Integrating Climate Change and Disaster Risk Scenarios into Coastal Land and Sea Use Planning in Manila Bay

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)
Ministry of Land, Transportation and Maritime Affairs, Republic of Korea (MLTM)
Korea Maritime Institute (KMI)

Integrating Climate Change and Disaster Risk Scenarios into Coastal Land and Sea Use Planning in Manila Bay

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA)
Ministry of Land, Transportation and Maritime Affairs, Republic of Korea (MLTM)
Korea Maritime Institute (KMI)

Integrating Climate Change and Disaster Risk Scenarios into Coastal Land and Sea Use Planning in Manila Bay

June 2012

Published by the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA). 74 p.

Printed in Quezon City, Philippines

PEMSEA. 2012. Integrating Climate Change and Disaster Risk Scenarios into Coastal Land and Sea Use Planning in Manila Bay. Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Quezon City, Philippines.

Cover Photo by Cheryl Ravelo, Reuters.

ISBN 978-971-812-029-3

PEMSEA is a GEF Project Implemented by UNDP and Executed by UNOPS.

PEMSEA Resource Facility
P.O. Box 2502, Quezon City 1165, Philippines
Tel: (+632) 929-2992   Fax: (+632) 926-9712
Email: info@pemsea.org
www.pemsea.org

TABLE OF CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

AOGCMs - atmosphere-ocean general circulation models
ArchDevt - Archipelagic Development Framework
BFAR - Bureau of Fisheries and Aquatic Resources
BICMP - Bataan Integrated Coastal Management Program
CCA - climate change adaptation
CCC - Climate Change Commission
CDP - Comprehensive Municipal Development Plan
CLUP - comprehensive land use plans
CMMO - Coastal and Marine Management Office
CNFIDP - Comprehensive National Fisheries Industry Development Plan
CRFC - Coastal Resources and Fisheries Conservation Project
CRMP - Coastal Resources Management Planning
CTI - Coral Triangle Initiative
CT-Phil MPAS - Coral Triangle-Philippines MPA System
DA - Department of Agriculture
DENR - Department of Environment and Natural Resources
DIVA - Dynamic Interactive Vulnerability Assessment
DPWH - Department of Public Works and Highways
DRM - disaster risk management
DRR - disaster risk reduction
EAFM - Ecosystem approach to management of fisheries
EFCOS - Effective Flood Control Operation System
ENSO - EL Niño–Southern Oscillation
FEMA - Federal Emergency Management Agency
GHG - Greenhouse Gasses
GIS - geographical information system
GMSA - Global Marine Species Assessment
HFA - Hyogo Framework of Action
HLURB - Housing and Land Use Regulatory Board
HUDCC - Housing and Urban Development Coordinating Council
ICM - integrated coastal management
ICRMP - Integrated Coastal Resource Management Project.
ICZM - integrated coastal zone management
IP - indigenous peoples
IPCC - Intergovernmental Panel on Climate Change
IUCN - International Union for Conservation of Nature
IUU - Illegal, unreported and unregulated fishing
LCCAP - local climate change action plans
LGU - local government units
LMP - League of Municipalities of the Philippines
LRFT - live reef fish trade
MBCO - Manila Bay Coordinating Office
mKBA - marine key biodiversity areas
MLD - million liters per day
MMDA - Metro Manila Development Authority
MPA - Marine protected areas
MTPDP - Medium Term Philippine Development Plan
NAMRIA - National Mapping and Resource Information Authority
NCR - National Capital Region (Metro Manila)
NDCC - National Disaster Coordinating Council (now the National Disaster Risk Reduction and Management Council)
NDRRMC - National Disaster Risk Reduction and Management Council
NEDA - National Economic and Development Authority
NFPP - National Framework for Physical Planning
NFRDI - National Fisheries Research and Development Institute
NFSCC - National Framework Strategy on Climate Change
NGA - national government agencies
NGO - nongovernmental organization
NIPAS - National Integrated Protected Areas System
NLUC - National Land Use Committee
NPFP - National Physical Framework Plan
NPOAs - National Action Plans
NSAP - National Stock Assessment Program
NUDHF - National Urban Development and Housing Framework
PAGASA - Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAMB - Protected Area Management Board
PD - Presidential Decree
PDP - Philippine Development Plan
PEMSEA - Partnerships in Environmental Management for the Seas of East Asia
PO - people's organization
RA - Republic Act
RBCO - River Basin Coordinating Office
RDC - Regional Development Councils.
RLUC - Regional Land Use Committees
SimClim - Simulator of Climate Change Risks and Adaptation Initiatives
SLR - sea level rise
SRTM - Shuttle Radar Topographic Mission
SUMACORE - Sustainable Management of Coastal Resources in the Bicol and Caraga Regions
UP MSI - University of the Philippines - Marine Science Institute

ACKNOWLEDGEMENTS

This report was prepared with the financial support of the GEF/UNDP/PEMSEA Regional Project on Implementation of the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA) and the Ministry of Land, Transportation and Maritime Affairs, Republic of Korea, in coordination with the Korea Maritime Institute (KMI).

This paper was prepared for PEMSEA by Dr. Rosa T. Perez, under the technical guidance of Mr. Robert Jara, Programme Specialist, and Mr. Stephen Adrian Ross, Chief Technical Officer. The contributions from the following organizations and people are also acknowledged.

- Manila Observatory, Center for Environmental Geomatics, headed by Dr. May Celine Vicente;

- Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Climatology and Agrometeorology Division, headed by Ms. Rosalina de Guzman;

- University of the Philippines – Marine Science Institute (UP-MSI), Dr. Laura David and Dr. Fernando Siringan;

- Housing and Land Use Regulatory Board (HLURB), Ms. Nova Diaz; and

- National Mapping and Resource Information Authority (NAMRIA), Coast and Geodetic Survey Division, Mr. Herbert Catapang.

CHAPTER 1

Introduction

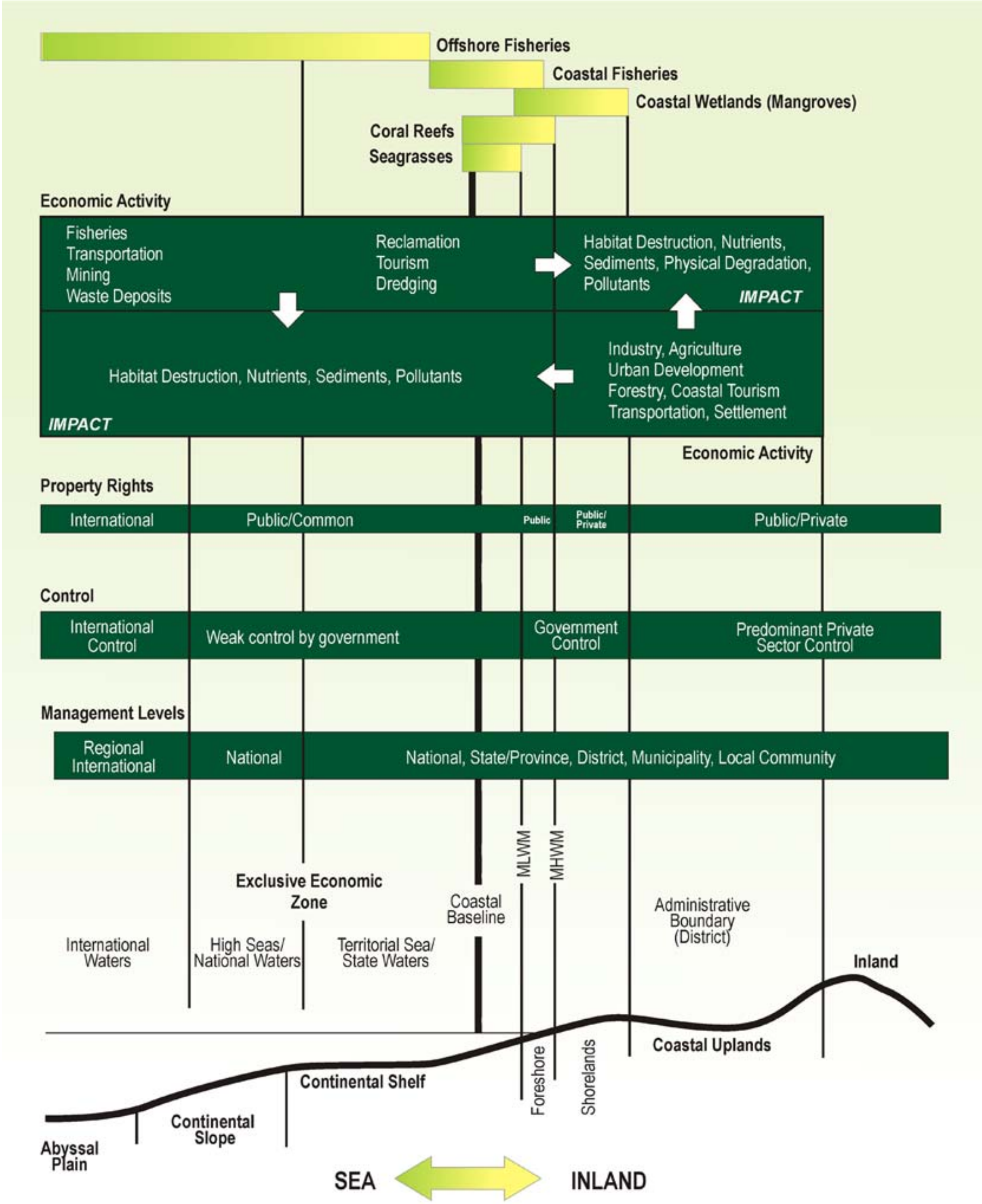
A general concept of coastal zone describes it as a dynamic area with frequently changing biological, chemical and geological attributes. It is also an area of high economic significance, which is often subject to fast economic development, large population migrations and urban development. The coastal area acts as a barrier for land-based pollution and discharges to the sea. The coastal areas are affected, through the coastal hydrodynamics, by the actions of the sea (e.g., storms, coastal erosion/ accretion, flooding, tsunamis, etc.). A general profile of the coastal zone area and its uses is shown in **Figure 1**.

Coasts are of great ecological and socioeconomic importance. They sustain economies and provide livelihoods through fisheries, ports, tourism, and other industries. They also provide ecosystem services such as regulating atmospheric composition, cycling of nutrients and water, and waste removal (Curran, et al., 2002). These areas have been centers of human settlement since perhaps the dawn of civilization, and have cultural and aesthetic values as well. Coastal ecosystems are among the most productive because they are enriched by land-based nutrients and nutrients that well up into the coastal waters from deeper levels of the ocean. Coastlines are also among the most populated regions. Nearly half the world's major cities are located within 50 km of a coast, and coastal population densities are 2.6 times greater than those of inland areas.

Two main types of influences affect coasts: terrestrial and marine, which are considered external to the coastal zone. ***Terrestrial influences*** are mostly anthropogenic in nature. They include land use changes and all the consequences of changing hydrological regimes and nutrient loading from sediment transport, runoff, and reduction of sediments through rivers (for example, from dam and channel construction and extraction of rivers and upstream). ***Marine influences*** are mostly natural phenomena, such as weather events (tropical cyclones and storm surges), tsunamis, wave patterns and coastal and ocean currents that affect the processes of nutrient, material, and heat transfer and mediate geo-morphological changes.

A suite of interacting factors that can be divided into two groups affects loss and degradation of ecosystems: direct

Figure 1. **A cross sectional view of the overlapping biophysical, economic, institutional and organizational boundaries in a coastal area.**



drivers and indirect drivers. The *direct drivers* (or proximate drivers) of loss and degradation of coastal zone ecosystems includes:

- **Loss, fragmentation and degradation of habitats**, primarily by land use changes, such as conversion to agriculture or settlement areas;
- **Overexploitation of resources** for livelihoods and commercial purposes;
- **Pollution**, mostly by nutrient enrichment from land-based activities, such as use of chemical fertilizers and discharge of domestic sewage, but also from toxins such as pesticides and hazardous chemicals;
- **Introduction of alien invasive species** and their rapid and uncontrolled spread (i.e., a form of biological pollution); and
- **Anthropogenic climate change and sea level rise**, which interacts with the previous factors listed, generally reinforcing their impacts.

Following are major **indirect drivers** (i.e., ultimate or root causes) that underlie the proximate causes:

- **Population expansion** – increase of populations is followed by increased demands for resources;
- **Distribution of wealth and social inequalities** – the poor often must emphasize survival over sustainability, while the wealthy are far removed from the consequences of overexploitation of resources, leading to degradation of natural systems;
- **Policy failure** – policies that do not take into account the inherent characteristics of ecosystems permit their unsustainable exploitation (e.g., policies on land tenure are especially responsible for changing the manner in which land and biological resources are used);
- **Market failure/distortions** – ecosystem goods and services mostly bypass markets and thus are often undervalued and underpriced, so the costs of environmental destruction are not reflected in the market;
- **Globalization** – trade and market liberalization have created a global system in which commodities and their prices are highly influenced by international pressures that do not usually take local and regional environmental impacts of production into account; and
- **Poor development model** – a development model that equates increased consumption rates with growth and advancement.

1.1 Purpose and Scope of Integrated Land and Sea Use Planning in Manila Bay

One of the key issues facing governments throughout the East Asian Seas (EAS) region is the impact of climate change, variability and extremes, particularly in coastal areas. Manila Bay is no exception, with incidents of flooding, storm surges, saltwater intrusion and erosion occurring with increasing frequency or heightened intensity. Of special concern is the threat of sea level rise in the Bay area and its effects on infrastructure as well as social and economic development in the area. The **Manila Declaration**, which was signed by the Ministers and Senior Government Officials from the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) Partner Countries in December 2009, called for countries of the region to strengthen and accelerate the implementation of integrated coastal management (ICM) for sustainable development and climate change adaptation in coastal areas of the region. In Manila Bay, the Department of Environment and Natural Resources (DENR) – River

Basin Coordinating Office (RBCO), Coastal and Marine Management Office (CMMO) and Manila Bay Coordinating Office (MBCO), and PEMSEA have been working with local government units (LGUs) to scale up the implementation of ICM around the Bay's coastline, building on the experience of ICM programs in the Provinces of Bataan and Cavite.

One of the major thrusts of ICM development and implementation is the preparation of an integrated land and sea use plan. This calls for the conduct of coastal use zoning, which will serve as a guide in the preparation of a plan and regulatory system to allocate the appropriate zones and corresponding uses of the coastal and marine area. Coastal use zoning is based on the functional capability and suitability of coastal waters and land as to the desired uses, the development envisioned by the stakeholders, existing policies and ecological, cultural and traditional considerations. The zoning process is a socio-political matter requiring scientific and technical inputs, involving multi-sector participation and extensive consultation with concerned stakeholders in order to reach consensus on the various zones and their corresponding uses.

A major gap in previous meetings and consultations concerning the sustainable development of Manila Bay is the lack of existing and projected impacts of climate change, variability and extremes on the area. Similarly, inputs to the development of integrated land and sea use plans by the local governments in Bataan and Cavite have been lacking guidance and information on changes that are expected to occur because of sea level rise, as well as other potential impacts of climate change (e.g., more intense rainfall or more intense storms). To address this gap, "macro-scale" land and sea use zones for Manila Bay will be prepared with a specific focus on the different scenarios for sea level rise, flooding and storm surges as a consequence of climate change, variability and extremes in the coastal areas over the next 50 years.

This document will provide information on climate change, variability and extremes and sea level rise, as inputs to the coastal land and sea use planning and zoning along the Manila Bay area. The physical boundaries of the coastal area to which the Coastal Land and Water Use Plan applies is governed by the Philippine Fisheries Code of 1998 (Republic Act 8550), which defines the coastal area as:

> *"a band of dry land and adjacent ocean space (water and submerged land) in which terrestrial processes and uses directly affect oceanic extent within a landmark limit of one (1) kilometer from the shoreline at high tide to include mangrove swamps, brackish water ponds, nipa swamps , estuarine rivers, sandy beaches and other areas within a sea ward limit of 200 meters isobaths to include coral reefs, algal flats, seagrass beds and other soft-bottom areas."*

1.2 Approaches and Methodology

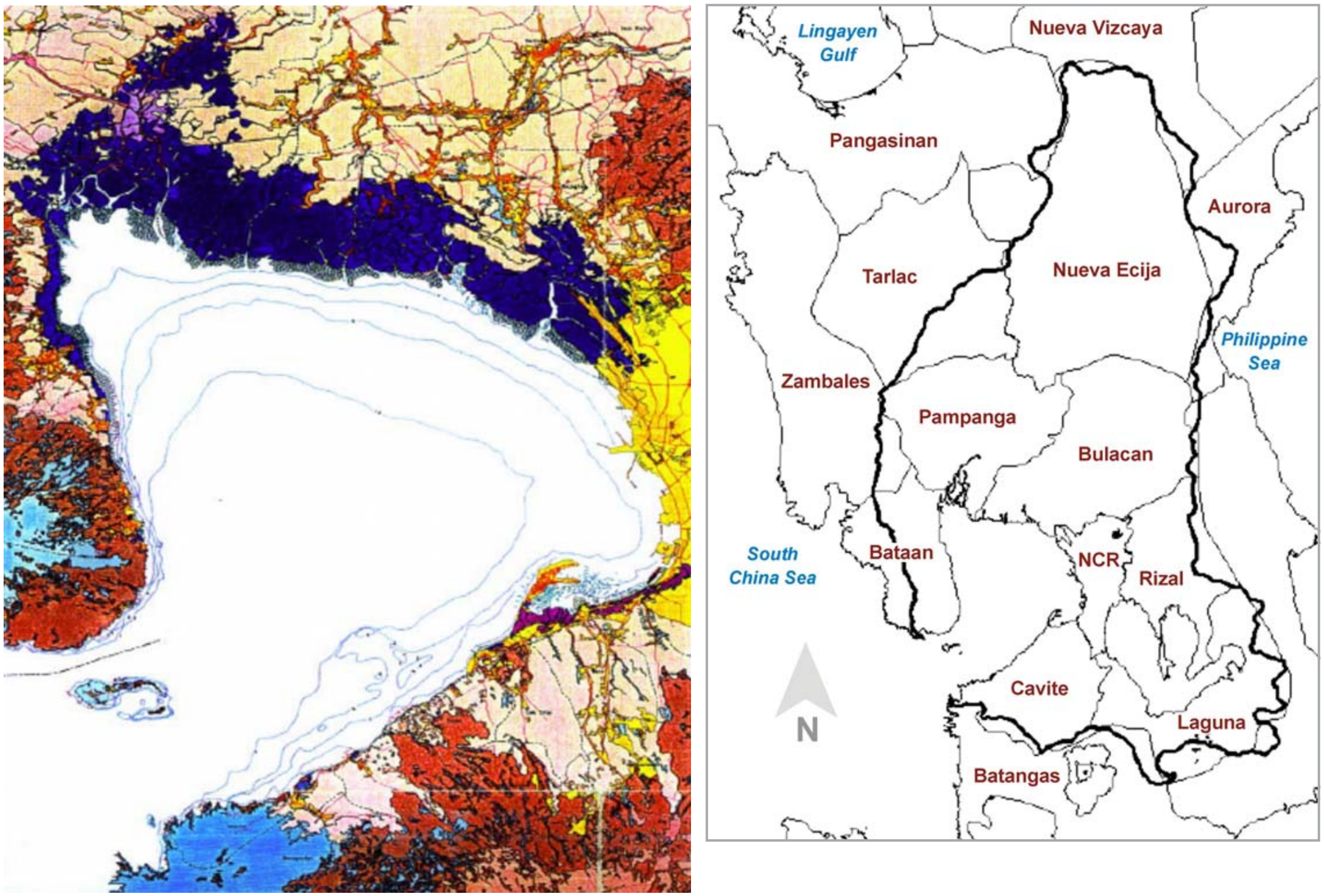
Coastal use zoning is a process of delineating the coastal areas into land and sea use zones, designating permitted, prohibited and conditional uses. It provides efficient mechanisms for allocating coastal space for appropriate uses based on the suitability with environmental, social and economic conditions, and compatibility with sustainable development objectives and principles, and with policies and legal requirements. It also presents a framework for resolving multiple use conflicts. Coastal use zoning likewise provides a regulatory framework for permitting and prohibiting human activities according to the designated use of coastal space.

The Coastal Land and Sea Use Zoning Plan is considered to be a tool to improve the use of coastal resources. It incorporates the context within which it operates; the mechanism required to assess, evaluate and monitor the outcomes; and the process through which these could be attained. It is based on certain principles which promote its effectiveness, responsiveness and acceptability to key stakeholders and which guide the integration and/or modification of existing land use plans for the sustainable

Figure 2. The Manila Bay coastal and watershed areas.

Figure 2a

Figure 2b



Source: BFAR,1995.

development of the coastal area as well as the adjacent watersheds and marine areas. Land use planning decisions about how an area grows lock people into development patterns that continue for many years. Where climate change is concerned, the broad uncertainties around key climate change outcomes, combined with uncertainty about socioeconomic trends (Corfee-Morlot, et al., 2009), place an emphasis on the need for careful risk management strategies to be integrated into the present decisionmaking process.

The situational analysis for this project will take into account existing and future hazards and exposure in the watershed and coastal areas, primarily on the flooding potential at the whole watershed-to-coastal area (or "ridge to reef" approach), to diagnose the factors affecting Manila Bay. The bold black line in Figure 2b indicates this boundary.

Inclusion of climate change considerations into coastal land and sea use planning are for the purposes of coming up with climate change actions consisting of two distinct but related components: (1) control of greenhouse gas emissions ("mitigation"); and (2) adaptation to predicted major climatic changes, including increased drought periods, increased heavy rainfall spells, and more storm surges.

Characterizing Manila Bay

Manila Bay is an almost land-locked bay facing the West Philippine Sea (also known as South China Sea), and covers an approximate area of 1,800 km^2. Major economic zones, financial and commercial centers can be found in cities and municipalities around the Bay. It is a major transport hub with the presence of major domestic and international airports and seaports. Manila Bay is bounded by the coastal municipalities and cities of the National Capital Region (NCR – Manila, Pasay City, Parañaque, Las Piñas and Navotas) and of the provinces of Bataan, Bulacan, Pampanga and Cavite (**Figure 2**). The towns bordering the Bay account for roughly 2,178.65 km^2 of land area. Also within the watershed of Manila Bay are the non-coastal provinces of Nueva Ecija and Tarlac in

Table 1. Characterization of the Manila Bay Coastal Area.

Zone	Location	Description
1. Brushland /Industrial	Southern Bataan (Mariveles and vicinities)	Coral reefs, seagrass and seaweeds
2. Urban/Aquaculture/ Agriculture	Bataan (from Limay and northwards)	Urban centers amid agricultural and aquaculture activities
3. Aquaculture and agriculture environment	Coastal Pampanga (Pasac River and environs)	Main drainage system for Central Luzon
4. Extensive aquaculture and agriculture environment	Coastal Bulacan (Tibaguin and Pamarawan River and environs)	Natural spawning area large tracts of fishponds
5. Aquaculture/ Industrial	Eastern Bulacan (Meycauayan and eastward)	Highest population of fisherfolk
6. Highly urbanized and industrialized areas	NCR, Navotas and environs, Pasig River area, Parañaque River area	Natural spawning area, Extensive aquaculture, Industrial areas, and Special economic zone
7. Extensive open-water aquaculture and urbanized environment	Northern Cavite (Bacoor and vicinities)	Productive aquaculture Commercial and residential areas
8. Limited aquaculture/ Extensive agricultural/ tourism	Southern Cavite (Rosario to Ternate)	Limited aquaculture activities
9. Natural environment	Southern Cavite	Mountainous terrain, Large agriculture areas inland
10. Island environment	Corregidor	Coral reefs, seagrass and seaweed

Source: MBEMP, 2001.

