LGU and the community.**
  - These can be in the form of the imposition of higher property taxes (disincentive) to generate revenues to sustain local/autonomous efforts for disaster risk mitigation and climate change adaptation (i.e. land banking, relocation, rehabilitation/retrofitting of public facilities).
  - Encouraging mandatory retrofitting of existing highly vulnerable structures can also be pursued through incentives (property tax holidays).
- **Situating settlement areas away from environmentally critical and sensitive areas**
  - This would minimize anthropogenic stresses (i.e. extraction of resource, encroachment, habitat destruction) to ECAs as a result of being in close proximity to settlement areas.
  - Decisions in locating propulsive growth centers should consider its proximity to these ECAs.
- **Incentive instruments to facilitate risk mitigation/climate change adaptation**
  - Pertains to instruments for incentives (i.e. tax discounts/holidays, allowing variances relative to regulations) for establishments adopting onsite innovative climate smart and eco-friendly technologies and practices.
  - This shall cover energy efficiency (using on site renewable energy generation technologies) and water management (rain harvesting, water recycling/treatment).
  - These practices should be recognized by the LGUs and incentive packages should be provided since these promote water sufficiency and the mitigation of greenhouse gases.

Production Areas

These cover the natural resource production areas such as crop production areas, fisheries, and forest based production areas. These areas can be situated in hazard-prone areas where implementation of risk reduction and adaptation options are prerequisites to reduce potential economic losses due to sudden and slow onset hazards.

- **Changing production practices to anticipate/adapt to potential changes in climate -** Pertains to adopting changes in resource production techniques/practices that adapt to potential changes in the climate. In the context of agricultural production, this may entail a better understanding of seasonal climate parameters through:
  - weather forecasting
  - early warning systems to influence current planting and harvesting schedules
  - using hazard resistant and early maturing crops (includes changing spatial location of crop types relative to hazard) to mitigate climate extremes
  - encourage crop diversity or pest resistant crops
  - site preparation (i.e. slope stabilization/control, soil conservation measures)

- **Strategic location of climate proofed production support facilities**
  - This pertains to considerations in locating facilities that house farm inputs, implements, machinery, and other storage facilities in areas where risks can be managed effectively.
  - Strategic location of community-level temporary/permanent, climate-proofed holding facilities can be established to address potential losses as a result of climate extremes.

- **Encourage agro-forestry production in upland or sloping areas**
  - Establishment of agro-forestry production (i.e. long lived fruit and multipurpose trees as an alternative to cultivated crop types) within sloping areas and forest buffers can be a good strategy in GHG mitigation, rehabilitation/increase vegetative cover, watershed management, stabilizing slopes and complement nearby forest ecosystems.
  - It is also a good way of maximizing idle upland agricultural lands and increase derived economic benefits to enhance adaptive capacities and reduce sensitivities of farmers.

- **Resource use within sustainable levels**
  - This recognizes the need to regulate extraction and/or activities that are within the capacity of the environment/s for natural regeneration and carrying capacity levels

- **Managing water sources**
  - In light of the potential impacts of climate change to water resources (specifically impacts to water supply associated with the decrease in rainfall amount in certain areas), interventions must be in place to secure water demand requirements for natural resource production.
  - Establishment of water impoundment facilities (community-based or farm site-level) with support irrigation networks should be encouraged.
  - Innovations in maximizing the use these facilities other than impoundment (i.e. utilizing them as inland fishponds in certain times of the year) can be encouraged.
  - Also, tapping ground water reserves, in a sustainable manner, taking into consideration the recharge levels and the potential variations in rainfall values due climate change, can also be pursued.

- **Encouraging post disaster economic protection measures**
  - To mitigate potential damages/losses, property owners engaged in resource production should have the capacity to access/afford post-disaster economic protection/financing (i.e. crop/property insurances).

Protection Areas

Protection areas are private lands, public lands, and water areas that are set aside for conservation, preservation, and rehabilitation because of their long-term strategic benefit and because of the observed and projected impact of climate-related events and disasters to these areas[21]. Designating protection land uses can significantly contribute to disaster risk reduction and climate change adaptation using the ecosystem based approach. In general, the establishment of protection areas can reduce settlement and population exposure to prevent future risks, enhance the quality of the environment to increase its adaptive capacity to withstand impacts of climate change, contribute to the mitigation of GHG, and reduce the impacts of hazards. Here are some considerations in designing the land use scheme and in the formulation of policies:

- **Implement easements as an effective strategy in managing risks**
  - The establishment of buffer easements (i.e. coastal, river, forest buffer) and designating certain hazard-susceptible areas as no dwelling units are forms of reducing exposure to hazards.
  - Mandatory easements (prescribed minimum easements based on national laws) can be extended to account for the possible changes in extent and magnitude of hazards due to climate change which can be determined though empirical studies (i.e. flood modeling incorporating climate change projections on the one day extreme rainfall patterns).
  - One example is exceeding the minimum coastal easement from 20 meters to a distance that would accommodate the projected change in the coastline associated with sea level rise, and the run-up distances/inundation areas of storm surges.
  - Extending easements along rivers (where flood modeling studies can establish peak flood elevation and velocities) can be set aside as either part of the protection land uses (as buffer strips/ open spaces left in its natural state), production (if these can be sustainably utilized for resource production despite the expected intensity and recurrence of the hazard), or even urban use areas in the form of open spaces such as linear/forest parks to minimize, prevent and even eliminate population and property risks.

- **Field Demarcation/Delineation of hazard prone areas**
  - Another form of risk reduction is the demarcation of highly susceptible hazard areas.
  - The main intention is to prevent encroachment and future exposure/disasters and to enhance local awareness on the spatial location of hazards.
  - These can be set aside as open spaces or natural buffer strips devoid of any development, set aside as public, open recreational spaces, or natural resource production uses where immediate and/or long term impacts can be mitigated and sustainable resource extraction can be employed.

[21] Housing and Land Use Regulatory Board, CLUP Guidebook: A Guide to Comprehensive Land Use Planning, Volume 1, 2006.

- **Protection of forests/watersheds**
  - Sustained rehabilitation and protection of upland forests and watersheds (falling under protection forests) as strategies for risk reduction and climate change adaptation.
  - Forest areas can act as carbon sinks to increase environmental capacity to reduce atmospheric GHG levels, enhance water absorptive capacity to reduce flood surface run-off and delay arrival times in low lying areas, increase slope resilience to failure (soft mitigation measure), reduce soil erosion, contribute to water sufficiency, improve air quality, and enhance biodiversity.

- **Protection and rehabilitation of ecologically sensitive and critical habitats**
  - The strict protection and rehabilitation of critical and sensitive habitats, in the context of CCA-DRR, can be viewed as measures for enhancing adaptive capacities of natural environments in order to cope with climate change.

- **Synergy and convergence of protection policies across Municipalities/ Cities**
  - Watershed areas encompass administrative boundaries. Inter-municipality convergence and synergy of land use policies emphasize the importance of establishing inter-LGU coordination/ synergy to facilitate and promote convergence of actions/policies in addressing disasters and climate change, including reducing and managing common/ shared risks across municipalities/cities.

Infrastructure and utilities

The manner in which linkage/access systems and distribution utilities are designed and how mitigation measures are constructed can either increase or can become a source new risks over time.

- **Strategic establishment of transportation access/routes as a means of redirecting settlement growth**
  - Establishing new transportation routes leading towards relatively safe areas can be employed to redirect settlement growth in more sustainable/suitable areas.
  - It has to be noted that areas adjacent to roads, especially when these transect hazard prone zones, should be regulated and monitored regularly to prevent unplanned settlement growth and generation of new risks.

- **Strategic establishment/upgrading of utility distribution systems**
  - Settlement growth is encouraged when necessary distribution systems are present (power, water and communication). The strategic establishment of distribution networks can be a good way of redirecting and restricting growth to prevent the future risks.
  - The decision to establish new or the upgrading of distribution systems should be mindful of whether the growth of settlements (increasing exposure), especially when these are located in highly susceptible areas can be managed and sustained overtime.

- **Mitigation measures should be adjusted to account for the impacts of climate change on the magnitude and severity existing hazards**
  - Mitigation measures, designed without consideration of projected trends in extreme daily rainfall due to climate change, is an example of maladaptation. Flood control works, designed to withstand historical probabilities of flooding (i.e. without adequate consideration of climate change), may not provide adequate protection.
  - However, this may require flood and climate simulation and special feasibility studies.
  - Urban drainage systems should be able to accommodate higher water runoff associated with extreme one day rainfall events to minimize urban flooding.

- **Climate proofing/mitigation of key distribution and access systems**
  - Among the major impacts of hazards is the major/prolonged interruption on the delivery of key utilities (power, water, and communication, transportation/access).
  - Ensuring the uninterrupted delivery (or minimizing disruptions at acceptable levels) and access through climate proofing of existing and new distribution networks should be considered and implemented as much as practicable.

- **Establishing strategic complimentary or back-up access and distribution systems**
  - Ensuring uninterrupted access and delivery of key utilities can be achieved through the establishment of alternate transportation routes and looping distribution networks in cases where the main networks are severely affected by hazards.
  - Policies in encouraging community-based or household level water and electricity-related facilities (i.e. water storage tanks, establishment of community based power generation facilities) and establishment of alternative routes to access key functional zones should be created.

Sample land use policies, specific to flood hazard, can be incorporated when formulating policies of identified settlement growth areas. Other policy options for other hazards can be prepared and incorporated when certain growth areas/land uses are within identified hazard prone areas. These land use policies can either be translated as programs and projects or regulations which can be included in the hazard overlay zones in the zoning ordinance.

Table 4.19 Sample Land Use Planning Options for Flood hazard areas

Parameters	Sample Land Use Policy Options
Site selection and development controls	• Ideally, situate settlement areas outside flood prone areas. If unavoidable, institute other risk mitigation measures such as density control and building design regulations, establishment of evacuation routes, and/or establishment of flood control infrastructure. • Redirect settlement growth by locating propulsive centers and central facilities outside or in low susceptible flood areas where risks can be managed within acceptable levels.
Density Control	• Encourage low density development in highly susceptible areas and moderate to high density development in areas less susceptible to floods assuming building design standards/regulations are followed. Density and bulk control measures include floor area ratio, minimum lot sizes, and building height restrictions. • Increase in density can be adjusted in high susceptible areas when property owners have capacities to employ structural mitigation (conform with building design standards or contribute/share the costs for flood mitigation infrastructure).
Building design	• Lowest floor of structures must be two feet (freeboard) above the estimated 100-year base flood elevation (or 100-year, depending on agreed flood level) based on climate change rainfall projections. • For a critical facility (i.e. hospitals, government building, fire/police stations, evacuation sites, jail, emergency management, and facilities that store highly volatile, hazardous, toxic materials) higher protection standards will be required, where freeboards are above the 100 (sample) year base flood elevation. • Design should also account for the expected flood water flow velocity and direction. • Encourage column or flow through crawlspaces rather than filling as the means in elevating buildings to minimize flood water flow obstructions and increase in flood heights as a result of diminished flood plain storage capacity. When land filling is employed, flood storage measures must be constructed either onsite or within the flood plain. • Structures can have high foundation walls, stilts, pilings. and occupants have access to the roof from inside the dwelling unit • Foundation of buildings should be constructed to account for erosion, scour, or settling. • Encourage onsite water storage facilities.
Strengthening and retrofitting, of existing buildings	• Legally require retrofitting of existing buildings that are high-risk or highly vulnerable using recommended building design standards as prescribed in the Building Code and the Structural Code of the Philippines. • When buildings and/or areas are totally damaged by floods, consider other options like relocation, land swapping, or land pooling.

Table 4.19 Sample Land Use Planning Options for Flood hazard areas

Parameters	Sample Land Use Policy Options
Protection of critical lifelines	•Situate critical point facilities outside of hazard prone areas to ensure accessibility and minimize service disruption during and after flood events. •Climate proof critical access (roads) and distribution systems (water, power and communication facilities). •Establish redundant/back-up and looping systems as alternative systems for access and distribution. •Design drainage or temporary storm water holding facilities to accommodate 25 to 50 year flood water volume (whenever feasible).
Open space preservation	•Encourage open spaces (parks and other buffers) or agriculture production areas in flood prone areas to minimize settlement area and population exposure. •Establish easements and river bank protection measures and maintain riparian vegetation to prevent erosion. •Protect wetland areas to absorb peak flows from floods.
Relocation	•Mandatory incremental relocation of highly at risk and vulnerable communities/ families.
Financial incentives and disincentives	•Real estate tax holidays to owners who retrofit structures based on new design standards •Provision of new development in suitable areas to locate new growth areas where necessary amenities are available. •Impose higher real estate taxes for properties benefiting from major flood control infrastructure
Other policy parameters	•Reforestation of upland forests to enhance vegetative cover, increase water absorptive capacity of watershed areas to manage volume and delay arrival of surface runoff •Establishment of flood mitigation infrastructure •Contingency plans within identified high-risk areas •Use of flood resistant crops or change cropping patterns/types •Land banking in identified growth areas as resettlement sites to accommodate families within high risk areas

Identification of Priority Programs and Projects.

Programs are set of projects in support of the realization of the CLUP. These are linked to the set of goals, objectives, and success indicators; and the operationalization of the desired land use scheme and policies. Various development challenges and the interventions to address climate and disaster risks have already been articulated in previous steps. This is the part where comprehensive programs, specific projects, and other support legislation are enumerated to support the various strategies relevant to the reduction and management of climate and disaster risks. Sample program and projects are, but not limited to, resettlement/relocation programs; hazard mitigation infrastructure projects; IEC programs for increased level awareness on disaster and climate change; disaster preparedness programs; formulation of river-basin management plans (in coordination with other municipalities); reforestation projects, comprehensive agricultural extension program (emphasis on climate change resiliency); capacity and capability building of executive and legislative officers in support of CCA-DRR; Programs for job creation and livelihood, road infrastructure projects (climate proofing of existing roads), and potable water infrastructure program. Also, supportive local legislation can be identified to implement the CLUP and address other specific/special issues. These may range from local ordinances providing incentives to eco-friendly industries/housing units (employing green building design), employing hazard retrofitting, special ordinances designating protected areas in watershed/forest areas, adjustments to be made to the property tax rates, or imposition of special levies for revenue generation for disaster mitigation related infrastructure (refer to sample priority programs-projects-legislation matrix).

These programs, projects will be interfaced and implemented in phases through the Comprehensive Development Plan (CDP) and funded through the Local Development Investment Program/Annual Investment Plan (LDIP/AIP). Local legislation may form part of the legislative agenda of local governments.

Table 4.20 Sample Priority Programs-Projects-Legislation

Vision Statement	Goals	Objectives	Programs, Projects, Activities, and Legislation
A vibrant and sustainable commercial, industrial, and tourism-based economy propelled by proactive and self-reliant citizenry living in a water-sufficient, adaptive, and balanced environment with competitive and pro-poor governance.	Ensure the adequate and efficient delivery of basic social support facilities/ services	• Establishment of 22 new BHS that are disaster and climate risk resilient by 2023 • Retrofitting and rehabilitation of 6 existing BHS and existing municipal hospital against potential hazards affecting the structure • Establishment of additional 139 classrooms that are disaster and climate risk resilient in safe locations and reduce cases of disruption of classes due to structural and equipment damage • Retrofitting and rehabilitation of 10 existing classrooms to mitigate potential hazards affecting the structure	• Opol Zero backlog health program • Hazard retrofitting of existing health related facilities
			• Opol education modernization program • Hazard retrofitting of existing educational related facilities
	Ensure human security by increasing the level of adaptive capacities of the population and establishment of sustainable and well adapted housing units	• Increase level of awareness of local population on emerging issues related to disasters and climate change including measures for adaptation and mitigation • Encourage the retrofitting/upgrading of 405 existing housing structures • Relocate 445 informal settler households considered highly vulnerable and at risk to flooding, sea level rise, and storm surges • Establish new housing units to accommodate future households (6,420)	• Formulation of the municipal and barangay level DRRM Plans • Formulation of the Local Climate Change Action Plan • Formulation of contingency plans for various hazards • Storm Surge Modeling Project • Earthquake Hazard Modeling and Risk Assessment • Establishment of the Building Information Management System (BIMS)
			• Comprehensive Opol shelter program • Local ordinance on the provision of incentives to encourage building retrofitting

Table 4.20 Sample Priority Programs-Projects-Legislation

Vision Statement	Goals	Objectives	Programs, Projects, Activities, and Legislation
A vibrant and sustainable commercial, industrial, and tourism-based economy propelled by proactive and self-reliant citizenry living in a water-sufficient, adaptive, and balanced environment with competitive and pro-poor governance.	Ensure local food security and optimum productivity of agriculture and forest based industries	• Increase areas allocated for agricultural production • Reduce cases of land conversion of prime agricultural lands to non-agricultural uses • Establish climate proofed/risk resilient food warehouses • Increase in the average per hectare yield for rice and corn • Establish climate proofed/risk resilient post harvest facilities • Reduce damages to farm equipment and post-harvest facilities • Increase in agricultural crop production areas with access to water impoundment facilities • Identification of alternative water sources (surface and ground) for irrigation • Increase in agricultural crop production areas with access to irrigation facilities • Decrease amount of damage to crops due to flood, severe winds, and drought through sound and climate-proofed production techniques • Establish forest production areas and ensure sustainable production/resource extraction techniques	• Crop and Livestock Integrated Farming Systems Development Project • Establishment of Community-Based Agro-Processing Facilities for High-Value Commodities • Entrepreneurial Training Workshop for Farmers/Fisherfolks • Establishment of the Opol Central Warehouse • Value-Chain Study for Major Products (i.e. Banana, Abaca, Coconut) • Construction and Rehabilitation of Upland Barangay Farm-to-Market Roads • Rehabilitation/Restoration of Communal Irrigation Systems • Ground and surface water accounting study • Irrigation and water impoundment system study for Agricultural Production • Establishment of Technology Demo Sites for Emerging and Innovative Farming Practices and Technologies • Opol Sustainable Non-Timber Forest Product Development and Marketing Project

Table 4.20 Sample Priority Programs-Projects-Legislation

Vision Statement	Goals	Objectives	Programs, Projects, Activities, and Legislation
A vibrant and sustainable commercial, industrial, and tourism-based economy propelled by proactive and self-reliant citizenry living in a water-sufficient, adaptive, and balanced environment with competitive and pro-poor governance.	Establish climate-smart, risk-resilient and environment-friendly industries and services	• Increase area allocation for economic based establishments tourism, agri-industrial, forestry, and other service-related facilities/establishments • Increase in locally employed residents • Increase number of establishments employing water augmentation practices • Increase number of establishments using onsite renewable energy technologies • Increase number of establishments employing structural mitigation measures and/or decrease in the number business establishments exposed to hazards • Decrease economic losses due to hazards	• Awang-Patag Light/agri-industrial Area Feasibility and Site Development Plan • Opol Coastal Eco-Tourism Circuit Plan • Barra commercial center redevelopment project • Poblacion-Patag-Awang Municipal Road Construction • Lot Purchase/Land banking; • Establishment of the Building Information Management System (BIMS); • Local ordinance providing incentives to establishments using eco-efficient production/operation practices; • Local ordinance on the provision of incentives for economic enterprises participating in building retrofitting;

Climate Risk Sensitive Zoning Ordinance

The Zoning Ordinance is the legal/statutory tool to implement the Comprehensive Land Use Plan. It is a translation of relevant hazard risk mitigation and climate change adaptation related policies articulated in the CLUP which can be translated into zoning provisions. Zoning provisions may range from special building design restrictions, density control regulations, no-build provisions, and restricted uses within hazard susceptible areas. Areas can also be declared as risk management districts/zones where special regulations can be imposed to fast track the process of risk reduction. Among the objectives of the hazard overlay are ensuring the safety of building occupants; prevent substantial damage to structures and its contents; protect adjacent properties from hazards associated with building damage/failure resulting to injuries due to substandard building design; ensure ease of access during disaster response, and rescue and evacuation

Hazard Overlay Zones

In the formulation of the zoning ordinance, the hazard overlay zones can contain additional provisions on land/structural development regulations to impose on base zones. The hazard specific overlay zone/s should contain, at the minimum, provisions covering the following items:

1. **Hazard Overlay Map -** Visual representation of the extent/bounds of the zone. This is represented as an overlay map and a sub-set of the official zoning map (refer to Figure 4.5).
    - Flood modeling maps generated through studies conducted by mandated agencies (i.e. PAGASA, MGB) or any other entities where flood modeling maps have been peer reviewed and validated

    - Flood modeling maps should depict the annual chance of occurring, estimated flood height/elevation, estimated flow velocity, and flow direction which will be the basis for determining hazard resistant structural design specifications to both address flood heights and water velocities

    - Section 211 Flood Loads of the Structural Code of the Philippine (NSCP) prescribes a base flood of 1 percent chance of being equaled or exceeded in any given year (100-year flood) as basis for the Design Flood Elevation[22] which is applicable to structures covered by the NSCP. There are no related provisions on the base flood mentioned in the National Building Code.