Region 3, Laguna and Rizal in Region 4, and the non-coastal municipalities and cities of NCR (Caloocan City, Quezon City, Malabon, Makati, Mandaluyong, Marikina, Muntinlupa, Pasig, San Juan, Pateros, Taguig and Valenzuela). The Pasig River Basin (9,000 km^2) and the Pampanga River Basin (3,900 km^2) — two major catchment areas — make up more than 75 percent of the watershed of Manila Bay.

There are at least ten identified zones along the Manila Bay coastal area. The details of their location and description are given in **Table 1**.

2.1 Socioeconomic Profile

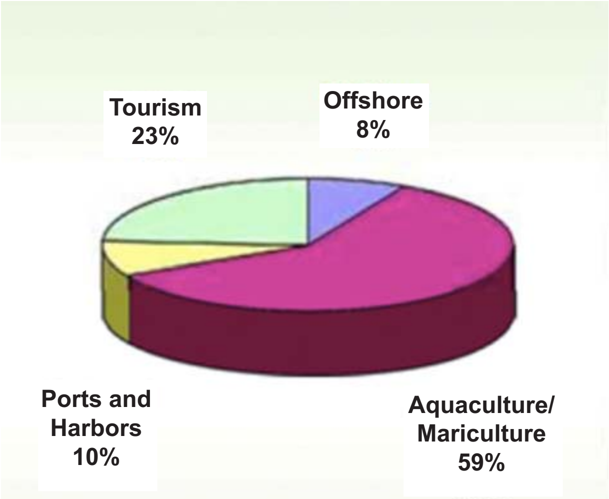
An economic valuation study (2005) of the uses of Manila Bay's resources (i.e., fisheries, aquaculture, tourism and shipping), as well as the benefits derived from key habitats (i.e., mangroves, mudflats and coral reefs), revealed a total value of more than P8 billion per year. Although this amount represents a partial assessment of the total economic value of Manila Bay, such information signifies that the Bay is a valuable resource that must be protected and managed sustainably. It is also a warning of what could be lost if concerted actions are not taken. An initial valuation of damages to the ecosystems of Manila Bay, and the resulting social and economic impacts, also completed in the 2005 study, amounted to PhP4 billion per year, about half of the total use value, primarily as a consequence of human activities in the coastal and watershed areas. The distribution of the economic values of important sectors around Manila Bay is illustrated in **Figure 3**.

Population

On the demographic side, maps of population density for 2007 (**Figure 4**), reveal that the highest number of persons per square kilometer are mostly in NCR, Bulacan and Cavite, with a few municipalities/cities exhibiting the same in Pampanga and Bataan.

In terms of poverty incidence[1] (**Figure 5**), all of NCR and some contiguous municipalities/cities of nearby provinces have low rates. Highest poverty incidence is found to occur further away from the NCR. Average poverty

Figure 3. Initial estimates of the economic values of Manila Bay.



Source: PEMSEA and DENR, 2005

[1] Poverty incidence refers to the proportion of families/individuals with per capita income/expenditure less than the per capita poverty threshold to the actual families/individuals (1997 Philippine poverty statistics, NSCB). This map was generated using the NSCB official statistics on the 2003 provincial poverty incidence of the Philippines.

Figure 4. Population density around Manila Bay (Manila Observatory, 2011).

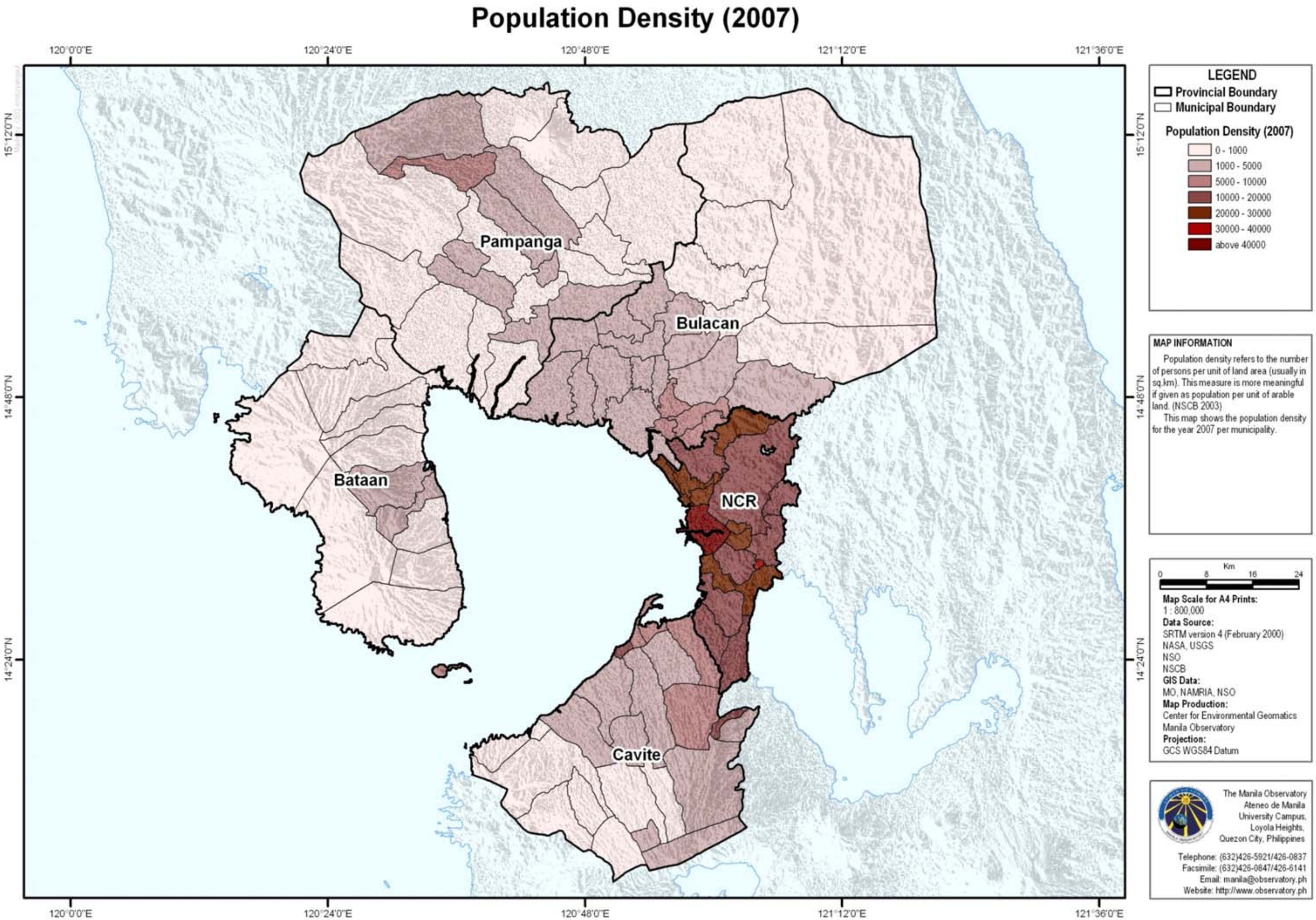
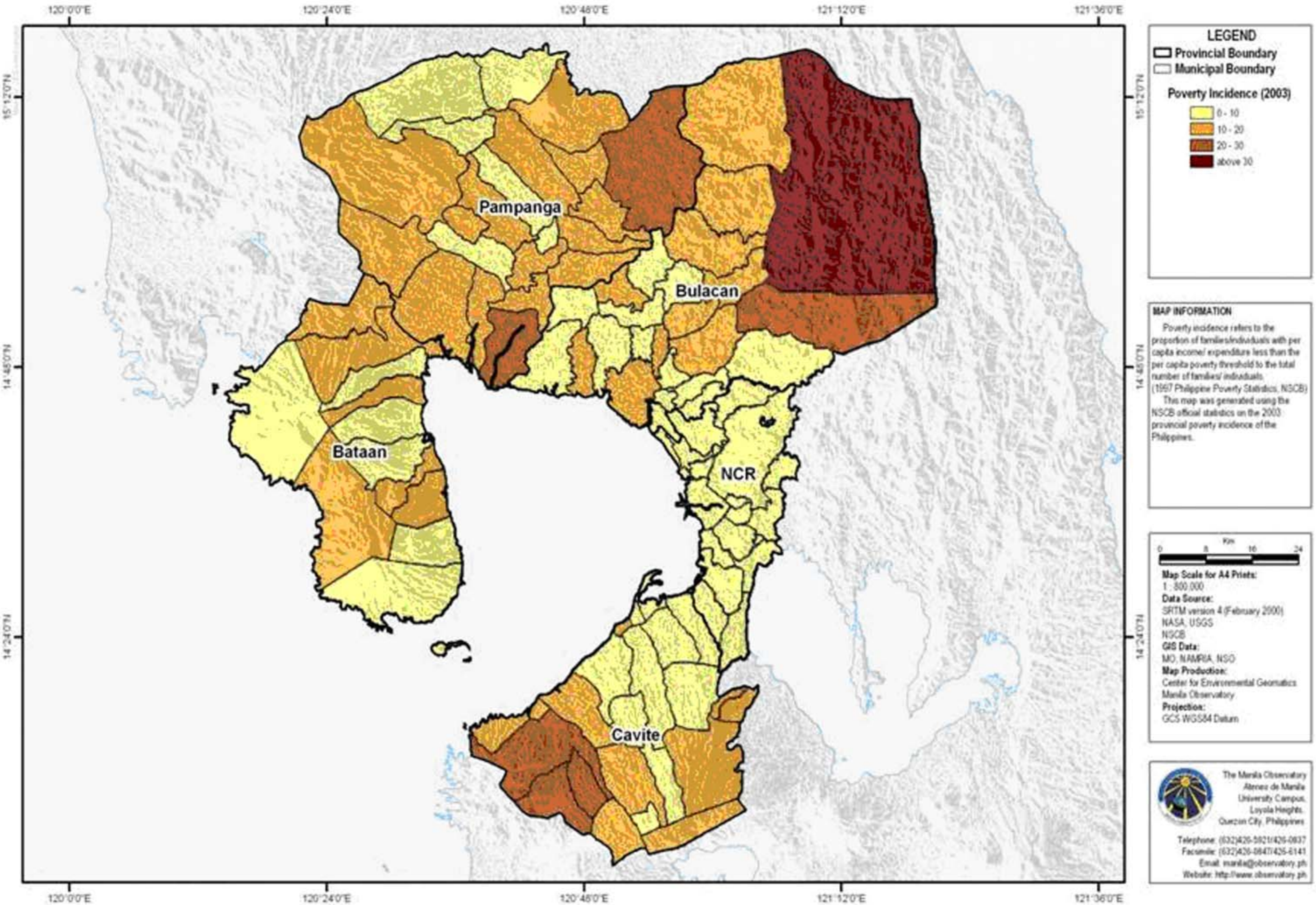


Figure 5. **Poverty Incidence (2003).**



incidence is found highest in Pampanga. Maximum and minimum rates are highest in Pampanga, followed by Bataan and Cavite.

Rivers, Major Roads, Bridges and Flood Control

In terms of major rivers, the first map in **Figure 6** indicates those that have been identified in the Philippine Biodiversity Conservation Priorities (DENR, 2002). The second map shows those resulting from the application of a hydrological model based on the SRTM 90 m. SRTM stands for Shuttle Radar Topographic Mission under the NASA (National Aeronautics and Space Administration). It produced a digital elevation model (DEM) of 90 m spatial resolution (the smallest detectable unit), where a picture element (or pixel) represents elevation at every 1 m increment. It is said that there are about 131 rivers that cross the coastal municipalities/cities and drain towards Manila Bay (Perez, et al., 1999).

The map of bridges and major roads (**Figure 7**) shows the network of physical infrastructure in the contiguous provinces located around the Manila Bay area. It was verified using Google Earth satellite imagery covering the PEMSEA Study Area. There is also the Effective Flood Control Operation System or EFCOS (**Figure 8**), which is said to be overseen by the Department of Public Works and Highways (DPWH). Its goal is effective flood control within the Pasig–Marikina–Laguna Lake complex as a realization of the Metro Manila Flood Control Master Plan, which encompasses the Manggahan Floodway and the Napindan Hydraulics Control Structure. The EFCOS and flood monitoring function were subsequently turned over to the Metro Manila Development Authority (MMDA). The Pampanga River Basin is covered by the flood forecasting and warning services of PAGASA (or the Philippine Atmospheric, Geophysical and Astronomical Services Administration).

Figure 6a. **Major river systems in the watershed (DENR, 2002).**

Rivers

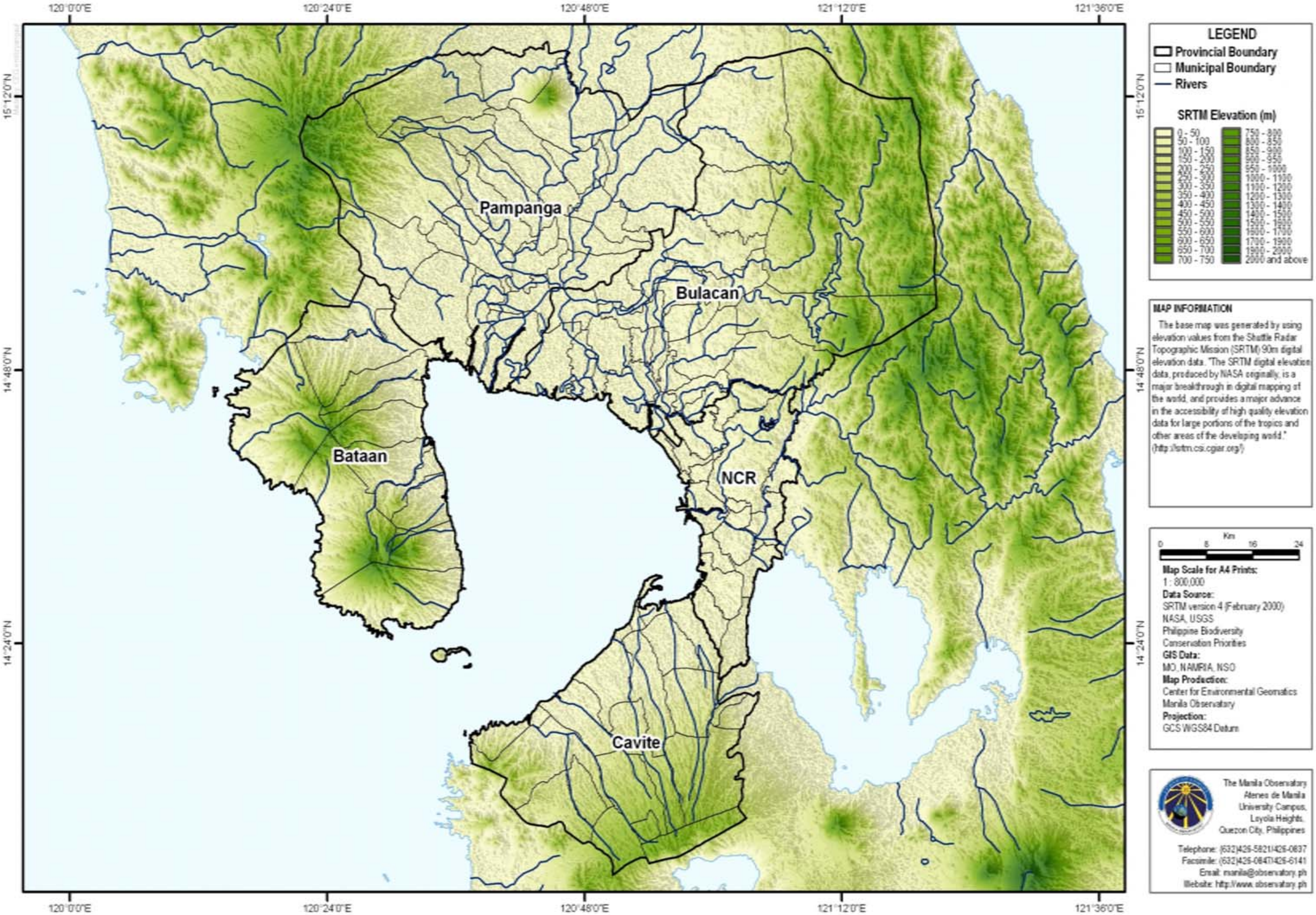


Figure 6b. Major river systems in the watershed (SRTM generated).