[22] The Association of Structural Engineers of the Philippines, Inc. (ASEP), National Structural Code of the Philippines, 6th Edition, Chapter 2, Section 211, page 112, 2010.

- Further categorization of the flood overlay zone into sub-zones (i.e. High, Moderate and low) or based on flood heights (i.e. 0.2-0.5 meters, 0.5-1 meter, 1-2 meters, 2-5 meters and above 5 meters) can be employed where different provisions can be applied in the sub-zones.

2. **Zone Coverage/Boundaries-** Zone coverage pertains to areas which will provide the coverage of the hazard overlay zone where the additional zoning provisions will be applied.

   - Enumeration of actual lot numbers which are within the flood overlay zone. This can be done through map overlaying (hazard and cadastral maps);

   - It can also be represented as meridional blocks coverage (refer to Figure 4.5 which can be further validated in the field during the locational clearance review and issuance process (refer to Table 4.21 for a sample zone coverage/boundary description using meridional block system);

   - Special GIS programs can also be used to derive the technical description (jn terms of bearing and distance, longitudinal and latitudinal extents);

3. **Prohibited Uses -** Pertains to uses which will be prohibited in the said areas such as evacuation centers, critical point facilities, other government related buildings (i.e. municipal/city hall, barangay halls, Regional level government buildings) and other uses handling toxic and hazardous substances.

   - Allowed uses as indicated in the base zones can be reviewed to ensure that a clear list of restricted uses are mentioned and enumerated in the hazard overlay.

   - Prohibited uses within the zone can include evacuation centers, hospitals, schools, establishments handling toxic and hazardous substances, protective services, government related buildings, schools, social welfare buildings, power and water related point facilities;

   - Socialized housing sites, or housing development which would accommodate dwelling units for low to middle income families (with low capacities for employing risk mitigation) can also be considered as among prohibited uses in areas where floods may exceed 0.5 meters.

Figure 4.5 Sample Flood Hazard Overlay Map, Barangay Barra, Municipality of Opol, Misamis Oriental

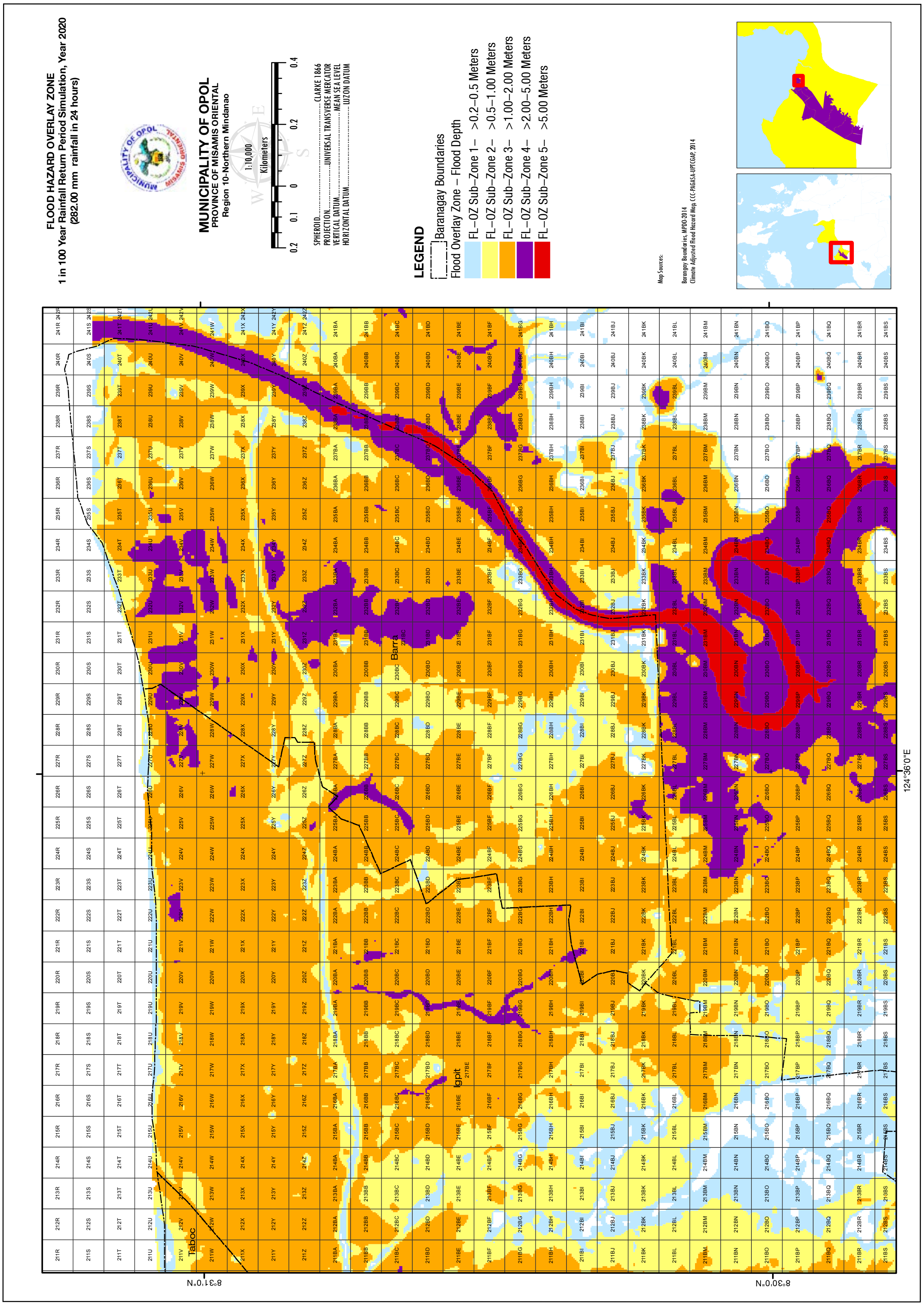


Table 4.21 Sample Zone Boundary Description, Flood Hazard Overlay Zone Map

Flood Overlay Sub-Zone	Estimated Flood Depth (Meters)	Meridional Block Coverage (Alpha Numeric Code)[1]
Flood Overlay Sub-Zone 1	0.2-0.5 Meters	220BK, 224BB, 225BB, 225BE, 226BA, 226BB, 226BI, 226BK, 227BA, 227BI, 227Z, 228BG, 228BH, 228BI, 228BJ, 228Z, 229BH, 229BI, 229BJ, 229BK, 229V, 229Z ....
Flood Overlay Sub-Zone 2	> 0.5- 1.00 Meters	220BJ, 220BK, 221BJ, 221BK, 221BL, 223BD, 223BH, 224BB, 224BC, 224BD, 224BE, 224BF, 224BG, 224BH, 225BA, 225BB, 225BC, 225BD, 225BE ....
Flood Overlay Sub-Zone 3	> 1.00-2.00 Meters	221BJ, 221BK, 221BL, 222BD, 222BF, 222BG, 222BH, 222BI, 222BJ, 222BK, 222BL, 223BB, 223BC, 223BD, 223BE, 223BF, 223BG, 223BH, 223BI ......
Flood Overlay Sub-Zone 4	> 2.00-5.00 Meters	236V, 236W, 236X, 236Y, 236Z, 237BA, 237BB, 237BC, 237BD, 237BE, 237U, 237V, 237W, 237X, 237Y, 237Z, 238BA, 238BB, 238BC, 238BD, 238U ....
Flood Overlay Sub-Zone 5	> 5.00 Meters	229W, 229X, 229Y, 230W, 230X, 230Y, 231W, 231X, 231Y, 231Z, 232BA, 232BB, 232BD, 232BE, 232BF, 232V, 232W, 232X, 232Z, 233BA, 233BB, 233BC ....

[1] Listed meridional blocks are only partial of the actual coverage. For presentation purposes only.

- Prohibited uses can be further fine-tuned depending on the estimated flood susceptibility level or flood heights such as allowing evacuation centers in low susceptible areas or those within flood 0.2 to 0.5 meters with the condition that these follow the hazard resistant design regulations mentioned in other provisions of the hazard overlay zone, but will be disallowed in areas of moderate to high flood susceptibility and/or flood heights exceeding 0.5 meters.

4. **Density and bulk restrictions -** Density and bulk restrictions can be further adjusted to manage the number of elements exposed to hazards. This may pertain to regulations on the maximum lot coverage (expressed as a percentage occupied by the ground level building footprint relative to the size of total lot area), floor area ratio (total floor area relative to lot area), and building height restrictions, etc.

- Limits pertaining to density and bulk restrictions as prescribed in the Building Code of the Philippines can be retained for as long as flood considerations have been considered prior to the preparation and determination of suitable building densities in the base zones (during the CLUP land use design scheme).

- Further reduction of the prescribed density and bulk regulations as per Building Code to accommodate more open spaces/access systems can be employed such as reducing the maximum lot coverage to lessen the building footprint to accommodate more impervious surface within the lot, as well as allow easy access to building occupants during cases of rescue and recovery.

- The minimum lot sizes in a particular hazard prone area can also be included in the provisions. This is to ensure that further subdivision of lots into much smaller lot sizes can be prevented which may lead to further development of dwelling units.

5. **Building and Site Design Regulations -** Pertains to special regulations related to building design specifications to mitigate hazards and ensure the safety of occupants, depending on the type of hazard and estimated base hazard magnitude/intensity. In the case of floods, design specifications will be dependent on the identified base flood design elevation. Specifications may include building design (i.e. two storey, multi storey, single storey on stilts), hazard-resistant wall materials/design, groundfloor building elevation requirements, foundation design, building shape and orientation, and provision of escape hatches (Balconies, roof openings). Site development regulations may include regulations such as minimum area for permeable surfaces, temporary storm water storage ponds, land compacting/filling regulations. It may also include special design standards covering critical point facilities such as hospitals, schools, and government buildings. Listed below are recommended provisions which can be included

    - Relevant provisions of the National Structural Code of Philippines of Flood Hazard resistant design.