Rivers

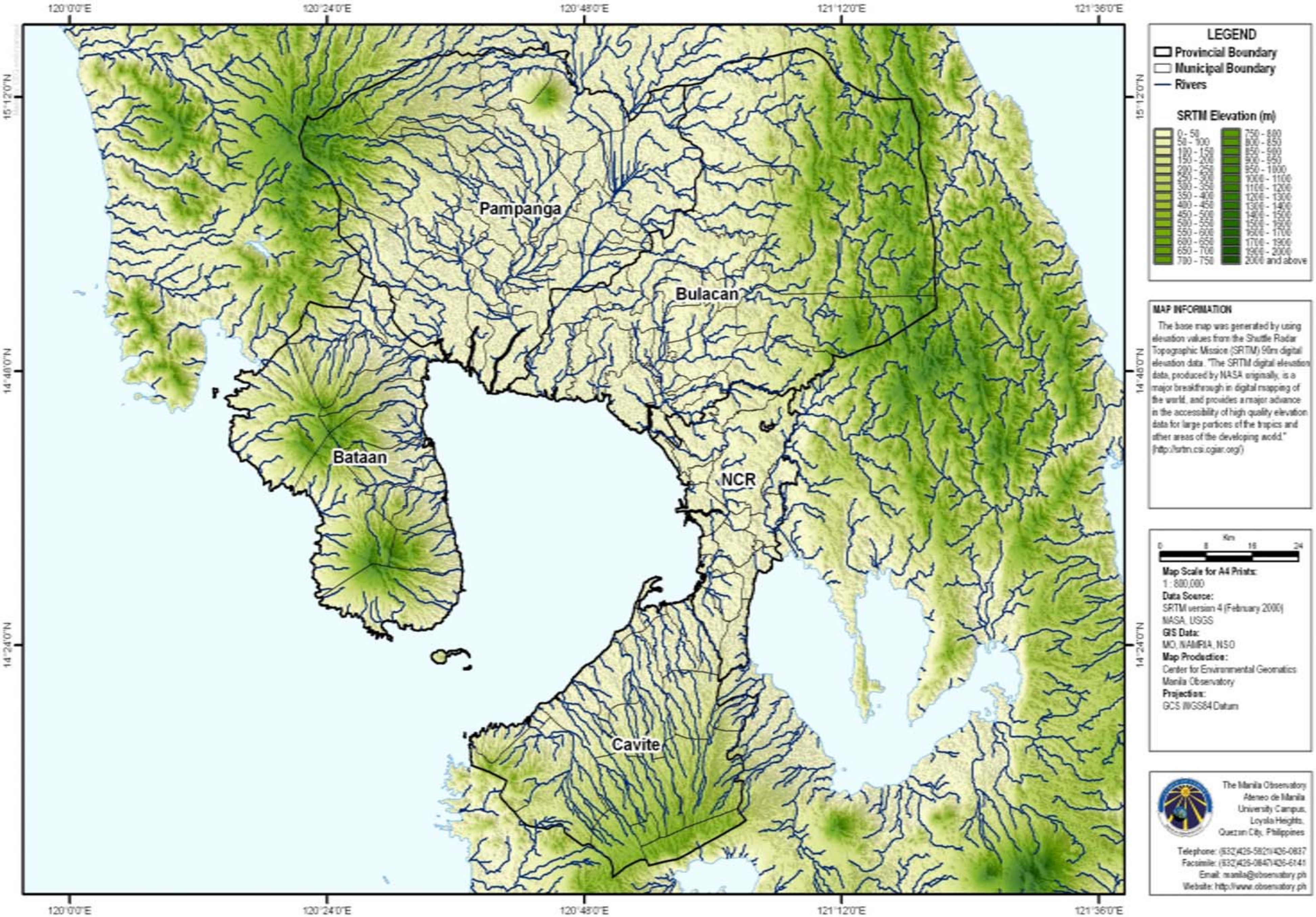


Figure 7. **Major road networks and bridges.**

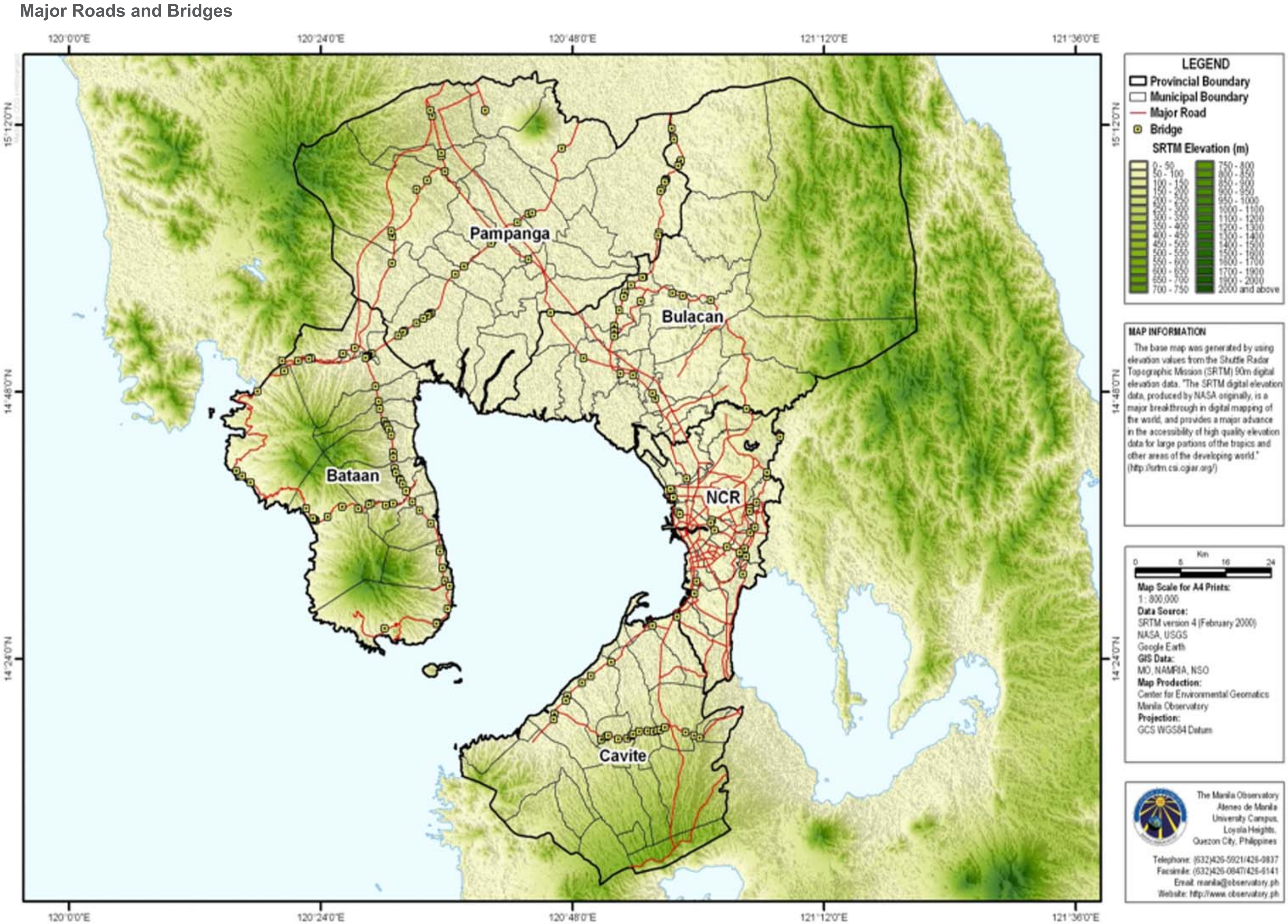
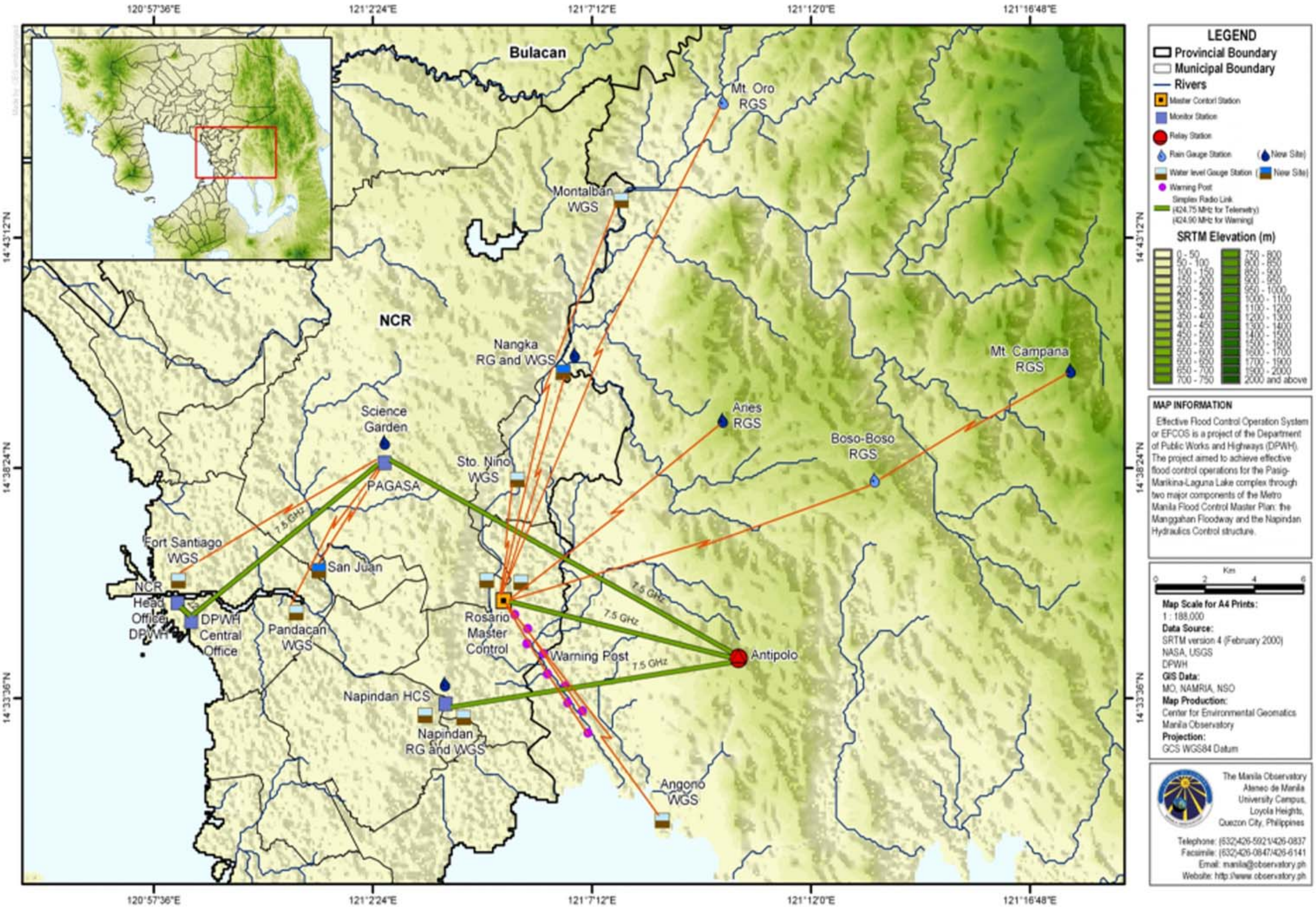


Figure 8. **Flood control operation systems.**

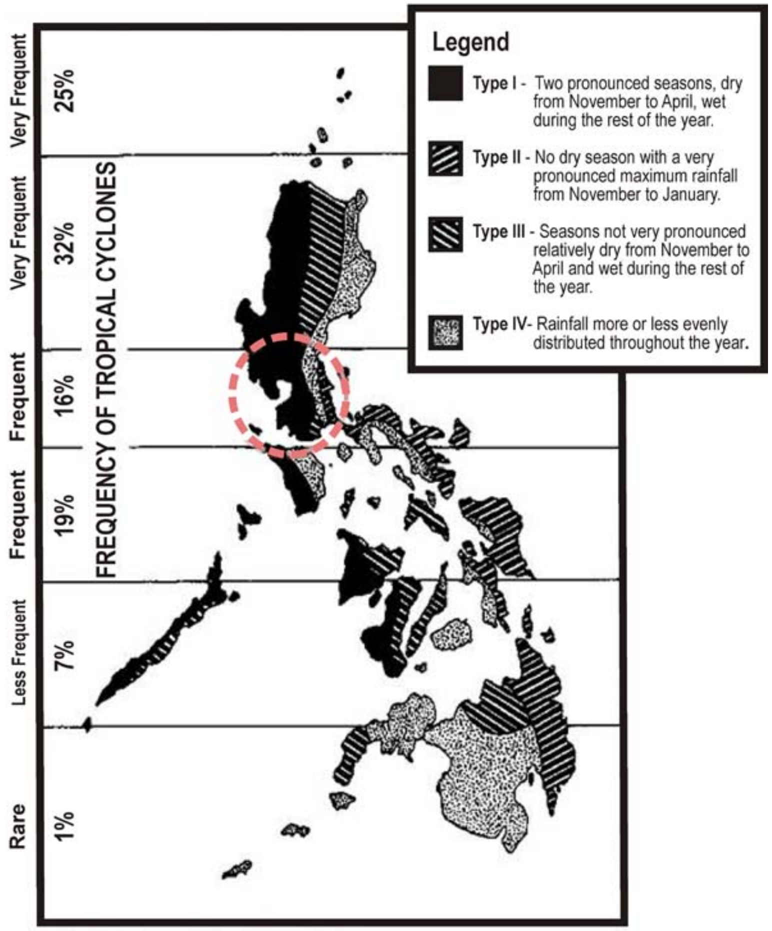
EFCOS (Effective Flood Control Operations System)



2.2 Baseline Climate

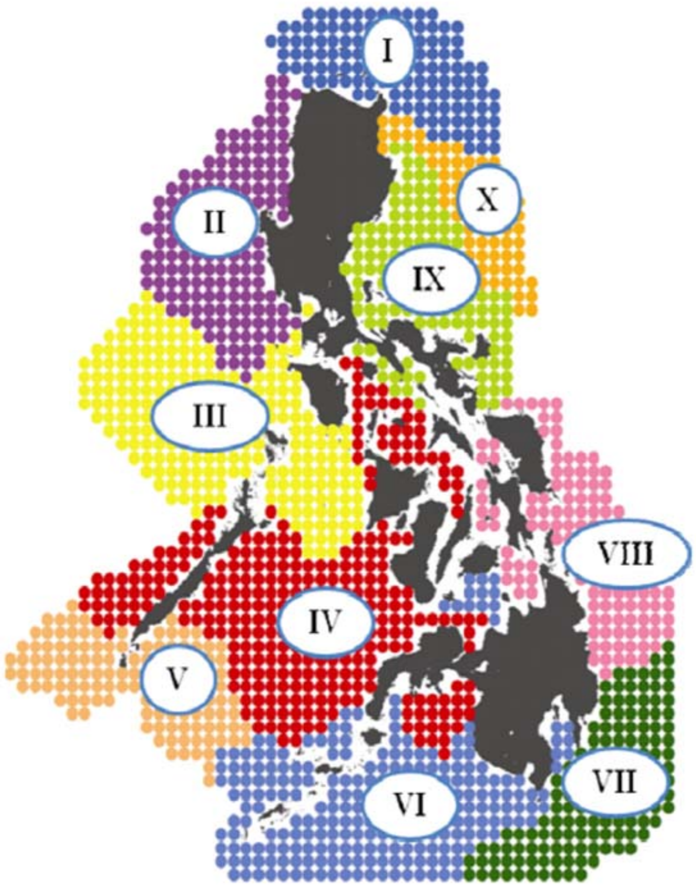
The climate along the land area of Manila Bay is under Type 1 in the Modified Coronas Classification. It has distinct tropical dry (November to April) and wet (rest of the year) seasons. About 16 percent of total tropical cyclones in the Philippines cross the area as shown in **Figure 9a**.

Figure 9a. Climate map of the Philippines according to modified Coronas Classification, and tropical cyclone frequency.



David, et al., (2011) developed a climate exposure characterization of the waters around the Philippines, where 12 zones were defined according to rainfall, wind and sea surface characteristics. As shown in **Figure 9b**, the water around Manila Bay is classified either as Type II (northern portion) or Type III (the southern portion), including around Corregidor Island. Sea surface temperature is cooler during El Niño and warmer during La Niña. Rainfall is very pronounced during the SW monsoon.

Figure 9b. Climate exposure of the waters around the Philippines (David, et al., 2011)**.**



Temperature

In **Figure 10a**, mean temperatures from 1951 to 2010 are observed to increase relative to the reference 30-year average (normal) temperature (1971 to 2000), shown by the zero line beginning in the latter half of the 1980s at the Port Area weather station. The same trend is seen with the observations from the Science Garden located in Quezon City.

Individually, though in the same period as above, the increase in average daytime (maximum) temperatures are smaller than the increase in average nighttime (minimum) temperatures for both sites, as shown in **Figures 10 and 11**. Comparing coastal and inland nighttime temperatures, it can be seen in Figures 11a and 11b that it is generally warmer near the coast but very variable year after year, as shown by large temperature differences from the normal. However, the inland nighttime temperature is seen to be steadily rising albeit in a more gradual way from year to year.

Also shown in these graphs are moving averages. The red line in the graph shows a five year moving average. A moving average is commonly used with time series data to smooth out short-term fluctuations and highlight longer-term trends or cycles. Mathematically, a moving average is an example of a low-pass filter used in signal processing and can be viewed simply as smoothing the data to see if there is a noticeable trend all throughout the period of study.

Figure 10a. **Difference of annual mean temperature (1951 to 2010) from the 30-year average (normal) mean temperature (1971 to 2000), for Port Area, Manila.**

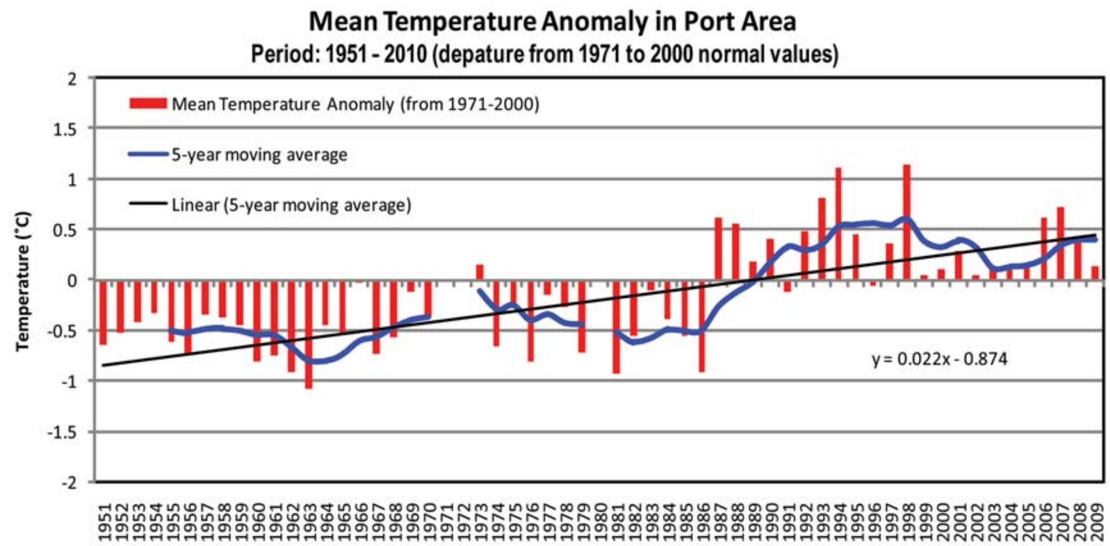


Figure 10b. **Difference of annual mean temperature (1951 to 2010) from the 30-year average (normal) mean temperature (1971 to 2000) for Science Garden, Quezon City.**

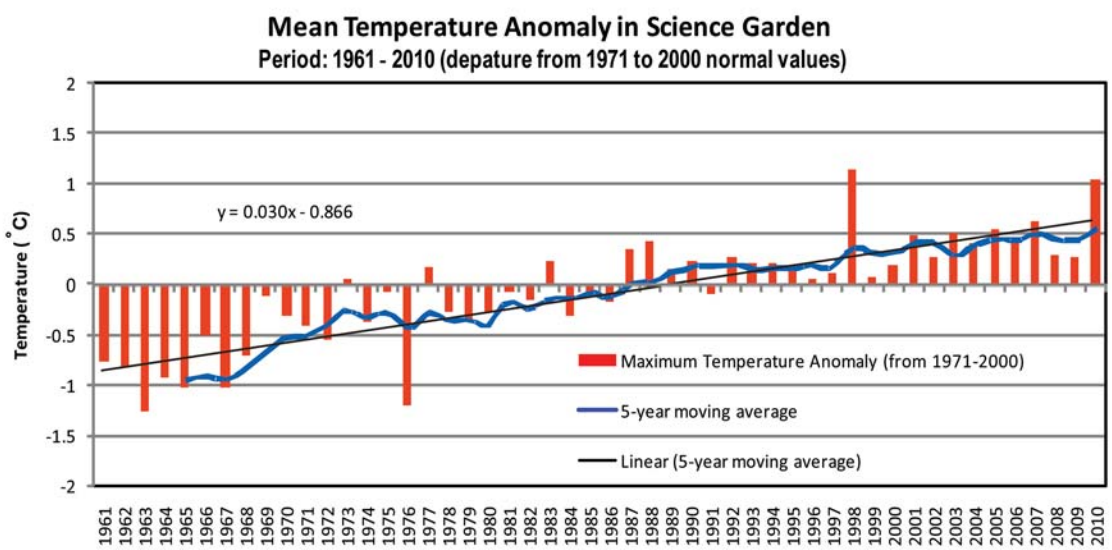


Figure 11a. **Difference of annual average maximum temperature (1951 to 2010) from the 30-year average (normal) mean temperature (1971 to 2000), for Port Area, Manila.**

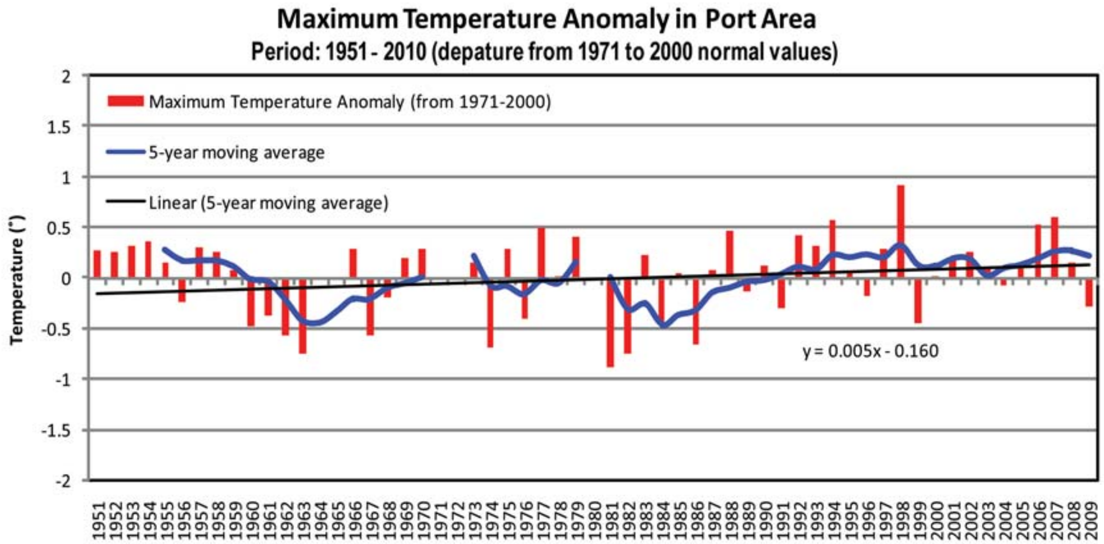


Figure 11b. **Difference of annual average maximum temperature (1951 to 2010) from the 30-year average (normal) mean temperature (1971 to 2000), for Science Garden, Quezon City.**

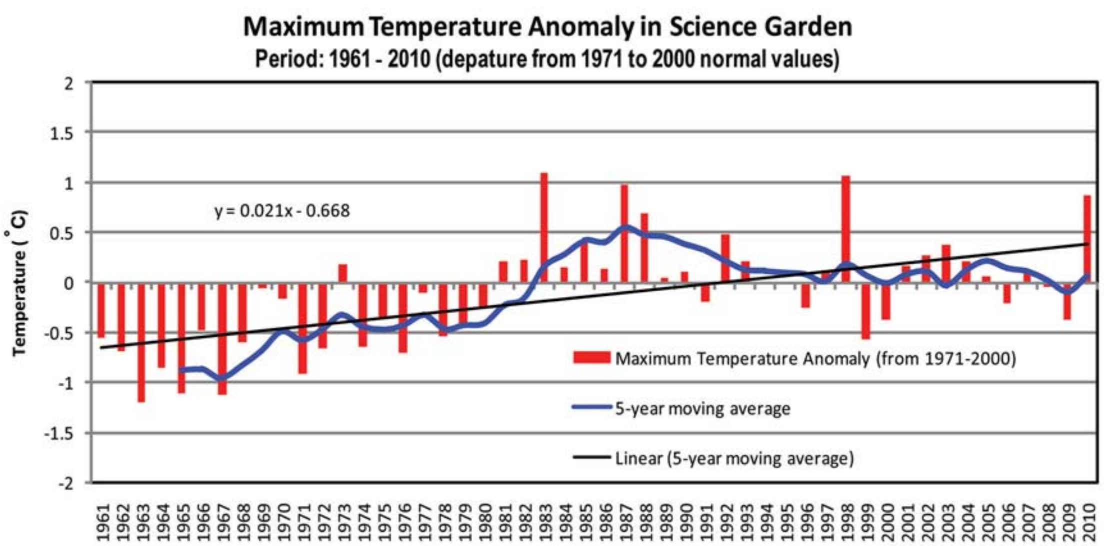


Figure 12a. Difference of annual average minimum temperature (1951 to 2010) from the 30-year average (normal) mean temperature (1971 to 2000), for Port Area, Manila.

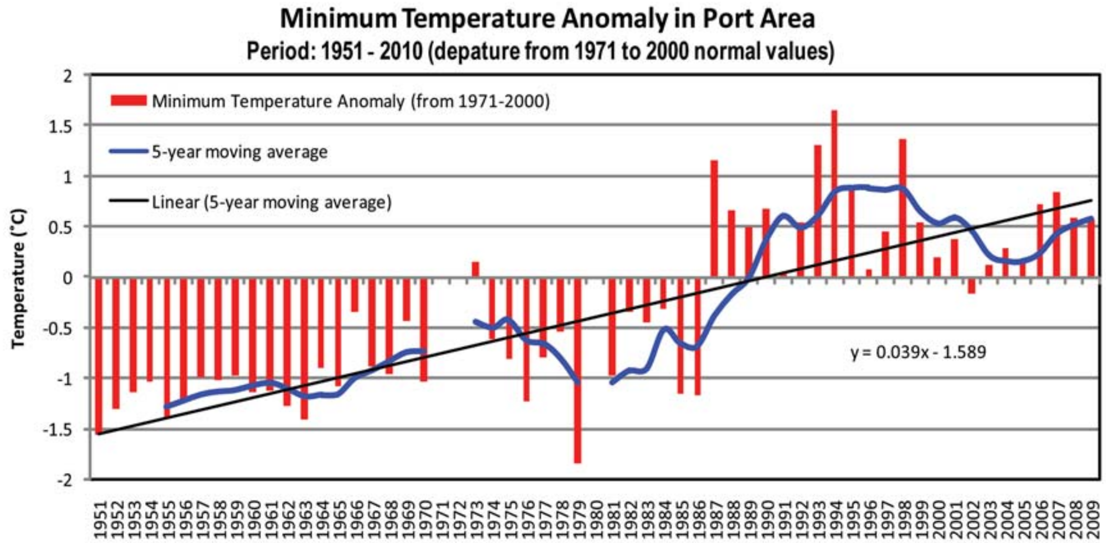


Figure 12b. Difference of annual average minimum temperature (1951 to 2010) from the 30-year average (normal) mean temperature (1971 to 2000), for Science Garden, Quezon City.