    - Lowest floor of structures must be 2 feet (freeboard) above the estimated 100-year base flood elevation using climate change adjusted one-day rainfall projections.

    - Wall and foundation construction materials and design should be able to withstand loads exerted by the expected flood water height (meters) and flow velocity (meters/sec) and water submergence.

- Foundation of buildings should be constructed to account for soil erosion, scour, or settling. Foundations should be constructed in the same stratum and/or pile driven to account for the potential hydrodynamic forces.

- When enclosed spaces are constructed below the base flood elevation, necessary wall openings should be established to allow water to flow inside the enclosed space and ensure that water levels inside and outside the house are balanced to prevent significant structural damage due to hydrostatic forces.

- Walls column or flow through crawlspaces shall be recommended, rather than, in-filling as the means of elevating buildings. This shall help minimize flood water flow obstructions and increase in flood heights (in adjacent properties) as a result of diminished flood plain storage capacity.

- When in-filling is employed as the means for elevating the lowest/ground floor of the structure, temporary flood storage retention structures must be constructed either onsite or within the sub catchment basin where the property belongs (size commensurate to the area occupied by the fill). In-fill should also not alter natural drainage ways and onsite drainage design should consider the estimated runoff volume to prevent increased flooding in adjacent properties.

- Protect the fill from erosion and scour. Proper soil compaction should be employed.

- Electrical and communication cable runs and control switches, as much as practicable, should be placed two feet above the base flood elevation.

- For emergencies and rescue, escape openings should be accessible to occupants either through a small balcony above the flood elevation and/or roof openings.

- Encourage onsite water storage facilities. Water storage fixtures (or any buoyant structures) should be above the flood elevation or secured/anchored properly to resist buoyancy forces. Also, minimize exposed pipes (distribution/collection) to minimize damage from floating debris.

- Stairways should be wide, straight with large landings to allow easy relocation of heavy and bulky furniture.

- Minimum impervious surface area of the total lot area, but can be adjusted depending on capacities of proponents to employ on-site drainage network/s and flood/storm water retention to accommodate expected run-off.

- Building should have at least 50% of the gross floor area, above the estimated base flood elevation. Buildings are also encouraged to establish an attic space for emergency storage.

For other hazards, please refer to relevant sections of the HLURB CLUP Guidebook: Model Zoning Ordinance (Volume 3). It covers hazard overlay zones such as floods, landslides and faults including recommended provisions.

6. **Other provisions -** Pertains to provisions related to incentives/disincentives, additional requirements during locational clearance and building permit issuance, and property insurance requirements.
    - Proponent will be required to attend a flood hazard awareness seminar and will be part of the locational clearance application process
    - Building owner will be required to purchase property insurance which covers flood associated damages
    - Allowed uses or structures as indicated in base zone and covered by the EIS system shall apply for an Environmental Compliance Certificate, which should include an Engineering Geological and Geohazard Assessment Report) as part of the locational clearance and building permit application process
    - Provide incentives such as tax holidays for a specified period of time, where savings can be used for employing hazard resistant building design/construction.

Risk Management Zones

Apart from the zoning and building/development regulations within hazard overlay zones, risk information can also be used to identify of Areas for Priority Action (APAs) which can be described as existing urban use areas within hazard prone areas (regardless of risk level) based on the results of the CDRA risk mapping.

These APAs should be addressed within an acceptable period (i.e. 10 years or depending on the discretion of the LGU or through consultation with property owners) to ensure that the process of risk reduction is achieved within the planning period. These can be identified through the consolidation/overlying of all hazard specificrisk maps and the identification of areas. There are three possible scenarios/approaches where the establishment of risk management districts can be applied:

1. Identified risk areas can still be developed provided that the establishment of hazard mitigation infrastructure and compliance to hazard resistant building design and density standards are feasible to significantly reduce risks through gradual/incremental adaptation. These may also cover areas where current and future capacities of property owners are not commensurate to the costs required for significant risk mitigation which can be passed to another party. When dealing with areas where settlement development can still be pursued, declaring the area as a risk management district or APAs can be an option. Regulations can be applied to encourage existing property owners to participate in risk mitigation. The following options can be applied:

- Requiring property owners to address risks within a given time frame (LGUs can adopt a 10-year period with consultation with owners).

- Land acquisition or swapping where LGU offers other suitable areas in the locality. LGU assumes responsibility of the property for allocation to other suitable uses.

- Relocation of existing households through resettlement. LGU offers other suitable land areas for resettlement (through land banking) provides housing (at discounted rates), and creates livelihood. LGU assumes responsibility for the area, to be leased or sold to other interested proponents. Revenues generated is to be redirected to the establishment/maintenance of resettlement site/s.

- Instituting local ordinances to increase property taxes and revenues derived from property owners, outside the risk management districts where revenues can be redirected in area redevelopment.

2. Identified risk areas where settlement can still be developed provided that the establishment of hazard mitigation infrastructure and compliance to hazard resistant building design and density standards are feasible and that current and future capacities of property owners are commensurate to the costs required for mitigation. Regulations can be applied to encourage existing property owners to participate in risk mitigation. The following options can be applied:

   - Property owner is required to submit a structural engineering assessment to be conducted by a licensed structural engineer. The structural engineering assessment provides the recommendation and requirement for building retrofitting to which the property owner is given a period to implement retrofitting works.

   - Require property owners to address risks within a given time frame (LGUs can adopt a 10 year period with consultation with owners).

   - Tax holiday for a period of five years with the condition that property owners employ the required structural mitigation measures/retrofitting.

   - When property is significantly damaged within the 10 year period, property owner will be allowed to repair and rehabilitate the structure provided that it follows the minimum standards on hazard resistant design.

   - If property owner fails to employ the minimum hazard resistant design standards, provisions in item 1can be applied.

   - Implementation of structural and non-structural risk mitigation measures where a portion of the cost/s will be shouldered by the property owners/beneficiaries.

3. Identified risk areas where the only recourse is to relocate existing properties/population due to possible hazards affecting the site and the establishment of mitigation measures to reduce risks are not feasible. The following options can be applied:

   - Mandatory relocation - all affected households will be prioritized in resettlement projects.
   - Structures within identified areas to be relocated will be given three years to vacate the premises and or relocate to suitable areas.
   - When property owner fails to relocate within a specified number of years, structure will be subject to demolition.
   - When structure incurs significant damage during a hazard event, property owner will not be allowed to rehabilitate the existing facility or construct a new structure.

Cross-cutting Regulations

These pertain to regulations, related to climate change adaptation and mitigation, that can be imposed to residents and the business sector to address climate change impacts; contribute to water sufficiency and energy efficiency (minimizing green house gas emissions); promote the protection and stability of the natural environment; and other concerns. These regulations can be added to the performance standards section of the zoning ordinance. Providing incentive mechanisms for the adoption of green building design standards can also be incorporated in the zoning ordinance (ZO) or in other support local ordinances. Some performance standards include:

1. **Water Efficiency Regulations -** Pertains to regulations imposed to property owners on the establishment of water storage/cisterns, and/or separate on-site piping system for non-potable water uses (flushing, gardening) to minimize potable water consumption for non-potable uses. Water for non-potable uses can be derived through rain-harvesting, and, if feasible, through centralized community based water treatment systems/facilities where storm water can be treated for potable uses. Other innovations such as modern sanitary fixtures/systems (i.e. water less urinals, low flow toilets) can also be pursued.

2. **Sustainable Energy -** Pertains to the provision of incentives (tax credits) to residences and business establishments to encourage the adoption of onsite renewable energy technologies such as photovoltaics and wind and solar water heating. These technologies can be encouraged to minimize dependence on energy derived from non-renewable and highly pollutive energy sources. Areas can also adopt off-grid, small scale, and community-based renewable energy technologies (if feasible). This may also pertain to building design regulations which reduced energy consumption for lighting and cooling through proper architectural design standards by maximizing ambient daylight and minimizing indoor temperature through solar orientation, proper ventilation, passive cooling, insulation, and heat reflective roofing.

3. **Green Spaces -** Pertains to regulations in the establishment and allocation for green spaces for the purposes of GHG sequestration, minimizing ambient temperature, improved air quality, and improve aesthetics. These can be done by prescribing a minimum green space ratio per lot (i.e. 30-50% of the total lot area to be devoted for green spaces) such as landscaping, residential tree canopy, and/or vegetative green roofs.

Mandaluyong City enacted the 2014 Green Building Regulations (Ordinance No. 535, series of 2014) and its implement rules and regulations to contribute to the global efforts in reducing green house gas emission and minimizing impacts of buildings on health and the environment. It provides a good example of relevant provisions to support climate change adaptation and mitigation. It covers standards on energy efficiency, water efficiency, materials and waste management, site sustainability, and indoor environmental quality, including incentives in the form of increased floor area ratio and tax discounts. Certain provisions can be adopted by other LGUs and incorporated in the ZO as separate sections.

Implementation of the CLUP and ZO

This phase is an integral part in implementing the CLUP and enforcing the ZO towards the realization of the identified vision, goals, and objectives. With emphasis on CCA-DRRM, the following areas should be taken into consideration:

Institutional capacity and capability building for land use and development planning and monitoring - Entails an assessment of current capacities of the LGU and concerned departments in sustaining CCA-DRRM efforts, and instituting changes to enhance the institutional structure, systems and procedures for continuous/sustained risk reduction and management and climate change adaptation related planning; information management; program and project development and management; resource generation/ fiscal management; investment programming; and monitoring and evaluation. This may also entail the establishment and maintenance of necessary geographic and information management systems (i.e. Geographic Information System, Building Information and Management System, Community Based Monitoring System).

Institutional capacity and capability building for zoning enforcement - Entails an assessment of current capacities and capabilities for effective enforcement of zoning regulations (including building designs), instituting changes in the systems/procedures in the review; approval and issuance of locational clearances (zoning department/office) and building permits (engineering department); and continuous inspection/ compliance monitoring, cadastral mapping, and field surveying. This also involves feedback mechanisms to allow future adjustments/revisions to further improve zone regulations.

Revenue Generation - Increase locally generated revenues to support the CCA-DRRM agenda. This may cover the imposition of special levies[23] to cover costs for CCA-DRRM related projects and activities that directly benefits property owners (i.e. flood control works, establishment of roads) where LGU can recover costs not exceeding 60% of the actual costs of public projects and reasonable rates to be fixed commensurate to service rendered[24]. Generate revenues from the special education fund (1% of the real property tax), which can be used for retrofitting educational related facilities/structures, and collecting idle land taxes (2% per annum based on the prevailing assessed value of the property) to encourage the use of agricultural lands and/ or fund adaptation measures for agriculture (establishment of improved irrigation, water impoundment facilities or other initiatives in support of climate resilient agricultural production). LGUs can also institute changes to improve tax collection efficiency and enforce necessary penalties on tax delinquency.