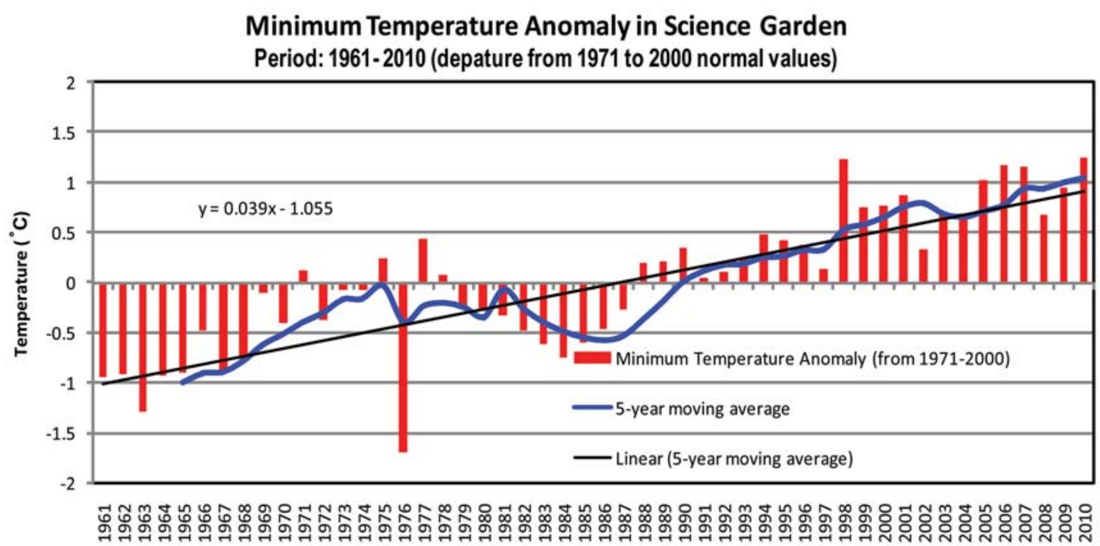
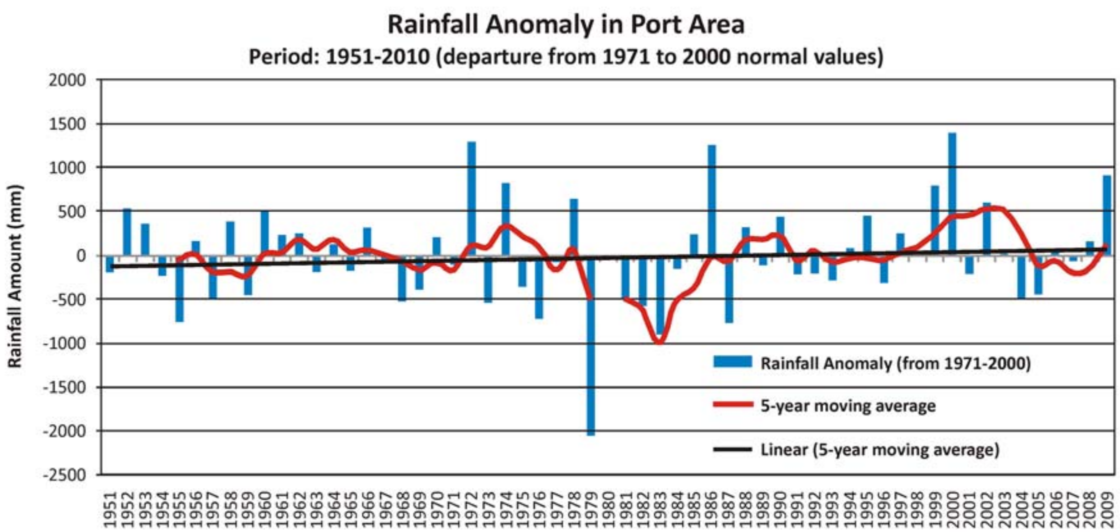
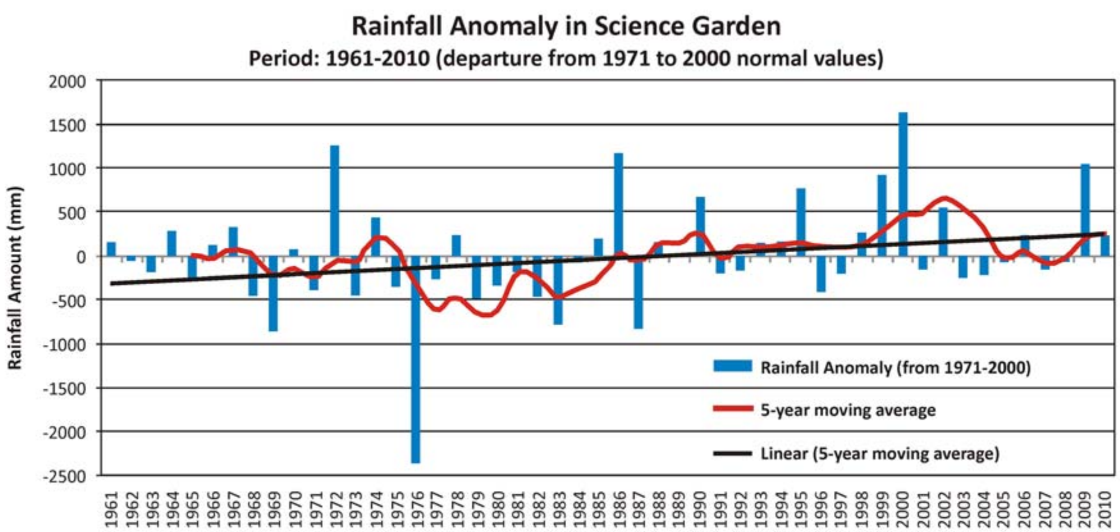


Figure 13a. Difference of Annual Rainfall from 1951 to 2010 from the normal (1971–2000) in (a) Port Area, Manila, and (b) Science Garden, Quezon City.





Rainfall

Rainfall is highly variable from year to year as indicated by observations in both sites (**Figure 13**). Very dry and very wet years are not the same for the two locations. The zero line indicates the normal or 30-year average annual rainfall. There is no statistically significant trend, instead, year to year variation is marked by extremes. For the years before 1995 the magnitude of decrease in rainfall appear to be more frequent and higher than the positive changes. But after that point, positive changes are more noticeable.

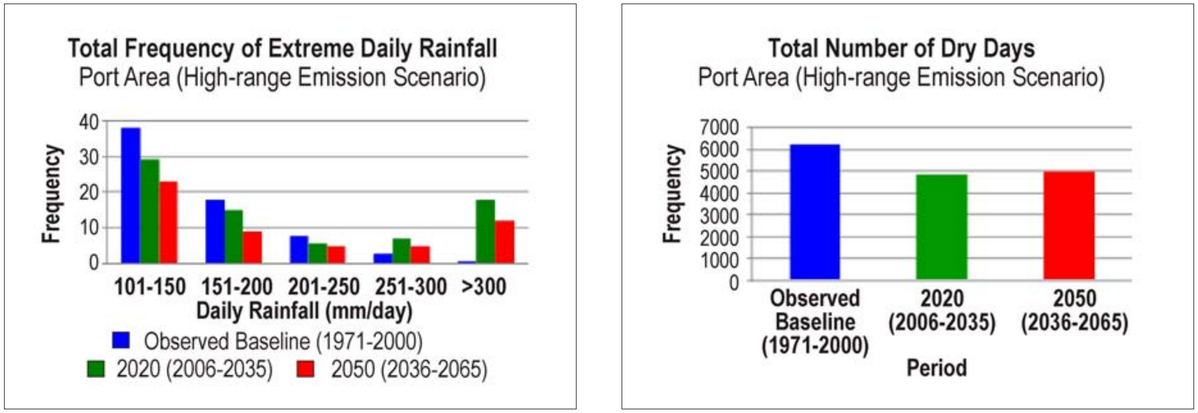
Extreme Rainfall

The number of days with extreme rainfall events (defined as a day with 100 mm or more of rainfall) as observed from 1971 to 2000 are shown in **Figures 14a** for Port Area and **14b** for Science Garden. The graphs basically result from counting the days with rainfall between the intervals of: 101 to 150 mm, 151 to 200 mm, 201 to 250 mm, 251 to 300 and greater than 300 mm. For both stations, it is observed that the more frequent extreme rainfall events occur for rainfall between 101 to 150 mm, as indicated by the blue bars. It can be seen that more more days with between 101 to 150 mm of rainfall were observed in the inland station in Science Garden than the coastal station in Port Area. However, days with rainfall greater than 150 mm were observed more frequently in Port Area than in Science Garden.

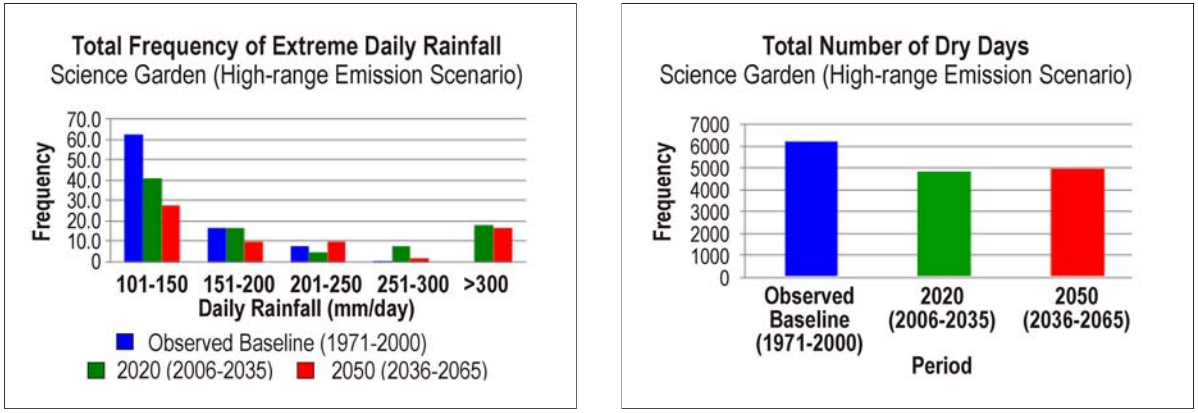
The total number of dry days are counts of days with zero rainfall. From the records, these counts corresponded to around 7,380 and 7,476 days for Port Area and Science Garden between the years 1971 to 2000. The graphs also show the projected rainfall in a high climate change emission scenario. The details of these projections will be discussed further in later sections.

Figure 14. Frequency of extreme daily rainfall events and the total number of dry days for the: (a) Port Area, Manila; and (b) Science Garden, Quezon City.

(a) Port Area, Manila



(b) Science Garden, Quezon City



2.3 Major Environmental Issues and Challenges

Coastal Hazards

> *"As the coasts become increasingly populated, more and more people are placed in harm's way. Thus far, science has not found effective ways to reduce most hazards. Therefore, citizens must look to strengthening communities. Building safer buildings and strengthening infrastructure are important steps, but it is the manner in which societies are built that largely determines disaster resilience. A vital part of effective disaster planning — whether for mitigation, preparation, response, or recovery — is an understanding of the people and institutions that make up each community, including their strengths and their weaknesses, as a basis for developing policies, programs, and practices to protect them. In the end, it is human decisions related to such matters as land use planning and community priorities that will build stronger, safer, and better communities."*
>
> **— H. John Heinz III Center for Science, Economics and the Environment, 2002**

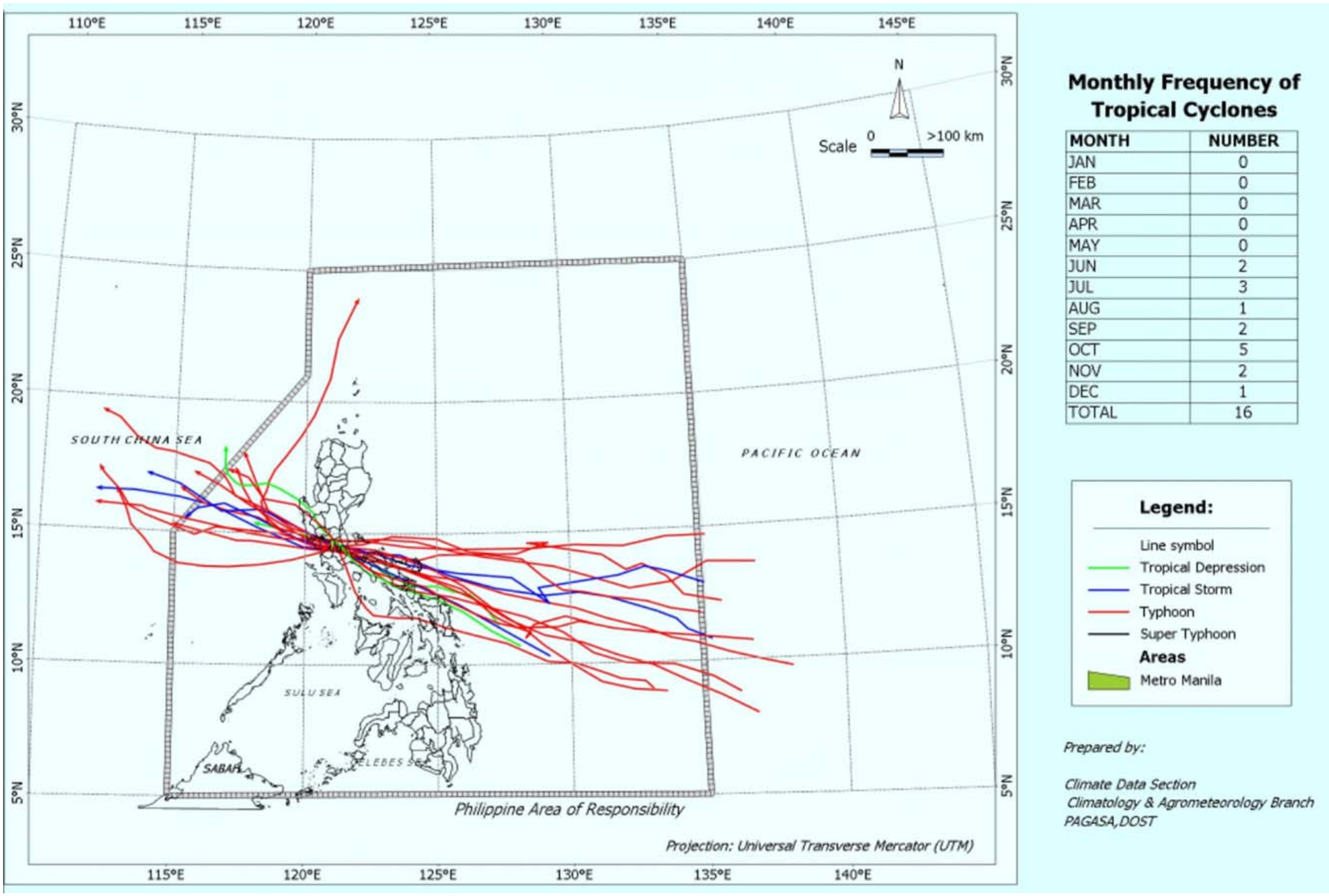
Local governments, which bear the largest responsibility for coastal planning, long have struggled with balancing strong demand for increasing development with protection of fragile environmental and cultural resources. Now these local governments, in a time of diminished revenues, must consider the threats that substantial coastal hazards pose to current planning, existing development, and disturbed ecological systems. These threats include inundation, flooding, enhanced storm surges, loss of infrastructure, destruction of wetlands and beaches, and increased risks for public health and safety. Although taking regulatory initiatives to adapt to predicted future threats can be difficult politically, it also can conserve resources, reduce disaster risks, and protect ecosystems. Intensive development in the coastal zone not only places more people and property at risk to coastal hazards, but it also degrades the natural environment, interfering with nature's ability to protect the human environment from severe hazard events. For instance, seawalls accelerate coastal erosion and inhibit the coast's ability to absorb storm energy, thus exposing buildings and infrastructures to the full force of wind and waves. Development can also destroy wetlands that serve as important buffers against storm surge and other types of flooding. So, while nothing can be done to prevent coastal hazard events, their adverse impacts can be reduced through proper planning.

Tropical cyclones

Coastal storms take many forms and occur throughout the year. All coasts experience storms and are susceptible to storm-related losses. Tropical storms and typhoons are intense tropical cyclones. The main threats associated with these hazards are storm surges, high winds, heavy rain, and flooding, as well as tornadoes. Intense monsoon regimes can also produce rough seas, coastal flooding, and beach erosion. Southwest monsoons along the Manila Bay, between June and September, account for more cumulative damage than typhoons because they occur more frequently and may last for several days. Most coastal erosion and land loss can also be attributed to unusual oceanographic

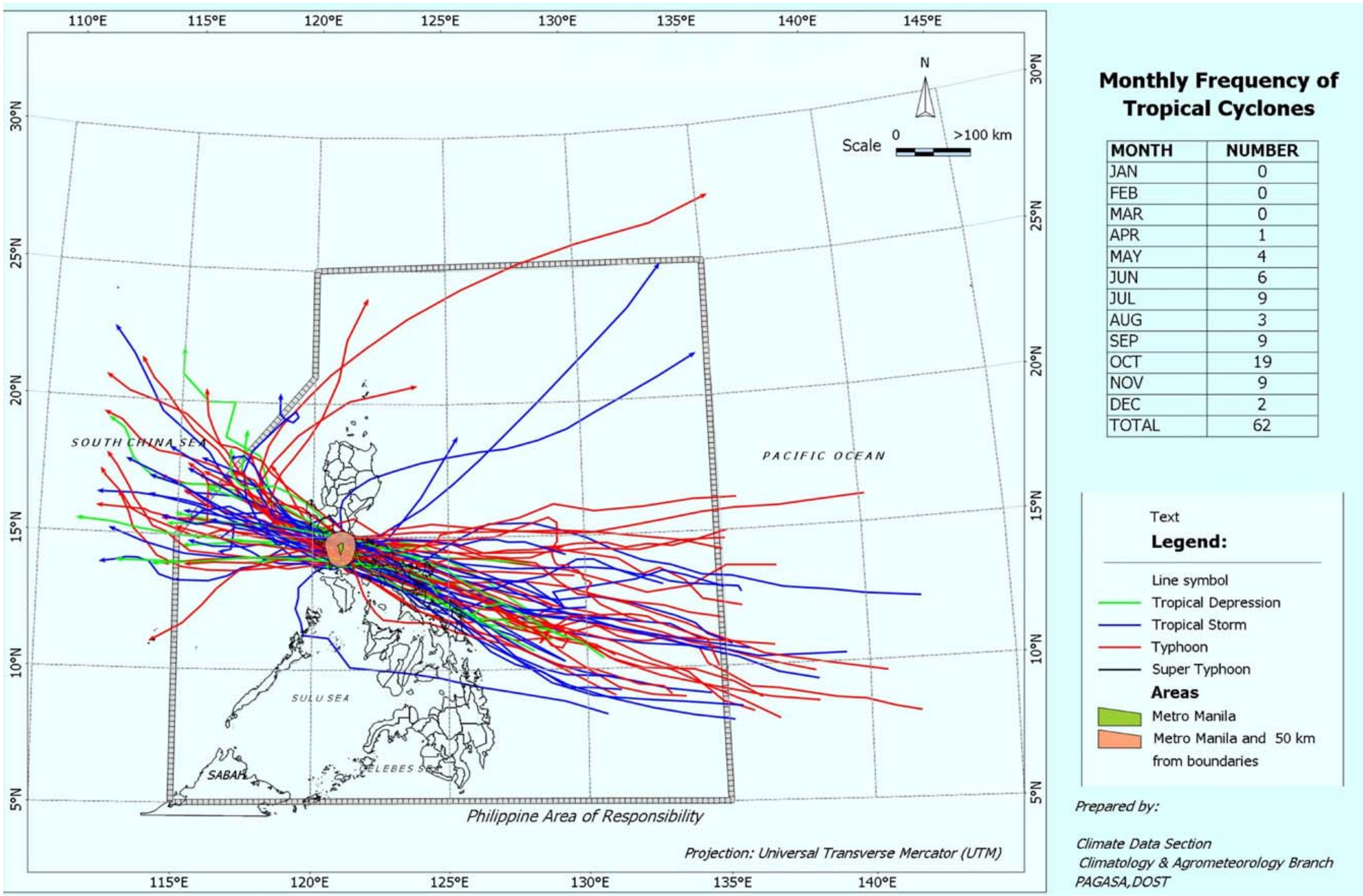
Figure 15. Tropical cyclone frequency.

Tracks of Tropical Cyclones which crossed Metro Manila from 1948–2009.



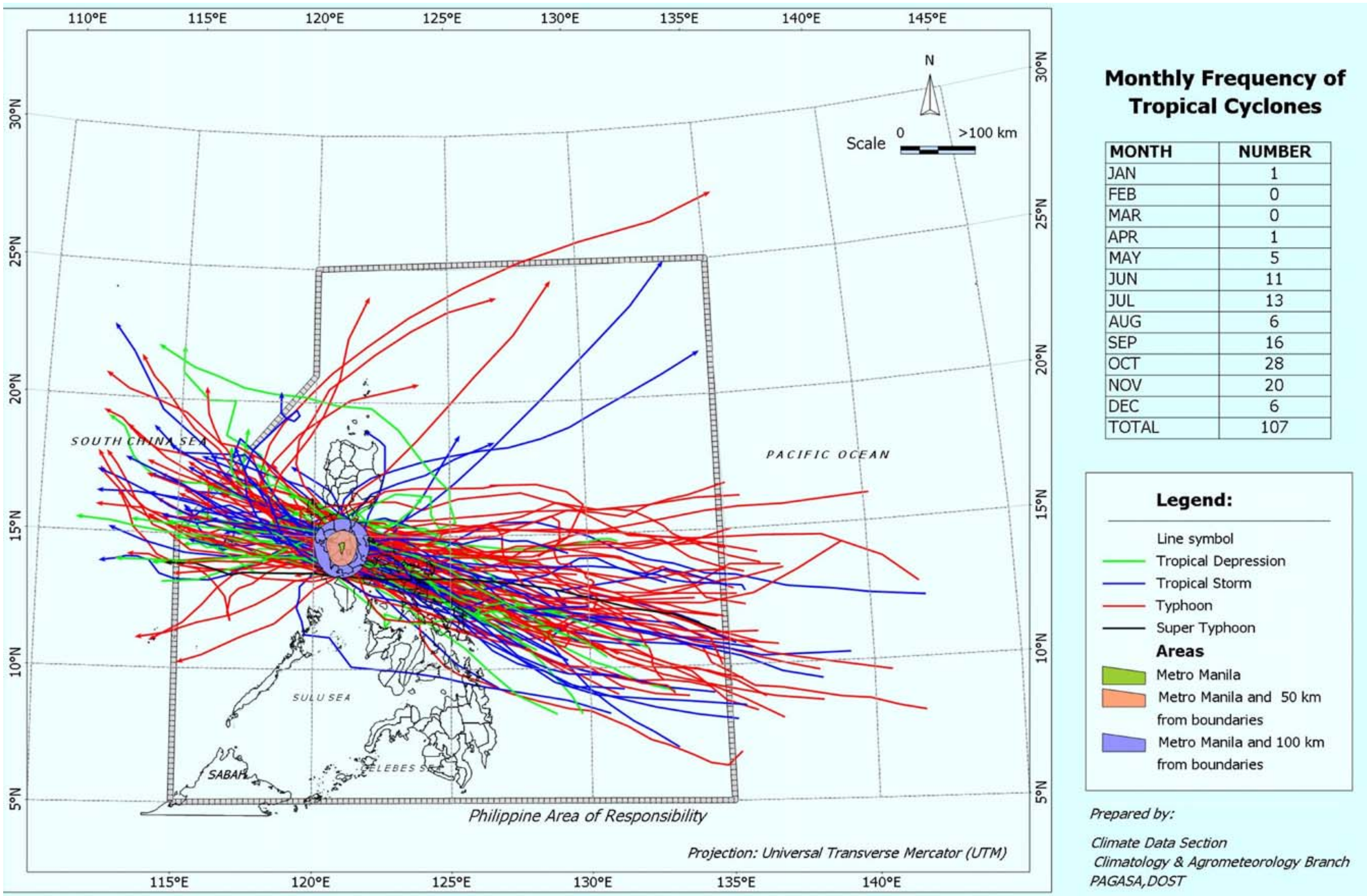
MONTH	NUMBER
JAN	0
FEB	0
MAR	0
APR	0
MAY	0
JUN	2
JUL	3
AUG	1
SEP	2
OCT	5
NOV	2
DEC	1
TOTAL	16

Tracks of Tropical Cyclones which crossed Metro Manila and 50 kilometers from boundaries from 1948–2009.



MONTH	NUMBER
JAN	0
FEB	0
MAR	0
APR	1
MAY	4
JUN	6
JUL	9
AUG	3
SEP	9
OCT	19
NOV	9
DEC	2
TOTAL	62

Tracks of Tropical Cyclones which crossed Metro Manila and 100 kilometers from boundaries from 1948–2009.



MONTH	NUMBER
JAN	1
FEB	0
MAR	0
APR	1
MAY	5
JUN	11
JUL	13
AUG	6
SEP	16
OCT	28
NOV	20
DEC	6
TOTAL	107

conditions, such as ENSO (EL Niño–Southern Oscillation), which occurs every four to five years and has a significant effect on weather patterns, sea levels, and ocean currents.

October is the stormiest month of the year as shown by **Figure 15**. PAGASA's database showed that there were a total of 16 tropical cyclones that directly passed over the Manila Bay area from 1948 to 2009, most of them as typhoons (indicated by red lines). Out of these numbers, five occurred during October. The reference point is the center of the tropical cyclones or "eye" for typhoons. Stretching the boundary to a maximum of 50 to 100-km radius from Metro Manila, it can be seen that the total number increased to 62 and 107 tropical cyclones. Again, most of them are in the typhoon category. In terms of intense wind, the influence become lesser as the center is observed further away, but in terms of rainfall, significant amounts can still be observed.

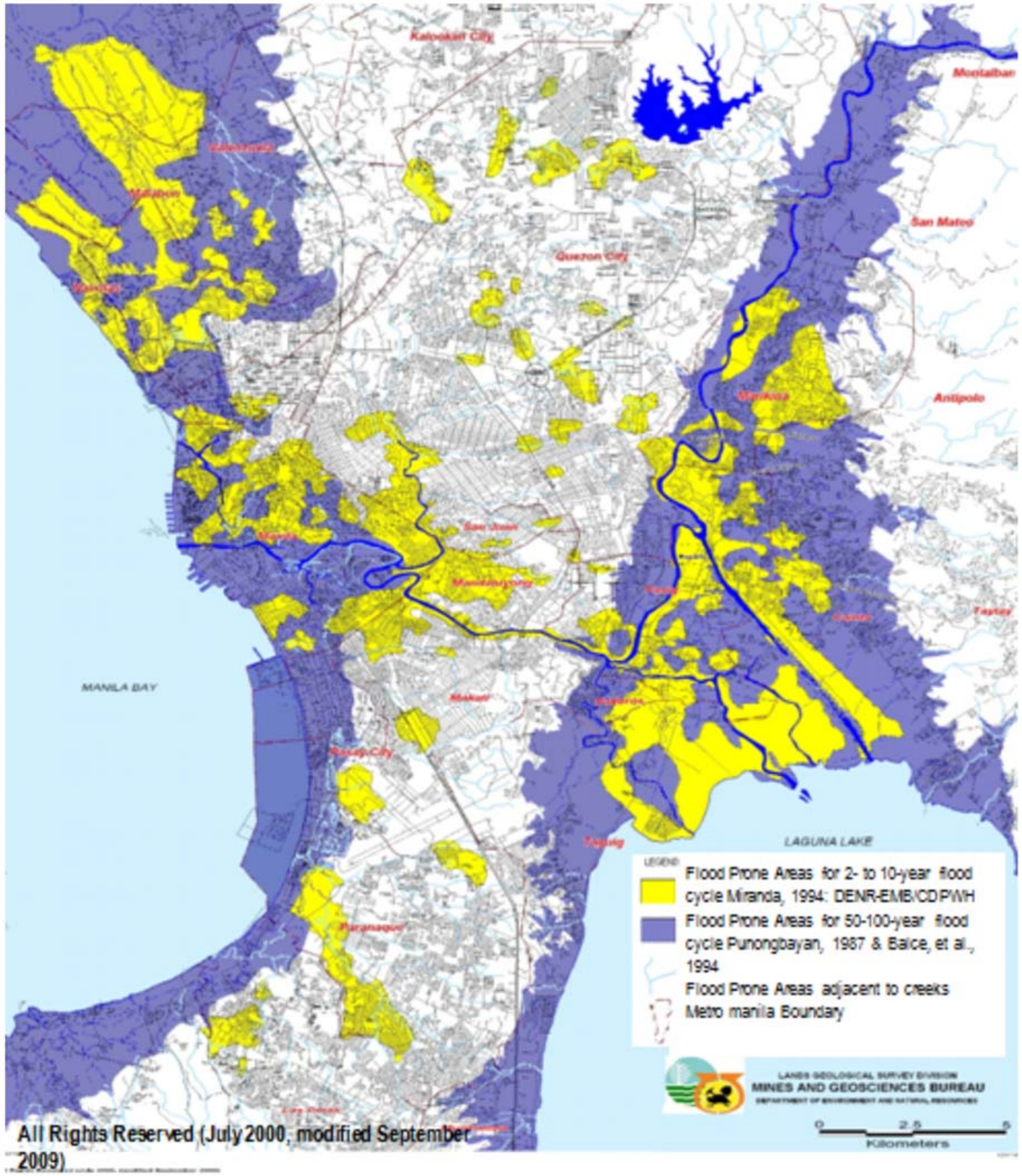
Intense tropical cyclones in the categories of severe storms and typhoons are usually (but not always) associated with storm surge occurrence. Storm surge is the abnormal rise in sea level at the coast due to land falling or land crossing intense tropical cyclone and also during its exit from land to water. Disastrous storm surges causing floods commonly happen during high tide conditions. Also, the semi-enclosed configuration of a bay, such as Manila Bay, reinforces the effect of storm surge as it permits the storm wind to pump up additional water into the bay and trap it there for an extended period of time. The most recent occurrence in Manila Bay during Typhoon Pedring (Typhoon Nesat) on 27 September 2011 generated 6-m waves, destroying the sea wall along Roxas Boulevard and resulting in flooding up to Taft Avenue. Previous occurrences of storm surge in Manila and vicinities (Cavite and Bataan) of undetermined heights were reported by PAGASA in various years as far back 1905 (PAGASA, 2000). Measured heights of 3–5 m waves were reported during the passage of Typhoon Sening from 10–15 October 1970 affecting Cavite and Bataan (Bagac and Morong). The passage of Typhoon Bebeng from 12–16 July 1983 also generated 0.66 to 1.9 m storm surge affecting several coastal towns of Bataan (Limay, Orion, Balanga, Orani and Cabcaben).

Flooding

Flooding causes more damage in the Philippines than any other severe weather related event. Flooding may result from a coastal storm, tsunami, dam break, or a heavy rainfall event. Development continues to intensify within flood-prone and marginal areas. Over the years, floodplain managers have become more aware of the benefits of protecting the natural functions of floodplains. Protecting floodplains preserves the natural functions of ecosystems and also helps prevent loss of life and property from damaging floods.

Figure 16 is a modified flood hazard map of Metro Manila and vicinities. About 69 percent of Metro Manila rests on high elevation with solid geological foundations. The remaining 31 percent of Metro Manila's land area is floodprone. This comprises the towns or cities of Manila, Navotas, Malabon and parts of Caloocan. In particular, Navotas and Malabon are the coastal towns that get easily flooded during high tides. On the eastern part, the flood prone towns are Pasig, Marikina, Pateros and Taguig. These towns rest on low-lying zones with structurally inferior soils (Cabanilla 1996:4.). Heavy flood damage is experienced in these areas due to recurrent flooding caused by the overflow of Pasig and Marikina rivers. The towns of Pateros and parts of Taguig

Figure 16. Modified Flood Hazard Prone Areas in Metro Manila.



specifically, can remain flooded for months. Rizal province lies at the periphery of these towns. However, only about 4 percent of its total area is prone to flooding, the rest lies on high elevation. In the map, the yellow areas are the frequently flooded areas with a return period of 2 to 10 years. The dark blue areas are subject to flooding of 50 to 100 year flood.

Coastal Erosion and Land Subsidence

Coastal erosion is a process whereby large storms, flooding, strong wave action, sea level rise, and human activities, such as inappropriate land use, alterations, and shore protection structures, wears away the beaches and bluffs along the coasts. Erosion undermines and often destroys homes, businesses, and public infrastructure and can have long-term economic and social consequences.

Land subsidence is a gradual settling or sudden sinking of the Earth's surface. This loss in elevation can cause damage but, importantly, it increases the dangers posed by flooding and sea level rise. Subsidence occurs naturally and as a result of human activities. Principal causes include groundwater removal, drainage of organic soils, underground mining, natural compaction, and thawing permafrost.

One indicator of subsidence, for example, is exposed roots of trees on the beach areas. Continuing soil erosion has been a major factor in the changing shoreline of Manila Bay. Apart from soil erosion, other environmental processes such as siltation and sea level rise have also contributed to changing the bay's coastline. In some parts of the bay, however, erosion is prevented by seawalls and breakers, particularly in areas where land has been reclaimed (Jacinto, et al., 2006). Severe storms can remove wider areas of the coast in a single event. In undeveloped areas, these high recession rates are not likely to cause significant concern, but in some heavily populated locations, 0.5 m may be considered catastrophic.

2.4 Climate Projections and Scenarios for Sea Level Rise, Flooding and Storm Surges in the Manila Bay Coastal Area

Climate Trends and Projections

It is increasingly getting warmer over Manila, of about 2.21°C in 110 years, as shown in the temperature observation from 1901 to 2010 (**Figure 17**). The number of extremely hot days (defined as days with greater than 35°C temperature) is projected to increase for both stations, as shown in **Table 2** (1,095 and 1,984 days for Port Area and Science Garden respectively).

Rainfall has its characteristic annual variability as shown by observations from 1865 to 2010, in **Figure 18** with above average rainfall becoming more frequent after 1920. This trend increases with time, but very gradually. Rainfall projections in a high GHG emission scenario will bring more rains in the area in time slice 2020 (from 2006 to 2035) with dry periods in between peak rainfall periods. The trend is the same for 2050 (2036 to 2065) but lesser than 2020 rainfall amount and slightly wetter than the baseline. This is supported by the projected extreme events prepared by PAGASA as shown in **Table 2.**

Figure 17. Annual Mean temperature (1901 to 2010).

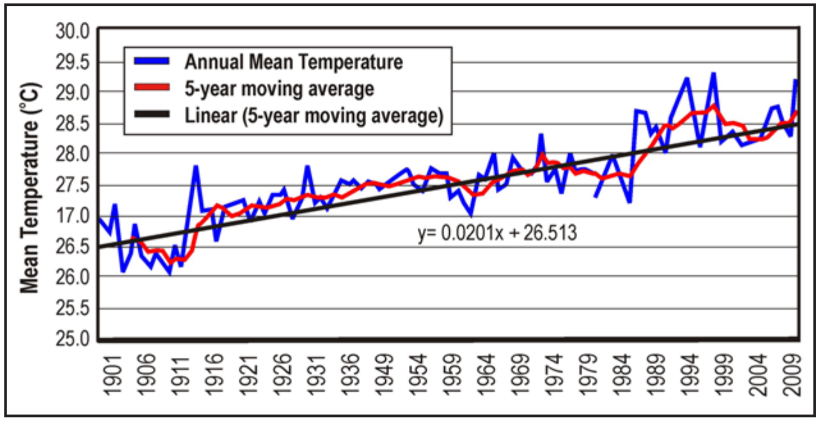


Figure 18. Rainfall anomaly in Manila, 1865 to 2010 (departure from 1971 to 2000 normal values).

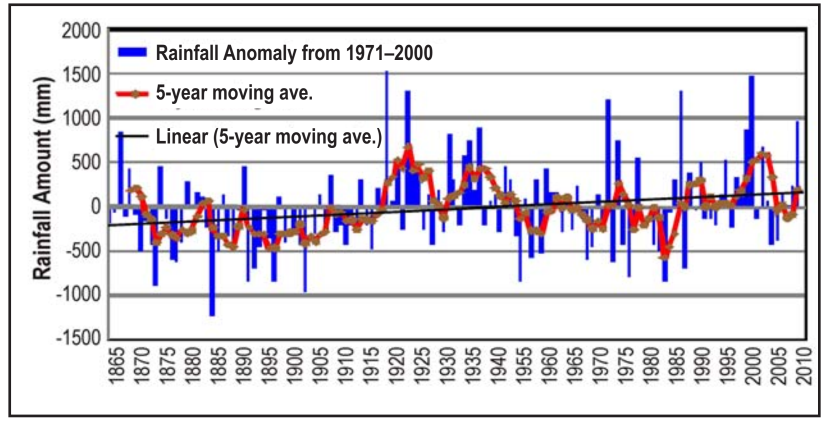


Figure 19. Baseline (1971 to 2000) and projected monthly rainfall in (a) Port Area, Manila and (b) Science Garden, Quezon City for a worst-case scenario (high emission scenario A2).

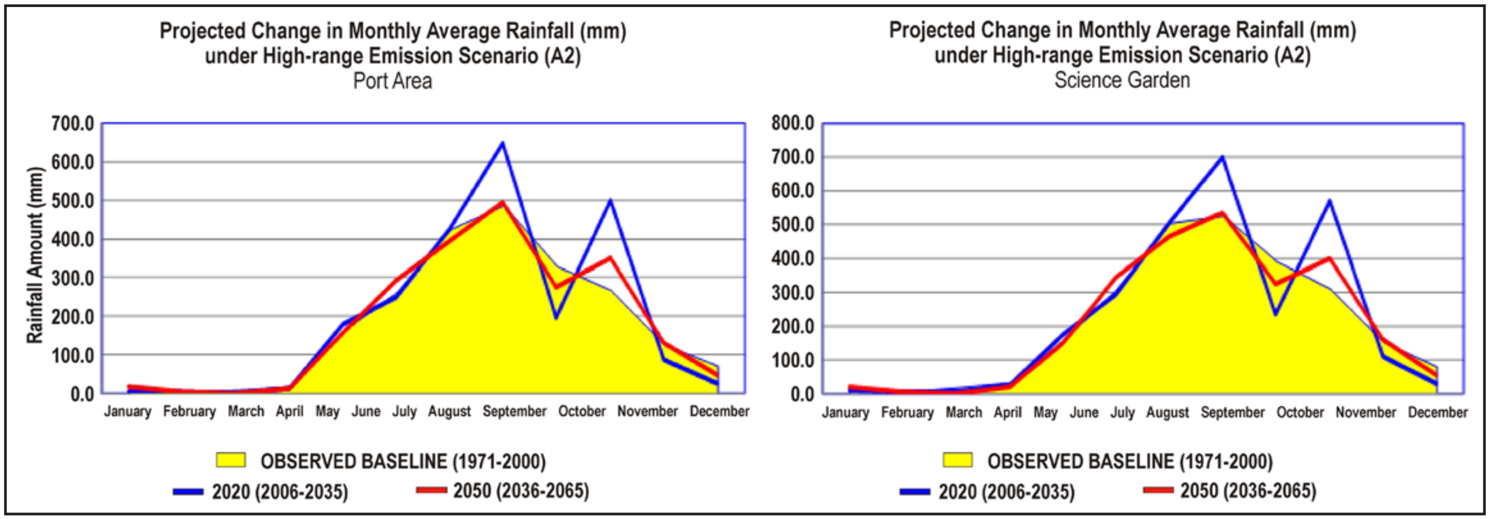


Table 2. Frequency of Extreme Events in 2020 and 2050 over NCR under Medium-range Scenario.

Provinces	Stations	No. of Days with Tmax> 35°C			No. of Dry Days			No. of days with rainfall>300mm		
		OBS	2020	2050	OBS	2020	2050	OBS	2020	2050
Metro Manila, NCR	Port Area	229	1,176	2,118	7,380	6,445	6,382	1	7	3
	Science Garden	1,095	1,984	3,126	7,476	6,302	6,220	0	8	4

Note: For North Kalookan, Quezon City, Marikina, Pasig, Taguig, San Juan, and Mandaluyong, use values of Science Garden. For Navotas, South Kalookan, Malabon and Valenzuela, use values of Port Area.

Source: PAGASA, 2011.

Figure 19 here shows the projected monthly rainfall for both the Port Area and Science Garden stations, under a high ghg emission scenario. There is no apparent shift in rainy season, however, there appears to be two distinct peaks in the projection: one in September and another in November. The magnitude of the increase or decrease is smaller for the time slice centered at 2050 than in 2020 for both stations.

Sea Level Rise

The local change in sea level at any coastal location depends on the sum of global, regional and local factors and is termed relative sea-level change. Thus, the global-mean sea level rise does not translate into a uniform rise in sea level around the world. The relative (or local) level of the sea to the land can change for a number of reasons and over a range of time scales. Over the main time scale of human concern (102 to 103 years), relative sea level is the sum of the following components:

- **Global-mean sea level rise** - is an increase in the global volume of the ocean. In the 20th/21st century, this is primarily due to thermal expansion of the Upper Ocean as it warms and the melting of small ice caps due to human-induced global warming. The contribution of Greenland is less certain, and Antarctica is expected to grow in size producing a sea level *fall*, offsetting any positive contribution from Greenland. Direct human influence is also possible due to modifications to the hydrological cycle (e.g., increased terrestrial storage of water (causing sea-\ level fall), versus increased groundwater mining (causing sea level rise)), although this balance is most uncertain.
- **Regional meteorological and oceanographic factors, such as spatial variation in thermal expansion effects, changes to long-term wind fields and atmospheric pressure, and changes in ocean circulation**. These effects could be significant with regional effects equal to the magnitude of the global-mean thermal expansion term. Models of these effects under global warming show little agreement, and this component has been largely ignored in impact assessments to date.
- **Vertical land movement (subsidence/uplift) due to various geological processes**. In addition to natural changes, groundwater withdrawal and improved drainage has enhanced subsidence (and peat destruction by oxidation and erosion) in many coastal lowlands, producing several meters subsidence in susceptible areas over the 20th century, including within some major coastal cities, including Tokyo and Shanghai (e.g., Nicholls, 1995).

Impacts of Sea Level Rise

Many other aspects of climate change will also have coastal implications that will interact with sea level rise, although the details will vary from place to place. A major concern is change in the frequency, magnitude and location of the tracks of severe tropical storms and this issue often excites more attention than sea level rise. The major impacts of sea level rise are:

- Inundation and increased flooding (frequency and depth)
- Increased coastal erosion

Table 3: Major Impacts of Sea Level Rise.

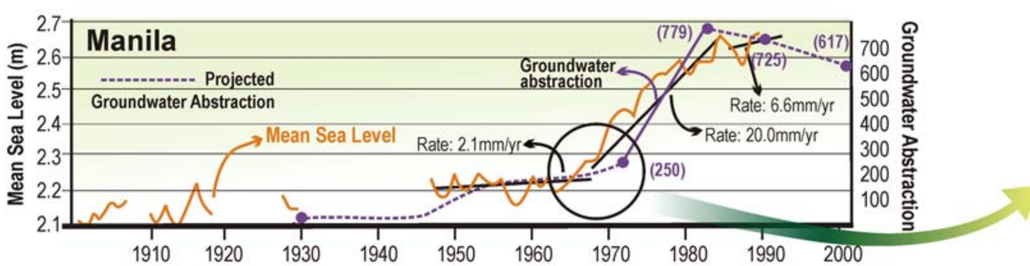
Bio-geophysical Effect		Other Relevant Factors: Climate	Other Relevant Factors: Non-Climate
Inundation, flood and storm damage	Surge	Wave and storm climate, morphological changes, sediment supply	Sediment supply, flood management, morphological changes, land claim
	Backwater effect (river)	Runoff	Catchment management and land use
Wetland Loss (and change)		CO_2 fertilization Sediment supply	Sediment supply, migration space, direct destruction
Erosion		Sediment supply, wave and storm climate	Sediment supply
Saltwater Intrusion	Surface Waters	Runoff	Catchment management and land use
	Groundwater	Rainfall	Land use, aquifer use
Rising water tables/ impeded drainage		Rainfall	Land use, aquifer use

- Displacement of coastal lowlands and wetlands
- Salinization of surface and groundwater

The main biophysical effects of relative sea level rise, including relevant interacting factors are listed in **Table 3**. Some factors (e.g., sediment supply) appear twice because they may be influenced by both climate and non-climate factors (adapted from Nicholls, 2002).

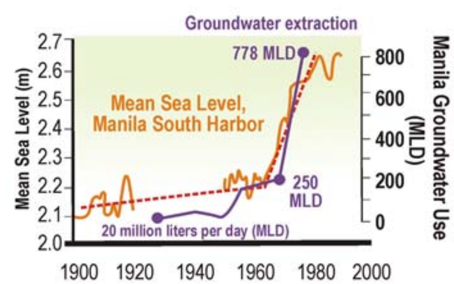
Vulnerable to flooding are low-lying coasts, with elevation within present mean sea level, where the risk of permanent submergence or inundation is high. It will also aggravate flooding in areas with gentle gradients. Coastal erosion will worsen in already retreating shorelines and will ensue in presently stable or accreting shorelines. During stormy conditions, greater inland penetration of large waves is expected. Island systems where the supply of freshwater is limited are particularly vulnerable to saltwater intrusion.

Figure 20a. Rate of relative sea level rise and water extraction around Manila Bay



Source: Rodolfo and Siringan, 2006.

Figure 20b. Details of sea level increase



Source: Siringan, et al., 2010.

Current observation and trend of sea level in Manila Bay

The relative mean sea level around Manila Bay is shown (**Figure 20a**) to be proportional to the rate of groundwater abstraction. While the sea level is gradually rising, with the global rate due to sea surface temperature increase, the relative mean sea level is driven mainly by subsidence due to groundwater abstraction and shown in detail in **Figure 20b**. Siringan, et al., (2010) estimated that the rate of sea level rise was 2 mm/yr from 1902 to 1960, and then it started to accelerate ten times thereafter. Before 1960, the rate of groundwater withdrawal was estimated at 20 million liters per day (MLD). Onwards, the rate increased from 250 MLD to the more recent estimate of 750 MLD.

Projections of sea level rise of 1 and 2 meters

Around Manila Bay area, Siringan, et al., (2010) have estimated that 11,700 ha of land with elevation of 0 to 1 meter will be permanently inundated by a 1-m SLR. With maximum tidal range of 1.4 m and stormwaves of 1 m, the maximum seaward incursion may affect approximately 12,700 ha of land in addition to the areas to be permanently inundated.

Sea level rise scenario with storm surge

A more recent study on flooding in Metro Manila by Muto (2010) used the scenarios with storm surge shown in **Table 4**. The assumption is that over the relative sea level rise, a 0.9-meter storm surge is added to the global rate plus subsidence. Siringan, et al., (2010) have estimated the current land subsidence rate at 2 cm/yr.