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[23] HLURB, CLUP Guidebook: A Guide to Comprehensive Land Use Plan Preparation , 2013

[24] National Structural Code of the Philippines, 2010, Chapter 2, page 2-112

Financing DRR- CCA initiatives - LGUs can utilize 70 percent of the total calamity fund to risk-reduction measures and 30 percent to quick response activities. These can be a source of funds to implement identified risk reduction projects and programs in the CLUP. LGUs can also tap into the People Survival Fund, under Republic Act No. 10174, to fund adaptation programs and projects subject to review and approval by the People's Survival Fund board. Also, LGUs can access climate financing offered by International entities in the form of grants and/or loans.

Strengthening LGU-NGO-PO Linkages - Encourage participatory planning, program and project development and implementation for CCA-DRRM endeavors by involving Non-Government Organizations, Peoples Organizations, Community Groups, and Civil Society to identify socially acceptable adaptation and mitigation measures.

Interfacing with other local plans - Ensuring consistency of short to medium term local plans such as the Comprehensive Development Plan, Executive and Legislative Agenda, and Local Development and Annual Investment Plans which are consistent with the Comprehensive Land Use Plan. Also, ensure consistency with higher level plans like PDPFP, RPFP, and NPFP.

Synergy - Establishing and strengthening inter-LGU linkages and cooperation for the reduction and management of common/shared risks. It also includes strengthening ties with concerned provincial level governments, regional line agencies, and other entities (i.e. Indigenous People) to ensure policies, programs, and projects related to land development and natural resources management are consistent.

Monitoring and evaluation

Monitoring and evaluation takes off from the CCA-DRRM related success indicators and targets articulated in the goals and objectives setting step of the CLUP formulation process. The purpose of monitoring and evaluation is to ensure that necessary systems/mechanism/ procedures are in place that will allow the consistent and systematic monitoring of CCA-DRRM interventions and its intended/desired results, the measurement of trends, and the evaluation of its benefits and impacts. It shall serve as the feedback mechanism and the basis for revising policy interventions so that alternative risk reduction and management measures can be identified. A sample monitoring and evaluation matrix can be prepared as basis for the detailing of methodologies/procedures.

Table 4.22 Sample Monitoring and Evaluation Indicators

Sample/Recommended Success Indicators/Targets Spatial DRR-CCA	Responsible Departments/Offices	Brief Description/Parameters for Monitoring
• Incremental relocation of 445 informal settler families considered highly at risk to floods and/or vulnerable to sea level-rise and storm surges	Municipal Social Welfare and Development - Municipal Planning and Development Office	• Annual number of relocated informal settler families.
• Increase area allocation for new residential areas to accommodate 6,420 households	Municipal Planning and Development Office	• Annual number of housing units constructed and number of household beneficiaries.
• Reduction in number of families dependent on post-disaster financing/assistance	Municipal Social Welfare and Development	• Annual data on the number of households/ residents who received financial aid and relief assistance. Data aggregation shall be at the purok/zone level.
• Reduction in the amount spent for post-disaster financing/assistance	Municipal Budget Office - Municipal Disaster Risk Reduction and Management Office	• Annual data on the cost incurred by the local government for financial assistance, disaster response, and relief assistance. Data shall be aggregated at the purok/ zone level.
• Reduced cases of deaths, severely affected families, and totally damaged structures	Municipal Disaster Risk Reduction and Management Office - Municipal Engineering Office/Municipal Building Official	• Standardized annual data on the number of deaths due to natural hazards • Standardized annual data on the number of partially and totally damaged structures to natural hazards. Aggregated by building type (residential, commercial, institutional, etc) and by purok.

Table 4.22 Sample Monitoring and Evaluation Indicators

Sample/Recommended Success Indicators/Targets Spatial DRR-CCA	Responsible Departments/Offices	Brief Description/Parameters for Monitoring
• 95% of highly vulnerable structures are retrofitted within 2022 • Achieve 95% conformance on structures employing disaster mitigation structural design standards (risk mitigation) or those located in relatively safe areas (risk avoidance) • Reduce/eliminate cases where residential/non-residential structures are constructed in highly susceptible hazard areas • Increase number of property owners with the capacity to afford post-disaster economic protection (property/life insurance)	Municipal Building Official/Engineering Department	• Establish an extensive geo-referenced building database on important parameters (i.e. building type, wall and roof materials, construction cost/assessed value, insurance coverage) which can be incorporated in the annual payment of real property taxes. • Incorporate structural engineering assessment and evaluation requirement as part of the real property tax payment process. • Annual monitoring of the number of building owners who employed retrofitting • Annual monitoring on the number of structures conforming to hazard resistant design • Annual monitoring of existing and new buildings constructed in identified no-build zones • Annual monitoring of existing and new building structures with insurance coverage
• Increase number of property owners with the capacity to afford post-disaster economic protection (life insurance) • 95% of population above the Poverty Index • Increase average annual income of families • Reduction in unemployment rate	Municipal Planning and Development Office	• 5-year interval trending on the number/ percentage population with life insurance coverage aggregated by household (CBMS) • 5-year interval trending on the number/ percentage population above the Poverty Index, aggregated by household (CBMS) • 5-year interval trending on the household income, aggregated by household (CBMS) • 5-year interval trending on the unemployment rate (CBMS)
• Generation of 1,200 jobs • Increase in number of new investors related to tourism, agri-industrial, forestry, and other service-related facilities/establishments	Municipal Planning and Development Office - Business Licensing	• 2-year interval trending on the number of new jobs generated aggregated by barangay by type of industry/profession

Glossary of Terms

Presented below are some basic DRR and CCA terminologies and concepts relevant to mainstreaming climate change and disaster risks in comprehensive land use planning. The definitions are mostly derived from the UNISDR, IPCC, and Philippine laws on DRRCCA and other local references.

Acceptable risk

The level of potential losses that a society or community considers acceptable given existing social, economic, political, cultural, technical and environmental conditions (UNISDR, 2009).

Adaptation

In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate (IPCC 2012).

The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (CC Act, 2009).

Adaptation assessment

The practice of identifying options to adapt to climate change and evaluating them in terms of criteria such as availability, benefits, costs, effectiveness, efficiency, and feasibility (IPCC, 2012)

Adaptive Capacity

The ability of ecological, social or economic systems to adjust to climate change including climate variability and extremes, to moderate or offset potential damages and to take advantage of associated opportunities with changes in climate or to cope with the consequences thereof (CC Act, 2009).

The combination of the strengths, attributes, and resources available to an individual, community, society, or organization that can be used to prepare for and undertake actions to reduce adverse impacts, moderate harm, or exploit beneficial opportunities (IPCC, 2012).

Capacity

a combination of all strengths and resources available within a community, society or organization that can reduce the level of risk, or effects of a disaster. Capacity may include infrastructure and physical means, institutions, societal coping abilities, as well as human knowledge, skills and collective attributes such as social relationships, leadership and management. Capacity may also be described as capability (PDRRM Act 2010).

Capacity Development

The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions (UNISDR, 2009).

Climate Change

A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use (IPCC, 2012).

A Change in climate that can be identified by changes in the mean and/or variability of its properties and that persists for an extended period typically decades or longer, whether due to natural variability or as a result of human activity(CC Act, 2009).

A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (UNFCC, 1992)

Climate extreme (extreme weather or climate event)

The occurrence of a value of a weather or climate variable above (or below) a threshold value near the upper (or lower) ends of the range of observed values of the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as 'climate extremes.'

Climate Risk

Climate Risk refers to the product of climate and related hazards working over the vulnerability of human and natural ecosystems (CC Act, 2009).

Climate Variability

The variations in the average state and in other statistics of the climate on all temporal and spatial scales beyond that of individual weather events (CC Act, 2009).
Climate variability refers to variations in the mean state and other statistics (such as standard deviations, the occurrence of

extremes, etc.) of the climate at all spatial and temporal scales beyond that of individual weather events. Variability may be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability). See also Climate change (IPCC, 2012).

Coping capacity

The ability of people, organizations, and systems, using available skills, resources, and opportunities, to address, manage, and overcome adverse conditions (IPCC, 2012). The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters (UNISDR, 2009).

Contingency Planning

A management process that analyzes specific potential events or emerging situations that might threaten society or the environment and establishes arrangements in advance to enable timely, effective and appropriate responses to such events and situatIons (PDRRM Act, 2010).

Disaster

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources (UN-ISDR, 2009).

Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (IPCC, 2012).

A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources. Disasters are often described as a result of the combination of: the exposure to a hazard; the conditions of vulnerability that are present; and insufficient capacity or measures to reduce or cope with the potential negative consequences, Disaster impacts may include loss of life, injury, disease and other negative effects on human, physical, mental and social well-being, together with damage to property, destruction of assets, loss of services, Social and economic disruption and environmental degradation (PDRRM Act, 2010).

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Disaster Prevention

The outright avoidance of adverse impacts of hazards and related disasters. It expresses the concept and intention to completely avoid potential adverse impacts through action taken in advance such as construction of dams or embankments that eliminate flood risks, land-use regulations that do not permit any settlement in high-risk ares, and seismic engineering designs that ensure the survival and function of a critical building in any likely earthquake (PDRRM Act, 2010)

Disaster Response

The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected. Disaster response is predominantly focused on immediate and short-term needs and is sometimes called "disaster relief'(PDRRM Act, 2010).

Disaster Risk

The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period (UNISDR, 2009).

The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic, or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (IPCC, 2012).

Disaster Risk Management

The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster (UNISDR, 2009).
Processes for designing, implementing, and evaluating strategies, policies, and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response, and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, and sustainable development(IPCC, 2012).

Disaster Risk Reduction

The concept and practice of reducing disaster risks through systematic efforts to analyze 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 (UNISDR, 2009).

Denotes both a policy goal or objective, and the strategic and instrumental measures employed for anticipating future disaster risk; reducing existing exposure, hazard, or vulnerability; and improving resilience (IPCC, 2012) Disaster Risk Reduction and Management

The systematic process of using administrative directIves, organizations, and operational skills and capacIties to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibIlity of disaster. Prospective disaster risk reduction and management refers to risk reduction and management activities that address and seek to avoid the development of new or increased disaster risks, especially if risk reduction policies are not put in place (PDRRM Act, 2010).

Disaster Mitigation

The lessening or limitation of the adverse impacts of hazards and related disasters. Mitigation measures encompass engineering techniques and hazard-resistant construction as well as improved environmental policies and public awareness (PDRRM Act, 2010).

Disaster Preparedness

The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the Impacts of likely, imminent or current hazard events or conditions. Preparedness action is carried out within the context of disaster risk reduction and management and aims to build the capacities needed to efficiently manage all types of emergencies and achieve orderly transitions from response to sustained recovery. Preparedness is based on a sound analysis of disaster risk and good linkages with early warning systems, and includes such activities as contingency planning, stockpiling of equipment and supplies, the development of arrangements for coordination, evacuation and public information, and associated training and field exercises. These must be supported by formal institutional, legal and budgetary capacities (PDRRM Act, 2010).

Exposure

The presence of people; livelihoods; environmental services and resources; infrastructure; or economic, social, or cultural assets in places that could be adversely affected (IPCC, 2012).

People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses(UNISDR, 2009).

The degree to which the elements at risk are likely to experience hazard events of different magnitudes(PDRRM Act, 2010). Hazard

A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UNISDR, 2009).

The potential occurrence of a natural or human-induced physical event that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, and environmental resources (IPCC, 2012).

A threatening event, or the probability of occurrence of a potentially damaging phenomenon, within a given time period and area that may cause loss of life or injury, property damage, social and economic disruption or environmental degradation or a combination of these. (NEDA, 2008)

Mainstreaming

The integration of policies and measures that address climate change into development planning and sectoral decisionmaking (CC Act, 2009).

Land-Use Planning

Land use planning refers to the rational and judicious approach of allocating available land resources to different land using activities, (e.g. agricultural, residential, industrial) and for different functions consistent with the overall development vision/goal of a particular locality. It entails the detailed process of determining the location and area of land required for the implementation of social and economic development, policies, plans, programs and projects. It is based on consideration of physical planning standards, development vision, goals and objective, analysis of actual and potential physical conditions of land and development constraints and opportunities (HLURB, 2006).

The process undertaken by public authorities to identify, evaluate and decide on different options for the use of land, including consideration of long-term economic, social and environmental objectives and the implications for different communities and interest groups, and the subsequent formulation and promulgation of plans that describe the permitted or acceptable uses (UNISDR, 2009).

Mitigation

Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation, and technological hazards and to ensure the ability of at-risk communities to address vulnerabilities aimed at minimizing the impact of disasters. Such measures include, but are not limited to, hazard-resistant construction and engineering works, the formulation and implementation of plans, programs, projects and activities, awareness raising, knowledge management, policies on land-use and resource management, as well as the enforcement of comprehensive land-use planning, building and safety standards, and legislation (PDRRM Act, 2010).

In the context of climate change, refers to human intervention to address anthropogenic emissions by sources and removals by sinks of all GHG, including ozone- depleting substances and their substitutes (IPCC, 2012).

In the context of disaster and disaster risk, The lessening of the potential adverse impacts of physical hazards (including those that are human-induced) through actions that reduce hazard, exposure, and vulnerability (IPCC, 2012).

Preparedness

The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions (UNISDR, 2009).

Pre-disaster actions and measures being undertaken within the context of disaster risk reduction and management and are based on sound risk analysis as well as pre-disaster activities to avert or minimize loss of life and property such as, but not lImited to, community organizing, training, planning, equipping, stockpiling, hazard mapping, insuring of assets, and public information and education initiatives. This also includes the development enhancement of an overall preparedness strategy, policy, institutional structure, warning and forecasting capabilities, and plans that define measures geared to help at-risk communities safeguard their lives and assets by being alert to hazards and taking appropriate action in the face of an Imminent threat or an actual disaster (PDRRM Act, 2010).

Retrofitting

Reinforcement or upgrading of existing structures to become more resistant and resilient to the damaging effects of hazards (UNISDR, 2009).

Risk

The combination of the probability of an event and its negative consequences (UNISDR, 2009).

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. e 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 (NEDA, 2007)

Risk Assessment

A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment on which they depend (UNISDR, 2009).

A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihood and the environment on which they depend. Risk assessments with associated risk mapping include: a review of the technical characteristics of hazards such as their location, intensity, frequency and probability; the analysis of exposure and vulnerability including the physical, social, health, economic and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities in respect to likely risk scenarios (PDRRMC Act, 2010).

Risk transfer

The process of formally or informally shifting the financial consequences of particular risks from one party to another whereby a household, community, enterprise, or state authority will obtain resources from the other party after a disaster occurs, in exchange for ongoing or compensatory social or financial benefits provided to that other party (UNISDR, 2012).

Resilience

The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions (IPCC, 2012).

The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR, 2009).

Response

Any concerted effort by two (2) or more agencies, public or private, to provide assistance or intervention during or immediately after a disaster to meet the life preservation and basic subsistence needs of those people affected and in the restoration of essential public activities and facilities (PDRRM Act, 2010).

Post-Disaster Recovery

The restoration and improvement where appropriate, of facilities, livelihood and living conditions.of disaster-affected communities, including efforts to reduce disaster risk factors, in accordance with the principles of "build back better"(PDRRM Act, 2010).

Prevention

The outright avoidance of adverse impacts of hazards and related disasters (UNISDR, 2009).

Recovery

The restoration, and improvement where appropriate, of facilities, livelihoods and living conditions of disaster-affected communities, including efforts to reduce disaster risk factors (UNISDR, 2009).

Structural and non-structural measures

Structural measures: Any physical construction to reduce or avoid possible impacts of hazards, or application of engineering techniques to achieve hazard- resistance and resilience in structures or systems;

Non-structural measures: Any measure not involving physical construction that uses knowledge, practice or agreement to reduce risks and impacts, in particular through policies and laws, public awareness raising, training and education (UNISDR, 2009).

Vulnerability

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard (UNISDR, 2009).

The propensity or predisposition to be adversely affected (IPCC, 2012).

The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Vulnerability may arise from various physical, social, economic, and environmental factors such as poor design and construction of buildings, inadequate protection of assets, lack of public information and awareness, limited official recognition of risks (PDRRM Act, 2010).

The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity (CC Act, 2009).

Vulnerability Assessment

Systematic examination of impacts of climate change and disasters on natural and socio-economic systems (IPCC 2007).

Vulnerability assessments examine the underlying socioeconomic, institutional, and, to a lesser extent, political and cultural factors, that determine how people cope with climate hazards.

Vulnerability assessments make use of indicators that can help identify and target vulnerable regions,sectors or populations, raise awareness, and be part of a monitoring strategy (Downing et. al. 2001).

Annex

The concept of risk and vulnerability in the context of Disaster Risk Reduction and Climate Change Adaptation

Developing the methodology for climate and disaster risk assessment and climate change vulnerability assessment requires a better understanding of concepts developed by two communities of practice: disaster risk and climate change.

Climate Change

Climate change refers to a change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles, volcanic eruptions and persistent anthropogenic changes in the composition of the atmosphere or in land use[25]. The most recent findings by the Intergovernmental Panel on Climate Change (IPCC) showed that the global temperature has increased by an average of 0.85 degrees over the period 1880 to 2012[26]. The increase in global mean temperatures is attributed to the increase atmospheric concentration of greenhouse gases due to human activity since 1750 [27]. A changing climate could manifest in the changes in seasonal temperature and rainfall patterns; frequency and intensity of extreme precipitation events, intensity and duration of droughts, increase in tropical cyclone activity; and sea level rise as a result of the glacial mass loss and thermal expansion of oceans. Climate models used to develop climate change scenarios are run using different forcings such as increasing greenhouse gas and aerosols atmospheric concentrations. These emission scenarios known as the SRES (Special Report on Emission Scenarios) developed by the IPCC give the range of plausible future climate given the possible demographic, societal, economic and technological storylines (Refer to Table A1 and Figure A1)

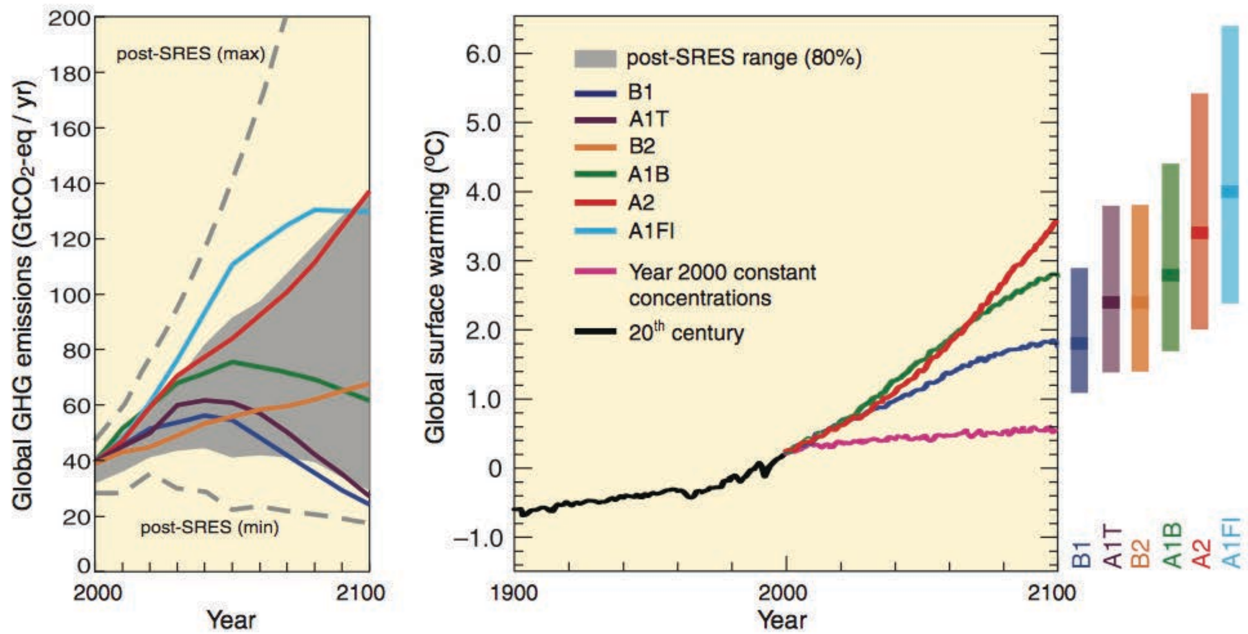
[25] IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Annex III, p 1450.
[26] Ibid, p. 5
[27] Ibid, p. 11

Table A1 The four SRES scenarios developed by the Intergovernmental Panel on Climate Change (IPCC)

Scenario Family	Development Pathway	
A1	Very rapid economic growth, a global population that peaks in mid-century and rapid introduction of new and more efficient technology. A1 is further subdivided into three groups that describe alternative directions of technological change	A1FI - Reliance on fossil intensive;
		A1T - Reliance on non-fossil fuels;
		A1B - Balance across all fuel sources
A2	A very heterogeneous world with high population growth, slow economic development and slow technological change.	
B1	Describes a convergent world, with the same global population as A1, but with more rapid changes in economic structures toward a service and information economy	
B2	a world with intermediate population and economic growth, emphasizing local solutions to economic, social, and environmental sustainability.	