Table 4: Metro Manila Climate Change Parameters.

Simulation Case	Temperature Rise °C, downscaled	Sea Level Rise (cm) (global)	Increase Rate of Rainfall 24-hr event (%)	Storm Surge Height (m) Manila Bay
1 Status quo climate	0.00	0.00	0.00	0.91
2 B1, no change in storm surge	1.17	19	9.4	0.91
3 B1, strengthened storm surge	1.17	19	9.4	1.00
4 A1F1, no change in storm surge	1.80	29	14.4	0.91
5 A1FI strengthened storm surge	1.80	29	14.4	1.00

Source: Muto, 2010.

Table 5. Areas around Manila Bay to be affected by 1 m and 2 m SLR.

Area	Areas Affected (Ha)	Areas Affected (1 m SLR) (Ha)	Percentage	Areas Affected (2 m SLR) (Ha)	Percentage
Metro Manila	59,583.11338	5,374.99831	9.02	7,866.65644	13.20
Cavite	56,392.87218	1,608.96189	2.85	2,701.01703	4.79
Bulacan	67,631.40549	22,691.40857	33.55	27,967.61012	41.35
Pampanga	143,961.5744	30,115.33937	20.92	41,594.57421	28.89
Bataan	288,928.4713	37,959.70203	13.14	51,651.150	17.88

To arrive at an estimate of local sea level rise around Manila Bay in 2050, for example, the following values of the contributing components are used.

- Global sea level rise: 0.21 – 0.48 m (A1B scenario, 2099) or ~ 0.24 m by 2050 [from IPCC,2007]
- Storm surge ~ 1.0 m [from Muto, 2010]
- Subsidence ~ 2.0 cm/yr [from Siringan, 2010]~ 80 cm by 2050
- Relative extreme sea level rise by 2050: 0.24 m + 1.0 m + .80 m = 2.04 m

A study by the Manila Observatory revealed that for the coastal areas of Metro Manila, a 1 and 2 meter SLR would inundate about 60 km^2 (or about 9 percent of its total land area) and 80 km^2 (or 13 percent of its total land area), respectively. Using the same satellite imagery, this analysis was extended to other areas around the Manila Bay. The maps in **Figures 21a and 21b** indicate areas physically vulnerable to 1 m and 2 m sea level rise, with provincial details in **Table 5**. Bulacan ranks first in terms of land loss potential by as much as 41 percent. Details for affected municipalities are in **Annex 4**.

Figure 21a. Areas around Manila Bay vulnerable to 1-m SLR.

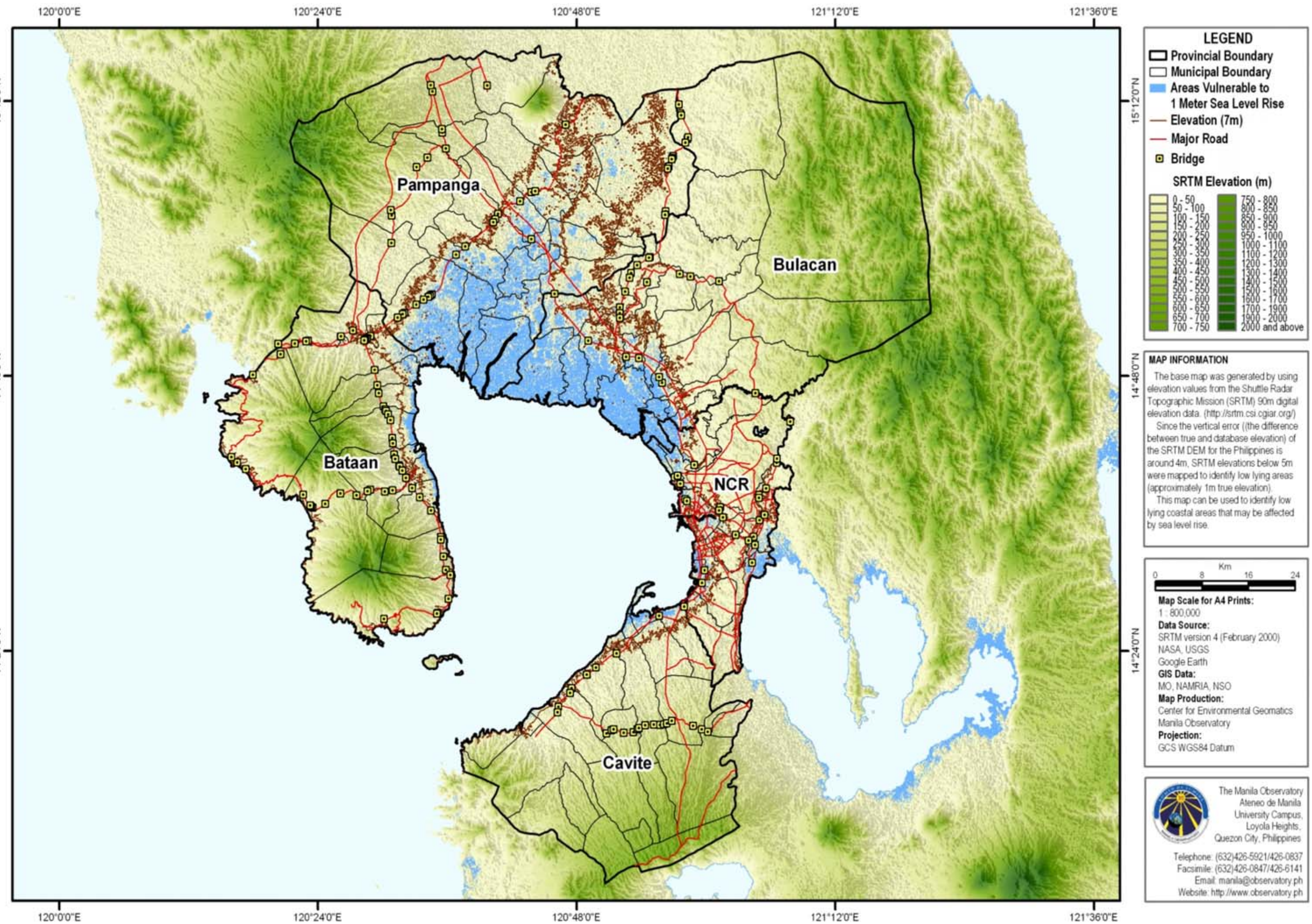
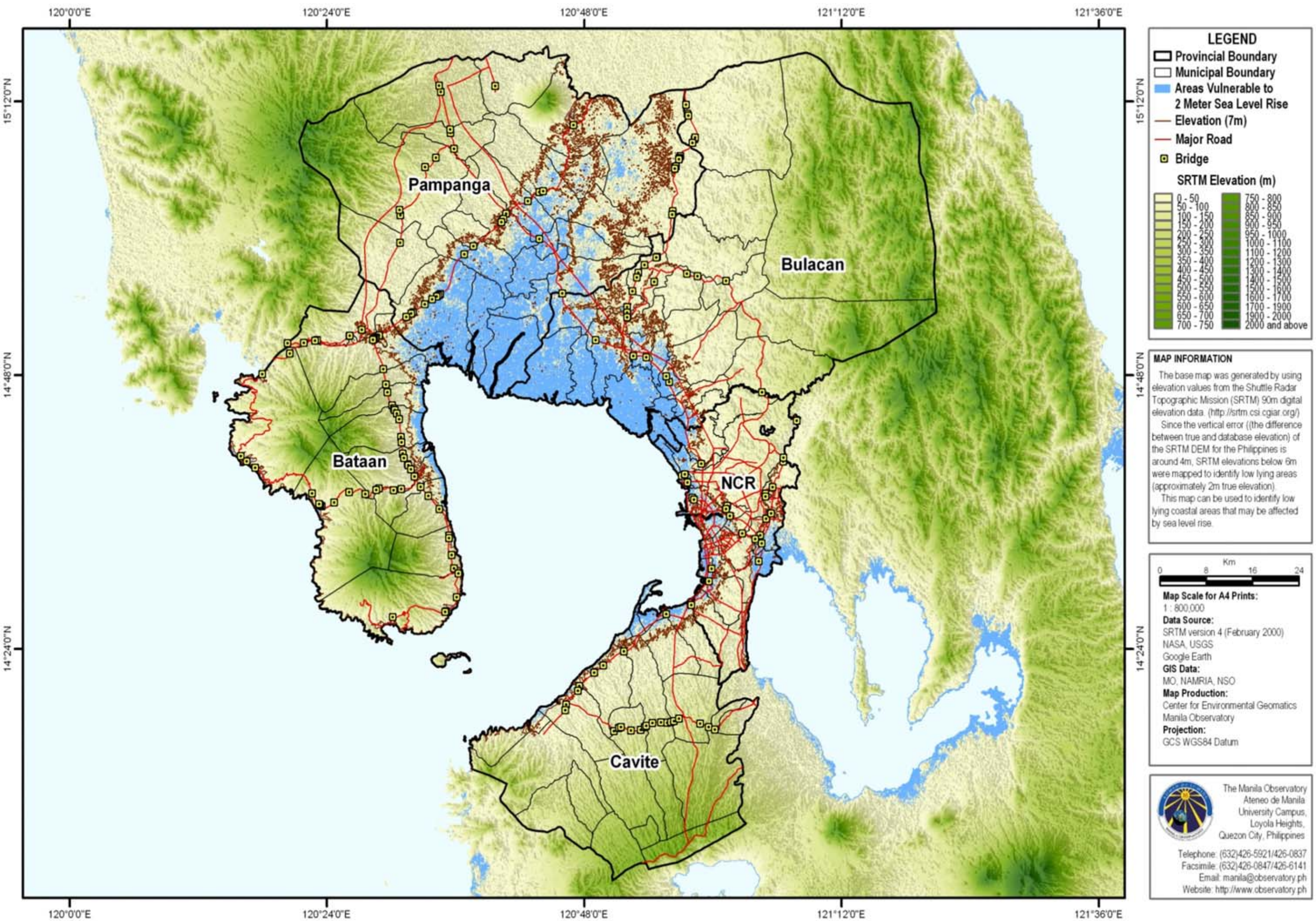


Figure 21b. Areas around Manila Bay vulnerable to 2-m SLR.



The flood hazard depicted in **Figure 22** is the product of flood simulations using Flo2d, a Federal Emergency Management Agency (FEMA)-approved flood routing application software. The inundation maps were simulated using rainfall associated with tropical storm Ondoy (Typhoon Ketsana) on 26 September 2009 from the SRTM. The rainfall event is considered as an extreme event that can generate floods with a 100-150-year return period.

Figure 22. Flooding scenarios for large rainfall events.

Source: www.nababaha.com.

The flood hazard maps are indicative inundation maps[2] for conditions of sea level rise and large flood events. These are useful only for knowing where not to be during extremely heavy rainfall. For local governments, these flood hazard maps can be used for localized emergency response (i.e., evacuation and access routes, road closures, location of key rescue facilities) and for urban planning. It should not be used for insurance and bank appraisal purposes. These hazard maps are only as good as the topographic map base that was used in the flood simulation.

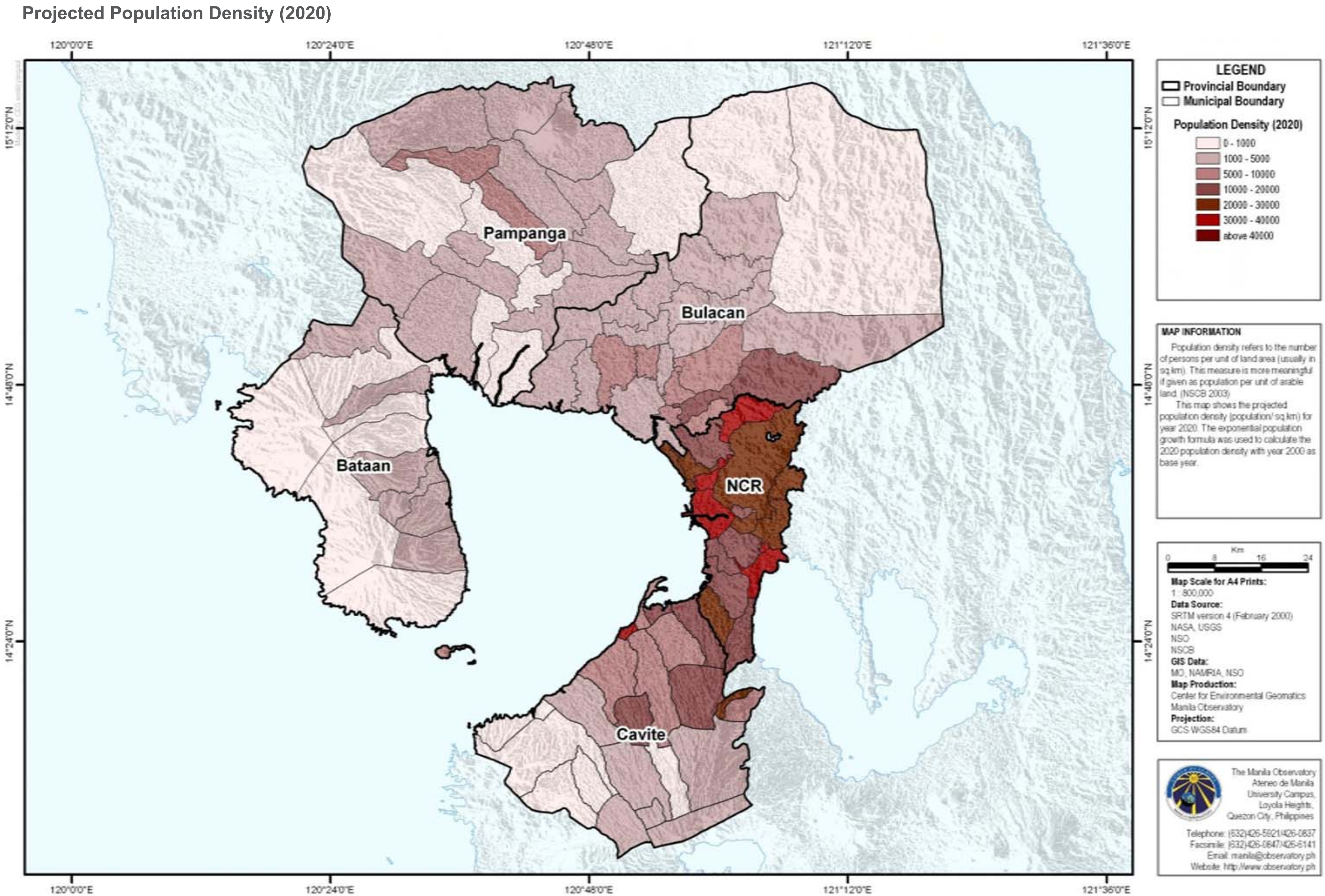
Demographics

Meanwhile, projected 2020 population forecasts in **Figure 23** indicate increased densities around the Manila Bay area and major river basins that drain into it. SLR is, thus, expected to continue to affect resident and working populations along the coast, specifically the more vulnerable group, as poverty incidence also increases (assuming maximum rate of increase based on current value).

Climate risks include flooding due to heavy rainfall and sea level rise

[2] As stated in www.nababaha.com, detailed and more accurate flood hazard maps of any city can be conducted upon request to the Flo2d simulation team of the National Institute of Geological Sciences, University of the Philippines Diliman, Quezon City.

Figure 23. **Projected Population Density (2020).**



Poverty Incidence (Maximum Rate)

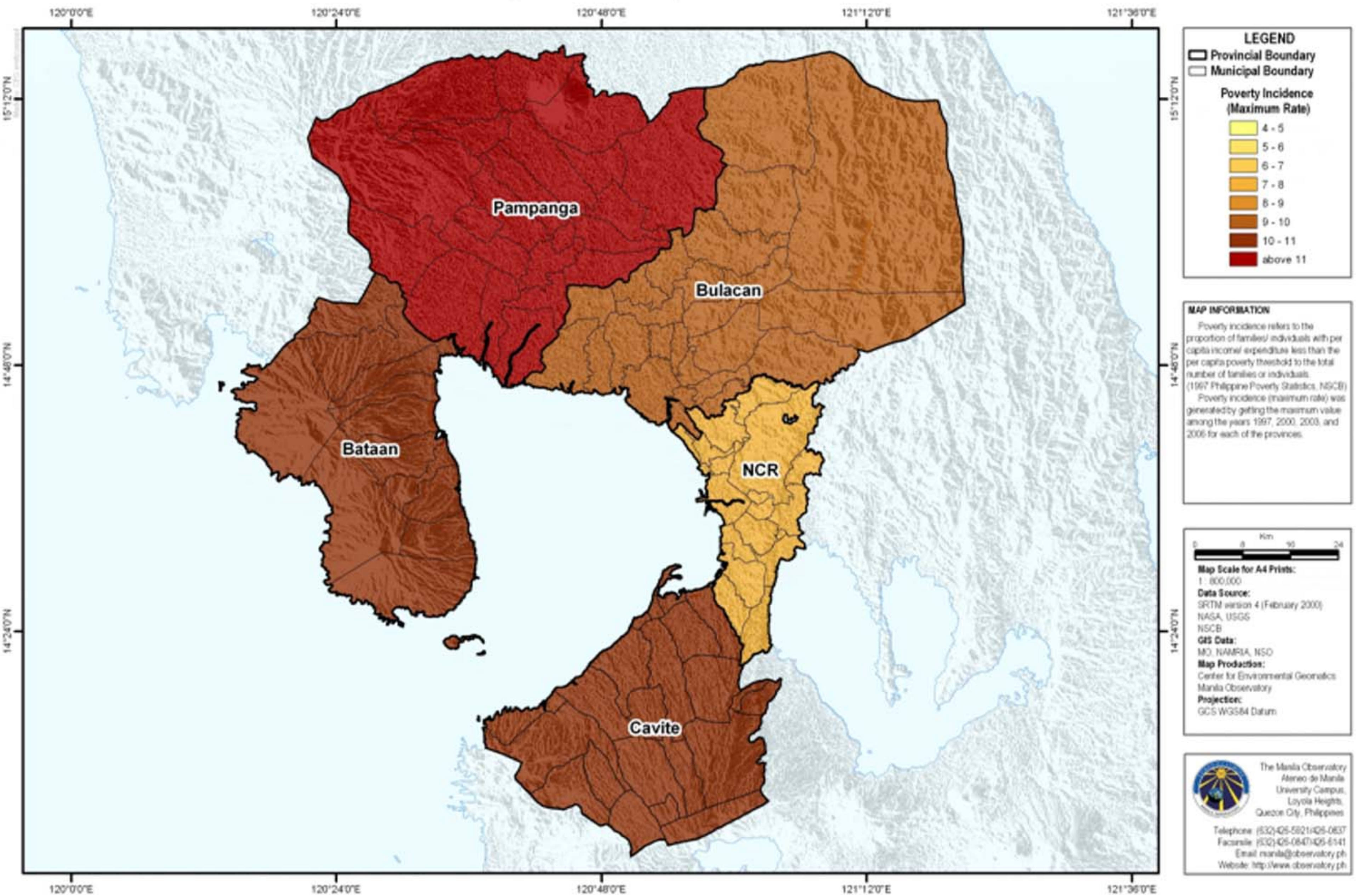


Table 6: Impacts of Sea Level Rise and Other Interacting Factors and Possible Adaptation Options (Nichols, 2011).

Natural System Effect		Possible Interacting Factors: Climate	Possible Interacting Factors: Non-climate	Possible Adaptation Approaches
1. Inundation/ flooding	a. **Surge** (flooding from the sea)	Wave/storm climate, erosion, sediment supply	Sediment supply, flood management, erosion, land reclamation	Dikes/surge barriers/closure dams [P - hard], dune construction [P - soft], building codes/flood-proof buildings [A], land-use planning/hazard mapping/flood warnings [A/R]
	b. **Backwater effect** (flooding from rivers)	Runoff	Catchment management and land use	
2. Wetland loss (and change)		CO_2 fertilization, sediment supply, migration space	Sediment supply, migration space, land reclamation (i.e., direct destruction)	Nourishment/sediment management [P - soft], land-use planning [A/R], managed realignment/forbid hard defenses [R]
3. Erosion (of "soft" morphology)		Sediment supply, wave/ storm climate	Sediment supply	Coast defenses/seawalls/land claim [P - hard], nourishment [P - soft], building setbacks [R]
4. Saltwater Intrusion	a. **Surface waters**	Runoff	Catchment management (overextraction), land use	Saltwater intrusion barriers [P], change water extraction [A/R]
	b. **Groundwater**	Rainfall	Land use, aquifer use (over-pumping)	Freshwater injection [A], change water extraction [A/R]
5. Impeded drainage/ higher water tables		Rainfall, runoff	Land use, aquifer use, catchment management	Drainage systems/polders [P - hard], change land-use [A], land-use planning/ hazard delineation [A/R]

Legend: P - Prevention A - Accommodation R - Retreat

Source: Nicholls, 2011.

(SLR). Roads, bridges and the EFCOS are physical infrastructures that would be affected by flooding attributed to SLR and extreme rainfall events. In terms of other types of physical exposure, in-depth space-based research and inventories still have to be made as to the characteristics and quality of structures in the coastal and river basin areas susceptible to flooding. Although scientists have declared that sea level rise (and therefore, flooding) is one of the more certain impacts of global warming, the timing is highly uncertain. In the planning process, this should be contextualized in terms of three possible actions: accommodation, protection and retreat. Monitoring and observation of the coastal area with respect to sea level rise is therefore critical, and similarly with the occurrences of heavy intense rainfall.

In the **Table 6**, a general impact chain of sea level rise, rainfall and runoff, interacting factors (both climate and non-climate) are enumerated, together with possible interventions under three types of adaptation strategies — Accommodation, Protection and Retreat. Most of these are applicable to the situation in Manila Bay.

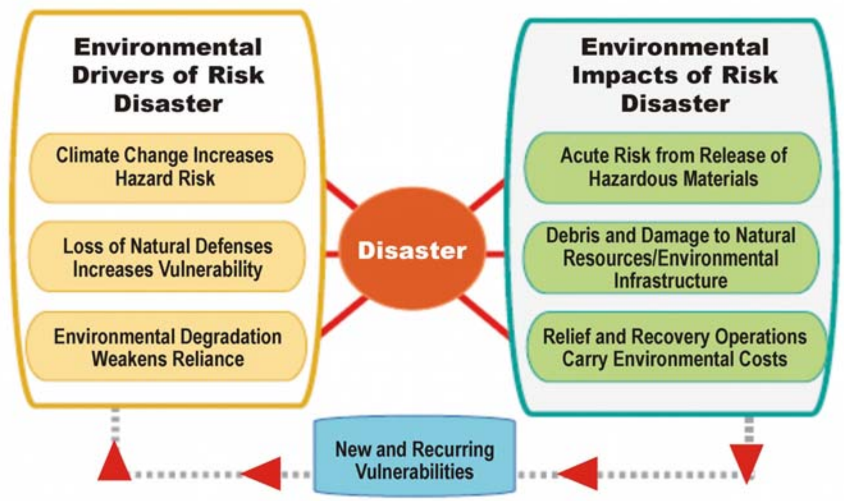
CHAPTER 3

Integrating Climate Change and Disaster Risk Scenarios into Coastal Land and Sea Use Planning

Development planning channels resources on activities that best achieve development goals; it is done to meet people's basic needs such as housing, education, jobs and health care. Land use planning seeks to accommodate these needs by allocating land between competing and sometimes conflicting uses. It encourages the rational and orderly development of land, promoting the sustainability of both human settlements and the environment. Without land use planning, the country may not be able to maximize its growth potential given that land is a finite resource. It could also result in the wanton and disorderly development of real properties. While spatial planning is an asset in any location where development is anticipated or in progress, it is absolutely necessary in coastal zones because of their extreme sensitivity and because well-established mechanisms for integrated coastal management (ICM) represent points of entry through which disaster risk and environment can be systematically considered. Strengthening ICM through spatial planning capacity should be paired with strengthening political commitment and capacity for enforcing zoning regulations.

An emerging issue in land use planning is the incorporation of disaster risk reduction and climate change adaptation. Risk here is defined as the confluence of hazard, exposure and vulnerability. Climate change is considered as a major driver of disaster risks among others. It compounds the impacts of disasters due to existing vulnerabilities (**Figure 24**). For example, SLR is seen to aggravate conditions of poverty along the coast, seriously affecting economic and livelihood sectors that depend on its resources.

Figure 24. Climate change is one of the drivers of disaster risks.



Source: UNEP-UNISDR, 2007.

Figure 25. Interaction of biophysical and socioeconomic factors in a changing climate.

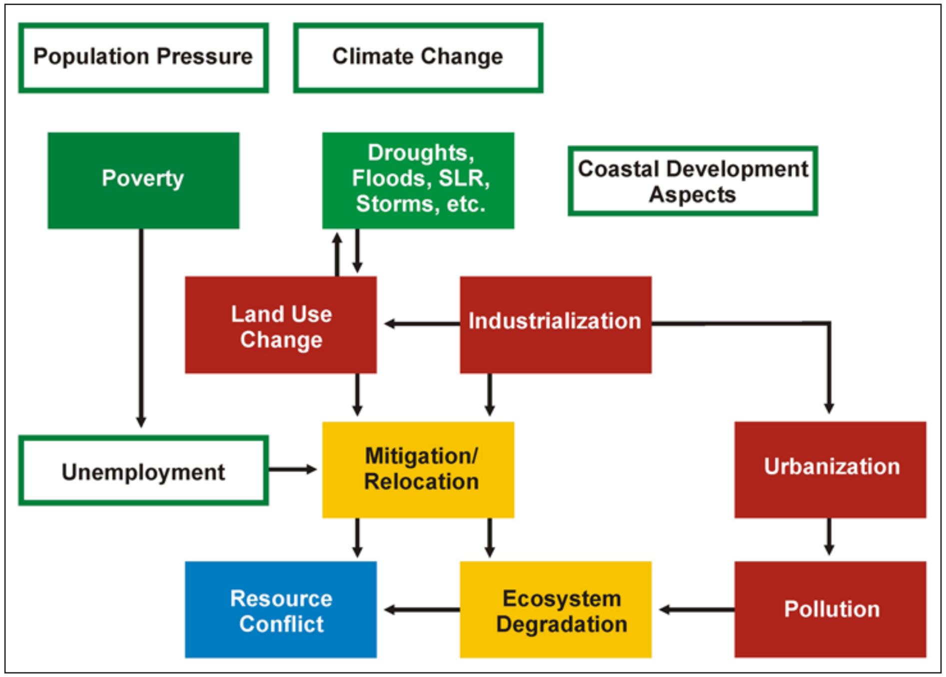
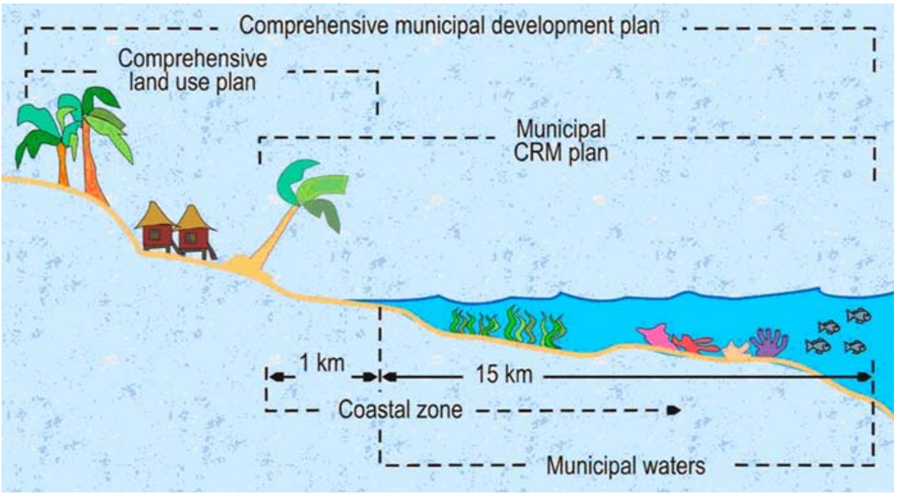


Figure 26. Municipal-level planning processes.



Source: DENR, Nd.

In terms of cross-cutting issues, Porio (2011) states that:

> *"… environmental-ecological vulnerability of the low-lying flood-prone areas interacts strongly with the social vulnerability of urban poor households, highlighting the effects of climate-related changes (sea level rise, increased typhoons, intensity of monsoon rains, floods and tidal/ storm surges) on this vulnerable population."*

As illustrated in **Figure 25**, various population pressures (e.g., poverty, labor challenges and resource use conflict) interact with biophysical changes and coastal development activities that add up to overall risks.

Land use planners need also to consider municipal waters use so that the coastal resources, which are the source of subsistence and livelihoods of the more economically disadvantaged groups in the community, can also be protected. Under the Coastal Resources Management Planning (CRMP), comprehensive land use plans (CLUP) need to include at least 1 km of the municipal waters from the shoreline (David, 2010). The Comprehensive Municipal Development Plan (CDP) harmonizes the CLUP and the CRMP to include people and resources into land use planning, and the factors affecting them, including climate change and disaster risks. These planning processes are captured schematically in **Figure 26**.

Planning within the Manila Bay Region

The development of a Coastal Land and Sea Use Zoning Plan in the Manila Bay Region is being pursued as part of the ICM scaling up program in the area, for the purpose of resolving multiple resource use conflicts in the coastal area. Also, it aims to provide a regulatory framework of permitting and delineation of coastal activities according to the designated use of coastal space. This concept was piloted in the province of Bataan, where the focal point is the provincial government. The preparation of the Plan was implemented under the Bataan Integrated Coastal Management Program (BICMP) of the Provincial Government of Bataan.

Applying the concept in the whole Manila Bay Region is a bit of a challenge with respect to institutional arrangements and delineation of responsibilities. Firstly, the Bay is surrounded by towns and cities of several provinces: Cavite, Pampanga, Bulacan and Bataan; and Metro Manila. Metro Manila itself is composed of 1 town and 17 cities and is within the coordinative umbrella of the Metro Manila Development Authority (MMDA). Under the Local Government Code, the LGUs — mayors and the *Sangguniang Bayan* (town or city council) — prepare the land use plan and approve the zoning ordinance.

On the other hand, one of the functions of the MMDA is to formulate, coordinate and **regulate the implementation** of medium and long-term plans and programs for the delivery of metro-wide services, **land use** and physical development within Metropolitan Manila, consistent with national development objectives and priorities.[3] One of the services of the MMDA is public safety, which includes the formulation and implementation of DRR programs and policies and procedures to achieve public safety, especially preparedness for preventive or rescue operations during times of calamities and disasters such as conflagrations, earthquakes, flood and tidal waves, and coordination and mobilization of resources and the implementation of contingency plans for the rehabilitation and relief operations in coordination with national agencies concerned.

The National Disaster Risk Reduction and Management Council (NDRRMC) is an inter-agency council responsible for the development of policies and plans and the implementation of actions and measures pertaining to all aspects of disaster risk reduction and management, including good governance, risk assessment and early warning, knowledge building and awareness raising, reducing underlying risk factors, and preparedness for effective response and early recovery. As the local networks of the NDRRMC, the local governments are responsible for planning, implementing, funding and carrying out specific activities related to DRR.

The preparation of local climate change action plans (LCCAP) is within the local governments' responsibilities but under the regulation and approval of the Climate Change Commission. The intention is to tie up LCCAP with the CDP and CLUP planning processes. The local governments are required to submit the CLUPs to the Housing and Land Use Regulatory Board (HLURB) for approval.

In the matter of executing various proposed infrastructure projects including sewage, water, roads, flooding, housing, reclamation, etc., the implementation depends on the funding sources. Some of the projects, for example roads, are

[3] Detailed listing can be directly accessed at http://hlurb.gov.ph/uploads/lgu/STATUSCLUPDec2011.pdf

Table 7: Matrix of the Roles of Various Agencies in the Preparation of CLUPs.

Activities	Agencies				
	City/Municipality	Province	HLURB	DILG	NEDA and other National Government Agencies
1. Formulation	Principal role	Supporting Role	Major Role	Supporting Role	Supporting Role
2. Review/Approval		Principal role	Principal role		Principal role
3. Monitoring	Principal role		Principal role		

Table 8: Matrix of the roles of various agencies in the preparation of CLUPs for Metro manila.

Activities	Agencies/Groups Involved
Public Exhibition/ Information Dissemination	LGU Civic Groups
Formation of Hearing Board City Mayors as Chairman	City Urban Planning and Development Coordinator HLURB Technical Representative *Sangguniang Panglungsod*
Public Hearing	• General Public • Representatives from private sector consisting of business (such as private investors and developers) and Professional Organizations Representatives from Civil Society consisting of NGO, PO, Environmental Organization, Women's Group, Labor, Academe and Church • Representatives from Local Government: Members of the Sangguniang Panlungsod, Members of the City Development Council, Congressmen, Key City Officials • Representatives from the National Agency
Review of CLUP/ZO	Metro Manila Development Authority (MMDA) Housing and Land Use Regulatory Board (HLURB) Concerned Agencies on Traffic (DOTC), flooding (DPWH), solid waste disposal (DOH & MMDA), informal settlements (NHA & HUDCC) Metro Manila Council
Approval of CLUP/ZO	Sangguniang Panglungsod Housing and Land Use Regulatory Board (HLURB)

nationally funded (or from loan proceeds obtained though the national government) and are implemented through the Department of Public Works and Highways (DPWH).

The HLURB is the government's regulatory body responsible for land use and housing and in the land use planning of local communities. But several national agencies also play institutional roles in terms of a national land use classification and allocation system adopted by the inter-agency National Land Use Committee (NLUC). The land use committees at various levels – national, regional and provincial are using these land use planning categorieswith their corresponding national sectoral agencies. The whole process is summarized below (SURP, 2005) in **Tables 7** and **8**.

For Metro Manila, the procedure is modified according to the Guidelines for the Formulation/Revision of CLUP, Series of 1990 issued by HLRUB.

In summary, although the responsibilities are clear, there are many actors involved in the planning processes and implementation of DRR, CCA and CLUP. The necessity for coordination has to be observed to avoid overlaps and conflicts.

CHAPTER 4

Policy Frameworks and Action Plans

Comprehensive Land Use Plans

Several laws currently govern land use planning in the Philippines, and the responsibility for the preparation, review, and implementation of land use plans is lodged with many agencies at different levels of government.

At the national level, it is governed by two laws: First is Letter of Instructions No. 1350, which established an Inter-Agency National Land Use Committee (NLUC) under the National Economic and Development Authority (NEDA). The said body is mandated to prepare the National Framework for Physical Planning based on, and within the context of the Medium Term Philippine Development Plan (or MTPDP).

The second is Republic Act 7279, or the Urban Development and Housing Act of 1992. This mandates the Housing and Land Use Regulatory Board (HLURB), under the Housing and Urban Development Coordinating Council (HUDCC), to prepare the National Urban Development and Housing Framework (NUDHF).

At the regional level, there is the Regional Land Use Committees (RLUC) mandated to submit regional physical framework plans for approval by their respective Regional Development Councils.

At the local level, Letter of Instructions No. 729 requires all local governments to prepare and submit their land use plans and zoning ordinances to the HLURB. This was reinforced by the Local Government Code, which empowered the city and municipal councils to enact comprehensive land use plans and zoning ordinances.

Status of CLUP

Exactly where are we now in terms of CLUP formulation and preparation? The latest figures from the HLURB (as of October 2011) show that out of 1,635 local government units in the country, 1,431 already have approved CLUPs. These local governments have new plans, updated CLUPs, or old CLUPs that are in the process of updating. There are 484 cities and municipalities that have current CLUPS (2003 to present), this means we have a total of 947 cities and municipalities in various stages of updating their land use plans (HLURB, 2011).

From the HLURB website, the following table lists the status of CLUP preparation for municipalities and cities around Manila Bay (HLURB, 2011).

Table 9: List of CLUP Preparation for Municipalities and Cities around Manila Bay.

Region/Provinces	Without Plan	Approved Plan			
		1994 Below with ongoing updating	For updating		2003-present Approved Plan
Region 3					
Bataan (12)	-	1	-	10	1
		Pilar		Abucay, Bagac, Dinalupihan, Orani, Orion, Samal. Mariveles, Hermosa, Morong and Balanga	Limay
Bulacan (24)	1	10	5	6	2
	Doña Remedios Trinidad	Bocaue, Calumpit, Hagonoy, Marilao, Norzagaray, Obando Paombong Plaridel, San Ildefonso, Pandi	Pulilan San Miguel, Malolos City, San Rafael, San Jose del Monte	Angat, Balagtas, Baliuag, Bustos, Sta. Maria Meycauayan	Bulacan, Guiguinto
Pampanga (22)	2	1	-	7	12
	Mexico, San Simon	Macabebe		Candaba, Angeles City, Minalin, Porac, Sta Rita, Sto. Tomas, San Fernando City	Arayat, Apalit, Lubao, Masantol, Floridablanca, Magalang, Mabalacat, Sta. Ana, Bacolor, Guagua, Sasmuan, San Luis
Cavite (23)	-	2	2	12	7
		Maragondon, Ternate	Carmona, Amadeo	Alfonso, Bacoor, Cavite City, Noveleta, Tagaytay City, Imus, Mendez-Nunez, Kawit, Dasmariñas City, Tanza, Trece Martires City, Naic	Gen. Trias, Indang, Gen Alvarez, Rosario, Magallanes, Silang and Emilio Aguinaldo
NCR (17)	-	1	-	6	10
		Manila		Marikina, San Juan, Muntinlupa, Mandaluyong, Pasig, Las Piñas	Parañaque, Valenzuela, Malabon, Pasay, Quezon, Makati, Taguig, Navotas Pateros, Caloocan

Current Policies Related to Climate Change and Disaster Risk Reduction and Management

Table 10: National Level policies related to climate change and disaster risk reduction and management.

Laws /Presidential Decrees / Executive Order	Brief Descriprion	Effectivity
Climate Change Act	An Act establishing the framework program for climate change, creating the climate change commission, appropriating funds therefore, and for other purposes. It complements a number of existing laws and programs, being implemented to support both mitigation and adaptation efforts of the country as below:	2009
National Strategic Framework on Climate Change Complementary Policy Initiative (For details, see separate section)	Provides a basis for the national program on climate change that defines key result areas to be pursued in climate-sensitive sectors	Signed in April 2010
Policies Addressing Mitigation		
Renewable Energy Act	The RE Act is expected to help the country's energy security, yield huge economic benefits, and boost effort to safeguard the environment.	2008
Biofuels Act (Republic Act 9367)	It calls for an establishment of a National Biofuels Board within 30 days of signing, spearheaded by the Department of Energy and represented by concerned departments of government (Agriculture, Trade and Industry, Sugar, Finance, Science and Technology, Labor and Coconut Authority). The Law provides a call for a mandatory mixing of 1 percent of biodiesel in petro diesel and 5 percent of ethanol in gasoline for the first 4 years. It will then be increased to 2 percent for biodiesel and 10 percent for ethanol	2007
Republic Act (RA 8749): Philippine Clean Air Act	The law that provides comprehensive air pollution control policy. Specifically, this legislative intends to apply air quality management in all sources in order to implement abatement and control of air pollution.	1999
Presidential Decree (PD) 1586 - Philippine Environmental Impact Statement (PEIS):	The law that requires that all agencies and instrumentalities of the national government including government-owned and controlled corporations as well as private corporations, firms and entities must prepare an environmental impact statement for every proposed project and undertaking which significantly affect the quality of the environment.	1978
Philippine Environmental Policy (PD 1151)	This policy encouraged the widest exploitation of the environment, subject to the condition that it shall not degrade the same, or endanger human life, health, and safety, or create conditions adverse to agriculture, commerce, and industry.	1977
Other relevant laws relating to emission control		
Ecological Solid Waste Management Act (RA 9003) Marine Pollution Decree	It provides the legal framework for the systematic, comprehensive and ecological solid waste management program of the Philippines, which ensure protection of public health and the environment. It emphasizes the need to create the necessary institutional mechanisms and *incentives*, and imposes penalties for acts in violation of any of its provision.	2000

Laws /Presidential Decrees / Executive Order	Brief Descriprion	Effectivity
Marine Pollution Decree	Provides for coastal resources protection and regulation of their exploitation; creation of the Philippine Coast Guard; restoration and rehabilitation of areas subject to development, exploration and exploitation, to their original conditions.	1976
Policies Addressing Adaptation (Significant existing policies related to CC adaptation)		
Disaster Risk Reduction and Management Act	Adopts the principles and strategies consistent with the international standards set by the Hyogo Framework of Action (HFA)—a comprehensive, action-oriented response to the international concern about the growing impacts of disasters on individuals, communities and national development. The Law encourages the government to shift its focus to disaster prevention and risk reduction by strengthening the communities' and people's capacity to anticipate, cope with and recover from disasters, as an integral part of development program. Mainstreaming DRR in the country's policies, plans and programs are the core of the DRRM Law.	2010
Executive Order 533	Adopts integrated coastal management as a national strategy to ensure the sustainable development of the Country's coastal and marine environment and resources and establishing supporting mechanisms for its implementation It stated among others, the application of coastal and marine use zonation as a management tool.	2006
Philippine Environment Code (PD 1152)	Provides a comprehensive program of environmental protection and management. The Code established specific environment management policies and prescribes environmental quality standards. - To achieve and maintain such levels of air quality as to protect public health and to prevent to the greatest extent practicable, injury and/or damage to plant and animal life and property, and promote the social and economic development of the country - Prescribe management guidelines to protect and improve water quality through: classification of Philippine waters: establishment of water quality standards; protection and improvement of the quality of the Philippine water resources; and responsibilities for surveillance and mitigation of pollution incidents - Set guidelines for waste management with a view to ensuring its effectiveness, encourage, promote and stimulate technological, educational, economic and social efforts to prevent environmental damage and unnecessary loss of valuable resources of the nation through recovery, recycling and re-use of wastes and waste products, and provide measures to guide and encourage appropriate government agencies in establishing sound, efficient, comprehensive and effective waste management covering both solid and liquid wastes	1977

Laws /Presidential Decrees / Executive Order	Brief Descriprion	Effectivity
PD 1775 Revised Forestry Code of the Philippines	Embodies the general mandate of the Philippine Constitution to conserve and to use properly the country's natural resources, particularly in the watershed areas.	
Republic Act 8435 (Agriculture and Fisheries Modernization Act)	The Act provides that the Department of Agriculture (DA) in coordination with PAGASA and other appropriate agencies, devise a method of regularly monitoring and considering the effect of global climate change, weather disturbances and annual productivity cycles for the purpose of forecasting and formulating agriculture and fisheries production program.	1997
RA 7586: National Integrated Protected Areas System (NIPAS) Act	The law that provides a paradigm shift in Protected Areas management from the national government agency through the Department of Environment and Natural Resources (DENR) to the local body known as the Protected Area Management Board (PAMB).The PAMB is a multisectoral body chaired by the DENR with representation from the local government units (LGUs), nongovernmental organizations (NGOs), people's organizations (POs), indigenous peoples (IPs) through their Council of Elders and national government agencies (NGAs).	1992
RA 8371:The Indigenous People's Rights Act (IPRA)	This legislation lays down the legal framework for addressing indigenous peoples' poverty. It seeks to alleviate the plight of the country's "poorest of the poor" by correcting, by legislative fiat, the historical errors that led to systematic dispossession of and discrimination against indigenous peoples.	1997
RA 8550, Fisheries Code was passed by both Houses of Congress on February 19, 1998 and was signed into law by then President Fidel V. Ramos on February 25, 1998. However, the implementing rules and regulations took effect only in 2000 when Executive Order No. 209 was signed into law on February 9, 2000.	Provides for the (i) Conservation, protection and sustained management of the country's fishery and aquatic resources; (ii) Poverty alleviation and the provision of supplementary livelihood among municipal fisherfolk; (iii) Improvement of productivity of aquaculture within ecological limits; (iv) Optimal utilization of offshore and deep-sea resources; and (v) Upgrading of post-harvest technology.	1998
Philippine Water Code	Provides the legislative basis for the management of the country's water resources; It is a decree governing the ownership, appropriation, utilization, exploitation, development, conservation and protection of water resources. The Code is based on a rational concept of integrated and multipurpose management of water resources and sufficiently flexible to adequately meet future development. As a guide to water resources planners, the country was divided into 12 water resources regions whereby 421 principal rivers were identified of which 18 were major river basins.	1976
Agri-Agra Reform Credit Act 2010 amended RA 10000 which amended PD 717 (original Agri-Agra Law)	The law requires banks to set aside 25 percent of their loan portfolio to the agriculture sector but some of its exemptions have defeated its main purpose. The original law was amended to remove exemptions on banks to funnel 25 percent of their loan funds into farm loans.	2010 2009 1975

The National Strategic Framework Plan on Climate Change 2010 to 2022

One of the mandates of the Climate Change Commission (CCC), established under the Climate Change Act of 2009, is to formulate a National Framework Strategy on Climate Change (NFSCC). The vision is to create a climate risk-resilient Philippines with health, safe, prosperous and self-reliant communities, and thriving and productive ecosystems. Then President Gloria Macapagal Arroyo signed the NFSCC on April 28, 2010.

The NFSCC is committed towards ensuring and strengthening the adaptation to climate change of the Philippines' natural ecosystems and human communities. The Framework aspires to chart a cleaner development path for the Philippines, highlighting the mutually beneficial relationship between climate change mitigation and adaptation. The critical aspect of adaptation is meant to be translated to all levels of governance, alongside coordinating national efforts, towards integrated ecosystem-based management, which shall ultimately render sectors climate-resilient.

The national framework is formulated within the context of the country's sustainable development goals and governance/institutional factors that affect the country's ability to respond to climate change. This Framework Strategy provides a basis for the national program on climate change. It identifies Key Result Areas **(Table 11)** to be pursued in key climate-sensitive sectors in addressing the adverse effects of climate change both under adaptation and mitigation. In order to achieve the key result areas, it is important to ensure that cross-cutting strategies are likewise given attention. As means of implementation, the framework puts forward multi-stakeholder partnerships, financing, valuation, and policy planning and mainstreaming.