Source: IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, p. 44

Figure A1 Scenarios for GHG emissions from 2000 to 2100 and projections of surface temperatures



Source: Climate Change 2007: Synthesis Report, IPCC, 2007, p.7

Climate Change in the Philippines

The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) released the official Climate Projections in the Philippines on February 2011. It contains information on the observed and future climate change scenarios at the provincial level based on the latest empirical and scientific studies and understanding. It was intended to provide decision makers the information to support development planning and anticipate the potential changes in extreme and seasonal climate parameters.

Using the Providing Regional Climates for Impact Studies (PRECIS) and using the B2 (low range emission) A1B (medium range emission) and A2 (high emission) scenarios, with baseline period from 1971-2000, the following trends were established to project the future climate model in two time frames—2020 and 2050 :

- **Seasonal rainfall change -** generally, there is reduction in rainfall in most parts of the country during the summer (MAM) season. However, rainfall increase is likely during the southwest monsoon (JJA) season until the transition (SON) season in most areas of Luzon and Visayas, and also, during the northeast monsoon (DJF) season, particularly, in provinces/areas characterized as Type II climate in 2020 and 2050. There is, however, generally decreasing trend in rainfall in Mindanao, especially by 2050.

- **Seasonal temperature change -** Mean temperatures in all areas in the Philippines are expected to rise by 0.9°C to 1.1°C in 2020 and by 1.8°C to 2.2°C in 2050. Likewise, all seasonal mean temperatures will also have increases in these time slices; and these increases during the four seasons are quite consistent in all parts of the country. Largest temperature increase is projected during the summer (MAM) season;

- **Frequency of extreme rainfall events -** heavy daily rainfall will continue to become more frequent; extreme rainfall is projected to increase in Luzon and Visayas only;

- **Frequency of days with temperatures exceeding 35oC -** hot temperatures will continue to become more frequent in the future;

- **Frequency of dry days or days with rainfall less than 2.5mm -** Number of dry days is expected to increase in all parts of the country in 2020 and 2050.

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[28] Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Climate Change in the Philippines, February 2011, pp

The Concept of Risk

Risk is defined as the combination of the probability of an event and its negative consequences. 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 a function of the probability of occurrence of hazards, elements exposed and vulnerability of elements exposed to the hazards, expressed as:

$$f \text{ (Risk)} = \text{Hazard, Exposure, Vulnerability}$$

Hazard is a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation. A hazard can be geological, such as an earthquake or volcanic eruption; it can be meteorological, such as flood and raininduced landslide.

Exposure refers to elements such as people, buildings, infrastructure, the economy and natural environment that are subject to the impact of specific hazard.

Vulnerability refers to qualities of the exposed element to withstand the impact of a hazard event; refers to the characteristics (i.e. building wall materials, age of the building) of an element exposed to a hazard that contribute to the exposed element's capacity to resist, cope with, withstand, and recover from the impact of natural hazard.

Following the H-E-V risk approach, probabilistic risk can also be expressed as:

$$f \text{ (Risk)} = \text{Probability, Consequence}$$

Wherein hazard is expressed as the probability of occurrence of the hazard or the estimated recurrence expressed as a return period (1/100 years or 1% chance of occurring in any given year) and consequence which is the interplay of the expected magnitude of the hazard, the extent of exposure, and the vulnerability conditions of the exposed elements. The other end of the spectrum is a deterministic risk approach wherein an assumption is adopted such that there is certainty that a hazard event will happen and the damage and losses associated to it.

Table A2. Comparative Matrix of Application of Concept of Risk

Risk and Components	Concept	Mainstreaming Guidelines on Sub-national planning	Reference Manual on Integrating DRR and CCA into the CLUP
Risk	Annual loss of lives, annual damage to properties	Annual loss of lives, annual damage to properties	Risk is measured qualitatively based on the indicative likelihood of occurrence score and a subjective rating/assessment on the severity of consequence based on the existing/baseline vulnerability attributes of exposed elements.
Hazard	A hazard's destructive potential or degree of hazard is a function of the magnitude, duration, location and timing of the event. Basic data would be the probability of occurrence. Probabilistic data must be historically established. This is usually reflected in the hazard maps.	Hazard maps do not reflect the probability of occurrence or return period of hazard events. Instead, susceptibility or proneness defined as highly susceptible area (HSA), moderately susceptible area (MSA), and low susceptible area (LSA) are reflected in the maps. Each of these areas of susceptibility were assigned return periods.	Flood modeling maps were generated for Surigao City for a 2, 5, 10, 25, and 50 year rainfall. The Rainfall Intensity Duration Frequency (RIDF) curves for Surigao City that were utilized in flood modeling and was based on the PAGASA observed historical daily rainfall data. The resulting maps depicted the estimated flood extent and heights along the Surigao River for the different scenarios (return period of rainfall). Other hazard maps used in the pilot areas were sourced from mandated agencies
Exposure	Ideally a probability density function for population exposure which takes into account nature of events, and spatial and temporal dimensions are used. For economic assets, detailed measures of the extent and quality of infrastructure and the economic value of the exposed land and resources are used.	Replacement value of structures (based on building permits data). Replacement value based on the cost of crops production from the Department of Agriculture. The barangay population count and the estimated barangay land area were used to compute for the estimated population density which was then used to estimate the affected persons based on the extent/area of the hazard per susceptibility class as a proxy variable for exposure.	Exposure was determined using map overlays of hazards and elements at risk covering population, built-up areas, agriculture, transportation, and critical point facilities (i.e. schools, government buildings, power, water and communication related facilities). Exposure per type are represented either as area, number of facilities, and replacement value.
Vulnerability	Vulnerability of elements exposed refers to their intrinsic characteristics that allow them to be damaged or destroyed. The weakness of physical and social systems is usually defined in terms of fragility curves, in which the weaknesses are quantified as a function of hazard severity.	Owing to data limitations, historical loss rates were used to estimate the loss expected when particular populations or economic assets are exposed to hazards. Vulnerability is represented by the factor of fatality and factor of damage (built-up areas and agriculture) and is referred to as "macro vulnerability". A "micro vulnerability" assessment was undertaken in the identified priority planning areas or the high risk areas in which the characteristics of the population, infrastructure and services, economy, other assets were evaluated and together with the coping capacity of the people and the locality, were considered in the design of appropriate risk reduction measures.	Vulnerability analysis is based on the existing/baseline attributes of the exposed elements. These attributes were described and summarized per barangay which were considered (along with the extent/number of exposed elements) in assigning the severity of consequence (degree of damage).

Sources: NEDA-UNDP-EU. 2009. Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning. Manila, Philippines, NEDA-UNDP-Australian Government.

Reference Manual on Integrating Disaster Risk Reduction and Climate Change Adaptation in the Comprehensive Land Use Plan Report, NEDA-UNDP-HLURB, 2011

Disaster

Disaster is defined as 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[29].

The NDRRMC (through NDCC Memorandum Order No 4. series of 1998, items 4a-b, items a. to b.) criteria for declaring a state of calamity provides the measurable criteria or thresholds which can be used as proxy indicators for disasters. It covers the minimum percentage of severely affected population, minimum percentage damage to means of livelihood, minimum duration of disruption in the flow of transport and commerce (e.g. roads and bridges), minimum percentage damage to agriculture based products, and duration of disruption of lifeline facilities (e.g. electricity, potable water systems, communication).

Table A3 Thresholds for declaring a state of calamity

Element	Criteria for declaring a state of calamity
Population	At least 20% of the population are affected and in need of immediate assistance.
Dwelling units	At least 20% of dwelling units have been destroyed
Means of livelihood	A great number or at least 40% of the means of livelihood such as bancas, fishing boats, vehicles and the like are destroyed; Widespread destruction of fishponds, crops, poultry, and livestock, and other agricultural products
Lifelines	Disruption of lifelines such as electricity, potable water system, transport system, communication system and other related systems which cannot be restored within one (1) week, except for highly urbanized areas where restoration of the above facilities cannot be made within twenty-four (24) hours.

[1] NDCC Memorandum Order No 4. series of 1998, items 4a-b, items a. to b

[29] United Nations International Strategy for Disaster Reduction , UNISDR Terminology on Disaster Risk Reduction, 2009.

Disaster Risk Assessment

Disaster risk assessment is a methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods and the environment to which they depend. Risk assessments and associated risk mapping include: a review of the technical characteristics of hazards such as their location, intensity, frequency and probability; the analysis of exposure and vulnerability including the physical, social, health and environmental dimensions; and the evaluation of the effectiveness of prevailing and alternative coping capacities with respect to likely risk scenarios. The series of activities is sometimes known as a risk analysis (UNISDR: 2009). In 2009, the NEDA in partnership with UNDP and European Commission Humanitarian Office (ECHO) developed the Guidelines on Mainstreaming Disaster Risk Reduction in Subnational Development and Land Use/Physical Planning where disaster risk assessment was introduced as a process for establishing areas at risk to natural hazards and the planning implications. A quantitative risk assessment methodology was used which adopted several assumptions due to the availability and quality of data.

Disaster Risk Reduction and Management

The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster. Prospective disaster risk reduction and management refers to risk reduction and management activities that address and seek to avoid the development of new or increased disaster risks, especially if risk reduction policies are not put in place[30].

Disaster Risk Reduction

The systematic efforts to analyze 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 (ADPC).

[30] United Nations International Strategy for Disaster Reduction , UNISDR Terminology on Disaster Risk Reduction, 2009.

The Concept of Vulnerability

Using the IPCC framework, vulnerability is defined as the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity [31].

$$f\ (\text{Vulnerability}) = \text{Exposure, Sensitivity, Adaptive Capacity}$$

where:

Exposure is the nature and degree to which a system is exposed to significant climatic variations.

Sensitivity is the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).

Adaptive capacity is the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Vulnerability Assessment

Is the systematic examination of impacts of climate change and disasters on natural and socio-economic systems. It is the key component of climate change adaptation which seeks to establish the elements exposed, describe their intrinsic characteristics that make them sensitive to the climate stimulus, estimate possible direct and indirect impacts, and determine the level of adaptive capacities to cope with the potential impacts. These shall be the basis for identifying the necessary measures for adaptation and mitigation.

[31] IPCC, Working Group II, Climate Change 2001: Impacts, Adaptation, and Vulnerability, 2001
[32] Ibid

Climate Change Adaptation

In human systems, it is the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, it is the process of adjustment to actual climate and its effects where human intervention may facilitate adjustment to expected climate[33]. In the context of land use planning, planned adaptation is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

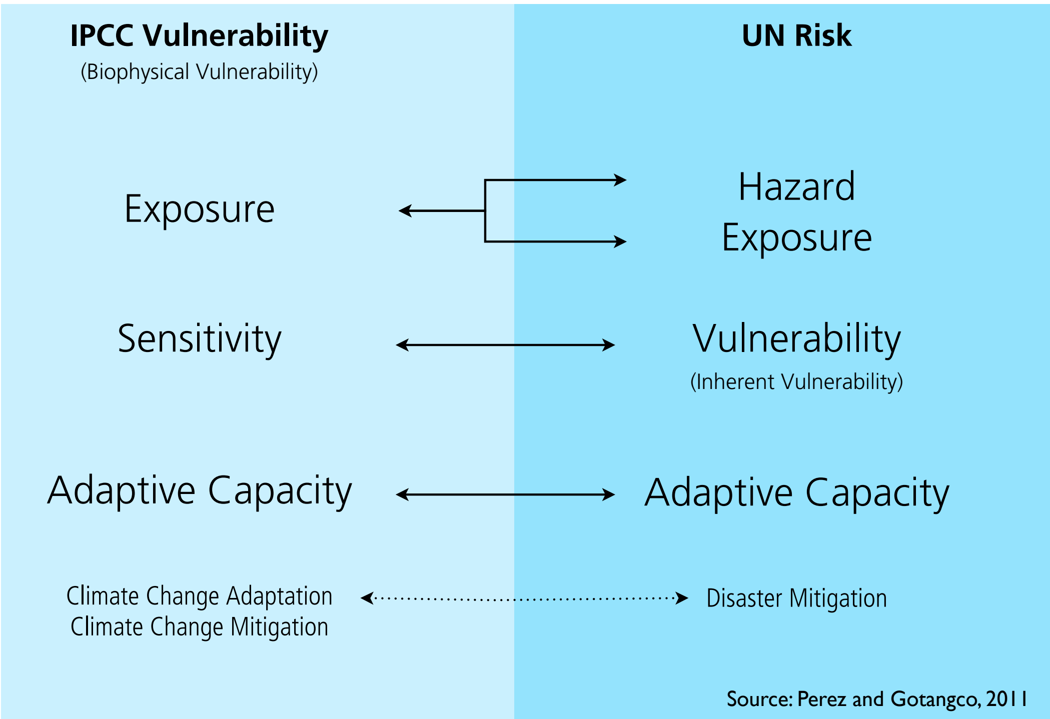
Climate Change Mitigation

In the context of climate change, climate change mitigation refers to human intervention to address anthropogenic emissions by sources and removals by sinks of all GHG, including ozone- depleting substances and their substitutes[34].

The correspondence between the risk and vulnerability frameworks

To facilitate the understanding of the risk and vulnerability frameworks, discussed below are the correspondence of the two frameworks.

Figure A2 Correspondence of the IPCC Vulnerability and UN Risk Frameworks



Note: Not a strict correspondence but a rough mapping to facilitate linking and understanding of

[33] IPCC, Working Group II, Climate Change 2001: Impacts, Adaptation, and Vulnerability, 2001
[34] Ibid

Vulnerability

The natural hazards community which emphasizes risk and the climate change community which emphasizes vulnerability are essentially examining the same processes. However, this has not always been immediately apparent due to differences in terminology. The separation of vulnerability into social and biophysical vulnerability enables us to appreciate the compatibility of the risk-based and vulnerability-based approaches[35].

1. Biophysical Vulnerability - in terms of the amount of (potential) damage caused to a system by a particular climate-related event or hazard. The IPCC definition for vulnerability falls under this category. "Biophysical" suggests both: (a) a physical component associated with the nature of the hazard and its first-order physical impacts; (b) a biological or social component associated with the properties of the affected system that act to amplify or reduce the damage resulting from these first-order impacts [36].

2. Social or inherent Vulnerability - a state that exists within a system before it encounters a hazard event that makes human societies and communities susceptible to damage from external hazards (e.g. poverty and marginalisation, gender, age, health, food entitlements, access to insurance, and housing quality). For nonhuman systems, "inherent vulnerability" may be used. The "sensitivity" under the IPCC framework and the "vulnerability" under the disaster risk framework fall under this category[37].

[35] Brooks, Vulnerability, risk and adaptation: A conceptual framework, 2003, p.7

[36] Climate Change Commission-Deutsche Gesellschaft fur Internationale Zeusammenarbeit, CLUP Resource Book Integrating Climate Change Adaptation and Disaster Risk Reduction and Management, 2013, p34.

[37] Ibid p34.

Hazard and Exposure

Climate-related or 'hydro-meteorological' hazards only represent one type of hazard dealt with by the disaster management community. The full range of hazards that DRR can encompass includes natural (e.g. geological, hydro-meteorological and biological) or those induced by human processes (e.g. environmental degradation and technological hazards). Therefore, DRR expands beyond the remit of climate change adaptation. Similarly, climate change adaptation moves outside the realm of most DRR experience to address longer term impacts of climatic change such as loss of biodiversity, changes in ecosystem services and spread of climate-sensitive disease, and those less likely to be addressed by the DRR community. Also, DRR focuses on reducing foreseeable risks based on previous experience, whereas adaptation originates with environmental science predicting how climate change will be manifested in a particular region over a longer time period[38]. Disaster Risk Reduction Management traditionally encompasses discrete, recurrent and rapid onset hazards, while the climate change can be considered to represent the continuous and slow-onset hazards[39].

The principal difference between the natural hazards risk-based approach and the IPCC biophysical vulnerability approach is that risk is generally described in terms of probability, whereas the IPCC and the climate change community, in general, tend to describe (biophysical) vulnerability simply as a function of certain variables. Disaster risk reduction practitioners usually assess vulnerability and capacities to respond to hazard events expected in the next season or years (e.g., hurricane seasons); whereas climate change experts are more likely to consider the long term impacts, in decades and centuries, of climate variability and change as well as related environmental change (e.g., degradation of coastline and sea level rise)[40].

Exposure in the risk framework refers to the elements exposed to the potential hazard, whereas exposure in the IPCC framework refers to the degree of climate stress upon a particular unit analysis represented as either a long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events. Hazard and exposure are two distinct variables in the risk framework, while exposure in the IPCC framework already incorporates the hazard variable.

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[38] Venton et. al, Linking climate change adaptation and disaster risk reduction, Tearfund, 2008

[39] Climate Change Commission-Deutsche Gesellschaft fur Internationale Zeusammenarbeit, CLUP Resource Book Integrating Climate Change Adaptation and Disaster Risk Reduction and Management, 2013, p35.

[40] Working Group on Climate Change and Disaster Risk Reduction of the Inter-Agency Task Force on Disaster Reduction (IATF/DR), On Better Terms: A Glance at Key Climate Change and Disaster Risk Reduction Concepts, 2006

Adaptive Capacity

Some disaster risk reduction practitioners use the concept of coping, and the term coping capacities in particular, to describe the use of mechanisms to reduce the adverse consequences and effects of disasters. Other disaster risk reduction managers, particularly those working in the interface with climate change issues, see a fundamental difference between coping and adapting. Climate change experts use the term adaptation to denote approximately the same concepts covered under "coping"/"coping strategies" (as denoted by the disaster risk reduction community). Yet many in the climate change community also differentiate between coping and adapting. Coping is used for short-term (or reactive) adjustments while adapting for long term (or proactive) ones[41].

Mitigation and Adaptation

Climate change mitigation measures recognize that the amount of Greenhouse gases in the atmosphere will influence the rate and magnitude of climate change. Therefore, it is within the capacity of humans to influence their exposure to change. Mitigation, in the context of risk reduction and management, refers to structural and non-structural measures implemented to reduce the impacts of natural hazards, environmental degradation and technological hazards. The climate change community would term these disaster mitigation activities as adaptation, although these activities would represent only one type of adaptation, namely reactive adaptation. The term adaptation to climate change embraces broader and more comprehensive activities[42].

Climate and Disaster Risk Assessment (CDRA)

In these supplemental guidelines, the two frameworks will be operationalized in the form of two distinct assessment tools: the disaster risk assessment (DRA) and climate change vulnerability assessment (CCVA) incorporated as part of the climate and disaster risk assessment (CDRA). The CDRA is intended to determine the major decisions areas characterized as areas at risk to natural hazards (established using the DRA) that can be exacerbated by its vulnerability to climate change (identified in the CCVA). Both tools are intended to describe the elements exposed to hazards/climate stimuli, identify the underlying factors contributing to sensitivities and vulnerabilities, and assess their adaptive capacities. These shall provide the basis for identifying possible interventions for risk reduction, climate change adaptation and mitigation.

[41] Working Group on Climate Change and Disaster Risk Reduction of the Inter-Agency Task Force on Disaster Reduction (IATF/DR), On Better Terms: A Glance at Key Climate Change and Disaster Risk Reduction Concepts, 2006
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Acknowledgment

This publication has been completed under Project Climate Twin Phoenix of the Climate Change Commission with the assistance of the Housing and Land Use Regulatory Board, United Nations Development Programme and the Australian Government.

The following institutions were consulted in the preparation of these guidelines:

Climate Change Commission
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Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) - Disaster Risk Management Sector
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PROJECT CLIMATE

Twin Phoenix

Understanding disaster risks in a changing climate,
Working towards sustainable recovery