Table 11. Key result areas identified in the National Strategic Framework for Climate Change.

Mitigation	Adaptation	Cross cutting issues:
• Energy efficiency and conservation • Renewable energy • Environmentally sustainable transport • Waste Management • National REDD++ (Reduction of Emission)	• Vulnerability and adaptation assessment • Ecosystem-based adaptation • River basin management • Coastal and marine systems • Biodiversity and REDD + • Water governance and management • Climate-responsive agriculture • Climate-resilient health • Climate-proofed infrastructure • Disaster risk reduction	• Capacity development; • Knowledge management; • Research and development; and • Technology transfer

Coastal and Marine Systems

Looking more closely to the coastal and marine systems section, the Framework states the objectives and strategic priorities, which will be the basis of activities of the local governments and other responsible national agencies when crafting the plan of actions on this sector.

Objective:

- To build up and improve the resilience of coastal and marine ecosystems and communities, including tourism industries, to climate change.

Strategic Priorities

- Establish marine reserve networks through active participation of local communities to serve as sources of marine propagules to replenish biodiversity to shallow water habitats.
- Determine optimal clustering and locations of marine reserves according to “sources and sinks.”
- Prioritize protection and management of mangroves, estuaries, sea grasses, coral reefs and beaches as a management unit to derive maximum benefits from synergistic interactions of these ecosystems that result to enhanced marine productivity.
- Strengthen sustainable, multisector and community-based coastal resources management (CRM) mechanisms and eco-tourism endeavors.
- Manage and expand the sink potential of marine ecosystems such as coral reefs and mangroves.

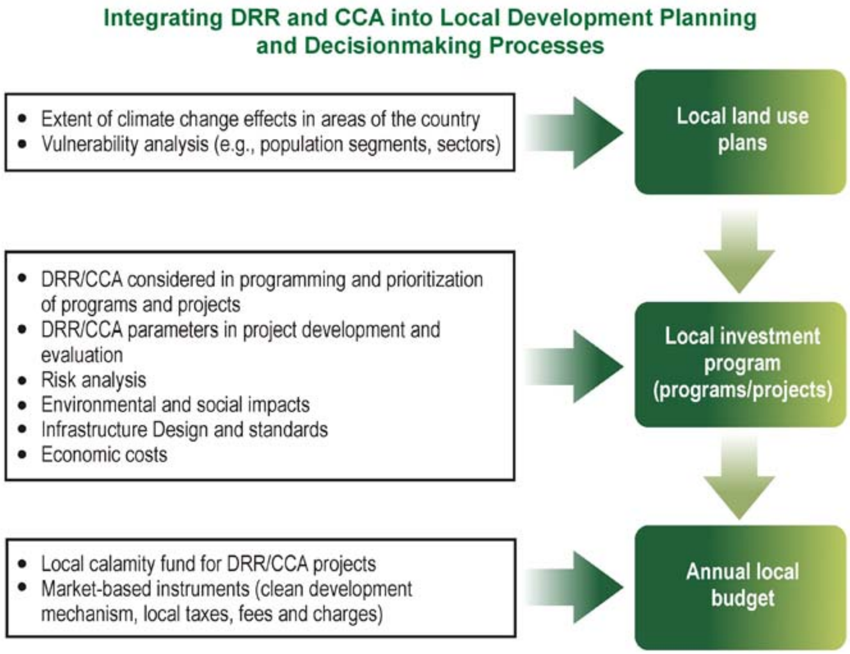
On integrating disaster risk reduction (DRR) and climate change into the physical framework planning

The National Economic and Development Authority (NEDA) has integrated disaster risk reduction (DRR) issues and investment projects into the Medium Term Philippine Development Plan (MTPDP) for 2004–2010. The 2011-2016 Philippine Development Plan (PDP) recognizes climate change and disaster risk reduction (DRR) as national development imperatives. Climate change and DRR are included as cross-cutting themes as stated in the introduction as well as key chapters on infrastructure (energy, transport, water, information and communications technology), agriculture and environment and natural resources. Much improvement could still be put in place by making the PDP more forward-looking instead of a business-as-usual approach, particularly in the areas of:

- Food self-sufficiency;
- Disaster risk reduction and management;
- Improved ecosystem, soil and water management; and
- Sustainable, off-grid, decentralized, community-based, efficient and new/renewable energy systems.

NEDA also incorporated DRR into the process of preparing the National Physical Framework Plan (NPFP). Guidelines were developed to mainstream disaster risk management (DRM) considerations into the comprehensive land use, development and budget plans of the local governments. Concerned line agencies were also encouraged to assimilate DRR components into their mandates, such as on infrastructure projects undertaken by the Department

Figure 27. NEDA's framework for integrating DRR and CCA into development planning.



Source: NEDA.

of Public Works and Highways (DPWH). A follow-up NEDA project is to link DRR and climate change adaptation (CCA) following the concept presented in **Figure 27**. The rationale behind the inclusion is to achieve: (a) Enhanced understanding of the planning environment; (b) Greater precision in land use planning and zoning policies to guide location of public and private investments; (c) Reduced potential damages and casualties in development programs and projects; (d) Risk reduction measures prioritization in local investment programs; and (e) The provision of funds and implementation of DRR/CCA programs and projects.

Throughout the implementation of the Mainstreaming DRR Project, close coordination was undertaken with another national government project under the National Disaster Coordinating Council (now the National Disaster Risk Reduction and Management Office) — the READY Project — that involved the preparation of multi-hazard maps (such as floods, earthquakes and landslides). The formulation of the DRR-enhanced plans built on the maps produced under this project, the only recognized official hazard maps. NEDA is responsible for the preparation of a handbook on establishing, managing and maintaining disaster risk and climate risk data for development and land use planning and in the preparation of 10 DRR/CCA-enhanced local land use/physical framework plans. NEDA will team up with the HLURB in the preparation of a reference manual on mainstreaming DRR and CCA in local land use planning.

Conclusions and Next Steps

Conclusion and next steps identified include:

- The coastal areas around Manila Bay are vulnerable to inundation due to sea level rise.
- The extreme relative sea level consists of the effects due to global warming, rate of subsidence and storm surge during the passage of intense tropical storms and typhoons.
- While we are certain that sea level will rise, the timing could be uncertain.
- Widespread flooding can also result from extreme rainfall events (> 300 mm/day).
- Sustainable coastal development planning means considering climate change adaptation and disaster risk reduction.
- CCA and DRR in the coastal land and sea use planning need to look at progressive avoidance, retreat, protection and accommodation of climate and disaster risks using updated information to avoid losses and damages.
- Soft and hard technological solutions could help but need to incorporate flooding risks due to relative sea level rise and extreme rainfall events in the design.

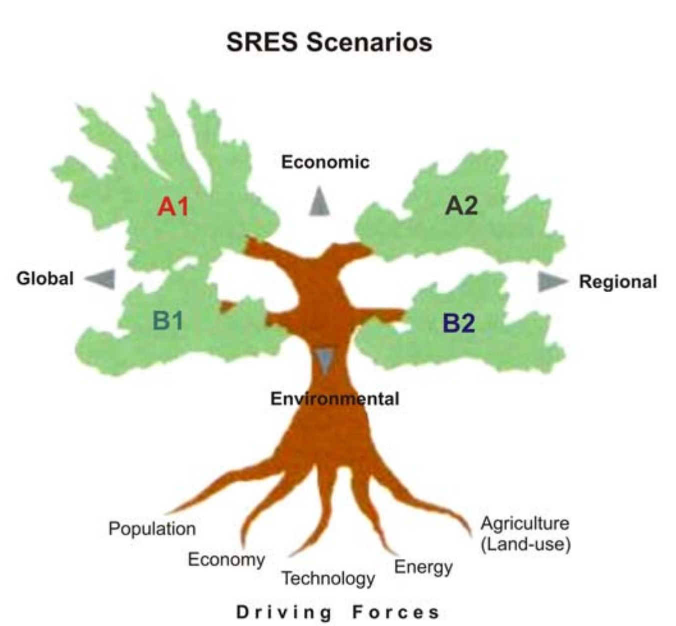
Conceptually, climate change can be isolated as natural or man-made. However, in the real world, the downstream impacts, such as floods and droughts, interact with existing socioeconomic conditions, for example, population pressure and coastal development activities that include land use change. Land use planning is an important area of public policy, especially for a developing country like the Philippines. With its fast-growing population and rapid urbanization, proper planning and regulation are essential to ensure efficient and rational use of land and resources, which also includes environmental drivers of disaster risks including climate change. It is expected that climate change will increase the frequency and magnitude of climate hazards and needs to be considered in the planning horizon.

A further step that needs to be taken is to assess SLR risks covering the Manila Bay Area in a more integrated way, that is, as an approximation of the compounding effect of the hazard as well as the exposure and vulnerability to it. Again, the socioeconomic impacts of SLR may be better addressed with satellite-based land use and cover as a major input. All of these are inputs to macro-zonation and delineation of boundaries that need to be subjected to ground truth verification. Meanwhile, the preparation of the actual land use and coastal water plans for the Manila Bay Region can be coordinated through the ICM program that is being put in place for the Bay, in partnership with the coastal Provincial Governments, municipalities and cities, DENR and PEMSEA.

The IPCC emission scenarios (from the IPCC Special Report on Emission Scenarios (SRES)

The IPCC scenarios consist of story lines A (1 and 2), B(1 and 2), a combination—A1B and a business as usual A1F scenarios, These are described briefly, below.

Figure A-1. The IPCC SRES Scenarios.



A1 – rapid economic growth, population peaks in mid-century then declines; rapid intro of newer, cleaner technology

A2 – heterogeneous world, increasing population; rapid but fragmented economic growth

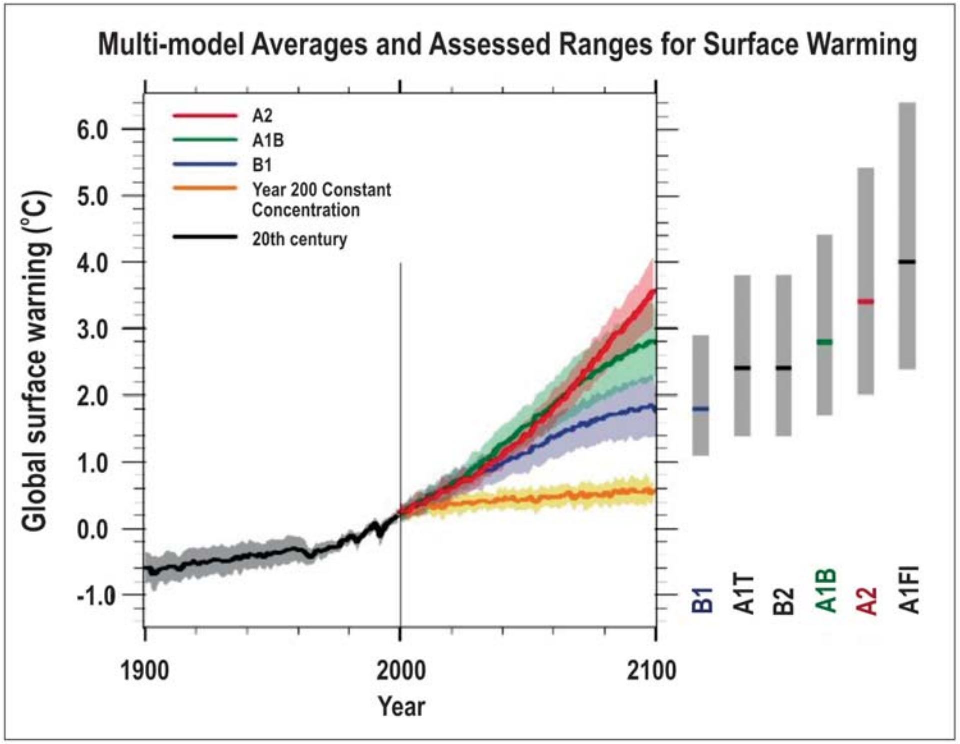
B1 – convergent world, as in A1 population; rapid changes economic structures, more service oriented reduced material intensity, clean resource efficient technology

B2 – local solutions to sustainability; increasing population but < A2, intermediate economic development

A1F which is not included in the Figure A-1 is a business as usual scenario which consists of a future with an extensive use of fossil-based fuel and sources of energy.

These scenarios are driven by population, economy, technology, energy use, agriculture and land use. The scenarios have equivalent impact on the climate through an increase in global mean temperature, schematically presented in Figure A-2.

Figure A-2: Projected global temperature increase following the IPCC SRES scenarios.



In the Figure, B1 is the most optimistic scenario, generating a a lower end 1.4°C increase in temperature; while A2 is the worst case of about 3.8°C, just 0.2° short of business as usual (A1F) that contributes a 4° warming overall.

Tools and Methods for generating Sea Level Rise Scenarios

Global sea level is projected to increase as global warming progresses. Sea level rise towards the end of the 21st century are given in **Table A-1**, in the different IPCC emission scenarios (see **Annex 1** for details). Changes outside this range are possible, especially if Antarctica becomes a significant source. There is a "commitment to sea level rise," which means sea level will still rise even as the emission has slowed down and atmospheric GHG concentrations are stabilized.

Some possible tools to generate sea level rise scenarios are enumerated below. The details for a to c methodologies are given in **Annex 3**.

a. Magic ScenGen
b. DIVA–DINAS COAST
c. CoastClim of Simulator of Climate Change Risks and Adaptation Initiatives (SimClim)

Table A-1. Projected temperature and sea level rise in different IPCC emission scenarios.

	Temperature Change (°C at 2090-2099 relative to 1980-1999)[a]		Sea Level Rise (m at 2090-2099 relative to 1980-1999)
Case	Best estimate	Likely range	Model-based range excluding future rapid dynamical changes in ice flow
Constant Year 2000 concentrations[b]	**0.6**	**0.3 – 0.9**	**NA**
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Source: IPCC, 2007.

Most existing studies have focused on either one or a combination of the consequences of sea level rise: (1) inundation, flood and storm damage; (2) erosion; and (3) wetland loss. Those studies are often based on very simple assumptions and ignore most landscape dynamics: wetlands are treated as passive elements of the landscape and are simply submerged as sea levels rise. In addition, interacting factors are often ignored. The effect of sea level rise on extreme water levels (i.e., storm surges) is explicit. It is assumed that surge characteristics are constant over time and relative sea level rise simply displaces these extreme water levels upwards. The main reason that saltwater intrusion and rising water tables have not been considered is that they are methodologically more difficult to analyze. Hence, most assessments of the biophysical impacts of sea level rise are incomplete in some aspect.

Kay (2006) enumerated the steps involved for a semi-quantitative rapid assessment to highlight possible impacts of a sea level rise scenario and to identify information/data gaps.

Steps:

- Collation of existing coastal data;
- Assessment of the possible impacts of a high sea level rise scenario;
- Implications of future development; and
- Possible responses to the problems caused by sea level rise

Some possible tools to generate sea level rise scenarios

A. MAGICC/SCENGEN

Description	MAGICC/SCENGEN is a user-friendly software package that takes emissions scenarios for greenhouse gases, reactive gases, and sulfur dioxide as input and gives global-mean temperature, sea level rise, and regional climate as output. MAGICC is a coupled gas-cycle/climate model. It has been used in all IPCC reports to produce projections of future global-mean temperature and sea level change, and the present version reproduces the results given in the IPCC Third Assessment Report (TAR). MAGICC can be used to extend results given in the IPCC TAR to other emissions scenarios. SCENGEN is a regionalization algorithm that uses a scaling method to produce climate and climate change information on a 5° latitude by 5° longitude grid. The regional results are based on results from 17 coupled atmosphere-ocean general circulation models (AOGCMs), which can be used individually or in any user-defined combination.
Appropriate Use	Can be used whenever future atmospheric composition, climate or sea level information is needed.
Scope	All locations
Key Output	MAGICC gives projections of global-mean temperature and sea level change. SCENGEN gives the following regional outputs on a 5° latitude by 5° longitude grid: changes in or absolute values of temperature and precipitation, changes in or absolute values of temperature and precipitation variability, signal-to-noise ratios based on intermodel differences or temporal variability, and probabilities of temperature and precipitation change above a specified threshold. The software also quantifies uncertainties in these outputs.
Key Input	Emissions scenarios for all gases considered in the SRES (Special Report on Emissions Scenarios) scenarios: CO_2, CH_4, N_2O, CO, NOx, VOCs, SO_2, and the primary halocarbons considered by the Kyoto Protocol (including SF6). The user also has control over various climate model and gas-cycle model parameters.
Ease of Use	The user-friendly software is largely self explanatory. It comes with a user manual and a technical manual.
Training Required	Requires little training for those familiar with basic climate science.
Training Available	A training course for an earlier version was held in 2000, but there are currently no plans for future courses.
Computer Requirements	Windows 95/98/NT/2000/XP, 64 MB RAM, 100 MB free disk space.
Documentation	Numerous publications in the scientific literature.
Applications	Widely applied in many regions and over a range of climate impact sectors. See References below.

Contacts for Framework, Documentation, Technical Assistance	Tom Wigley:Primary developer, wigley@ucar.edu. See also: www.cru.uea.ac.uk/~mikeh/software
Cost	No cost
References	• Other information is given in the atmospheric chemistry, climate projections, and sea level chapters of the IPCC TAR Working Group 1 report, Houghton, J.T., Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, D. Xiaosu, and K. Maskell (eds.). 2001. Climate Change 2001: The Scientific Basis. Cambridge University Press, New York. • Raper, S.C.B., T.M.L. Wigley, and R.A. Warrick. 1996. Global sea level rise: past and future. In Sea-Level Rise and Coastal Subsidence: Causes, Consequences and Strategies, J. Milliman and B.U. Haq (eds.). Kluwer Academic Publishers, Dordrecht, The Netherlands, pp. 11-45. • Santer, B.D., T.M.L. Wigley, M.E. Schlesinger, and J.F.B. Mitchell. 1990. Developing Climate Scenarios from Equilibrium GCM Results. Max-Planck-InstitutfürMeteorologie Report No. 47, Hamburg, Germany. • Wigley,T.M.L., Raper,S.C.B., Hulme,M. and Smith,S. 2000. The MAGICC/SCENGEN Climate Scenario Generator: Version 2.4, Technical Manual, Climatic Research Unit, UEA, Norwich, UK, 48pp. • Wigley, T.M.L. 1993. Balancing the carbon budget. Implications for projections of future carbon dioxide concentration changes. Tellus 45B:409-425. • Wigley, T.M.L. and S.C.B. Raper. 1992. Implications for climate and sea level of revised IPCC emissions scenarios. Nature 357:293-300. • Wigley, T.M.L. and S.C.B. Raper. 2001. Interpretation of high projections for global-mean warming. Science 293:451-454. • Wigley, T.M.L. and S.C.B. Raper. 2002. Reasons for larger warming projections in the IPCC Third Assessment Report. Journal of Climate 15:2945-2952.

B. DIVA and DINAS-Coast

Description	Dynamic Interactive Vulnerability Assessment (DIVA) is a tool for integrated assessment of coastal zones produced by the EU-funded DINAS-Coast consortium in 2004. It is specifically designed to explore the vulnerability of coastal areas to sea level rise. It comprises a global database of natural system and socioeconomic factors, relevant scenarios, a set of impact-adaptation algorithms and a customized graphical-user interface. Factors that are considered include erosion, flooding salinization and wetland loss. DIVA is inspired by the paper-based Global Vulnerability Assessment (Hoozemans et al., 1993), but it represents a fundamental improvement in terms of data, factors considered (which include adaptation) and use of PC technology.
Appropriate Use	DIVA is designed for national, regional and global scale analysis of coastal vulnerability, including consideration of broad adaptation issues.
Scale	DIVA covers all 180+ coastal nations in 12,148 coastal segments at national, regional, and global scales.
Key Output	The impacts of sea-level rise under a range of different user-defined scenarios, including some adaptation options. For each SRES the program produces a table, a map and chart.

Key Input	The user's chosen scenarios.
Ease of Use	The software is explicitly intended to be easy to use, and draws on extensive experience in graphical user interfaces.
Training Required	Designed to be used without significant training, an interested user should be able to explore this tool without any training.
Training Available	If required, contact DINAS-COAST consortium, see contacts.
Computer Requirements	Windows 2000/XP, 2 GHz Pentium, 512 MB memory, 5 GB free hard drive.
Documentation	Included with the DIVA tool.
International studies	DIVA has been used to develop assessments of wetland loss and the effects of mitigation. Examples of studies are; Hoozemans et al. (1993), Nicholls (2002), Hinkel and Klein. (2003), Vafeidis et al. (2003, 2004a, 2004b).
Contacts for Framework, Documentation, Technical Assistance	JochenHinkel Potsdam Institute for Climate Impact Research, Germany; e-mail: hinkel@pik-potsdam.de or http://diva.demis.nl/.
Cost	Free download from http://diva.demis.nl/.
Validity	DINAS-Coast database contains limited segments for many areas.

C. CoastClim of Simulator of Climate Change Risks and Adaptation Initiatives (SimCim)

Description	The Simulator of Climate Change Risks and Adaptation Initiatives (SimClim) software enables examination of future climate scenarios in several contexts. The method features a separate consideration for sea level rise (sea-level generator) due to climate change and global warming and that resulting from local land movements. One of the distinct advantages of using the generator is that it allows rapid generation of place-based sea-level scenarios, which account for some uncertainties associated with emissions scenario, but may not account for isostatic change. SimClim also includes a set of developed impact models. For the coastal zone, the focus is on erosion and flooding. The simple erosion model is a modified version of the Bruun Rule, which takes into account storm effects, local sea level trends and lag effects in order to provide time-dependent response of the shoreline to sea level rise at selected sites. The coastal flood model is spatial and allows the user to examine changes in the areas of potential inundation from the combined effects of sea level rise and extreme storm events. The purpose of SimClim is to link and integrate complex arrays of data and models in order to simulate, temporally and spatially, bio-physical impacts and socioeconomic effects of climatic variations, including extreme climatic events. In this way, it provides the foundation for assessing options for adapting to the changes and reducing the risks. SimClim is designed to support decisionmaking and climate proofing in a wide range of situations where climate and climate change pose risk and uncertainty.
Appropriate Use	A tool to aid decisionmaking under changed climate conditions.
Scale	SimClim can be applied in subnational, national, regional and global analysis.

Key Output	Current shoreline (m).
Key Input	For the coastal erosion model part of SimClim, one requires; shoreline response time, closure distance (m), depth of material exchange (m), dune height (m) and residual movement (m/year) and well as storm parameters.
Ease of Use	The distinctive advantage of the SimClim open system, as opposed to the hard-wired system, is the flexibility afforded to users for importing their own data and models in order to customize the system for their own purposes—much like a Geographical Information System (GIS).
Training Required	Yes
Training Available	Training can be arranged by contacting Peter Urich at management@climsystems.com or http://www.climsys tems.com
Computer Requirements	Computer access
Documentation	Included with the SimClim software
International Studies	Kenny, et al. (1999, 2000) Warrick, et al. (1996, 2005)
Contacts for Framework, Documentation, Technical Assistance	Climsystems Ltd P. O. Box 638, Hamilton, New Zealand. Climsystems Website. www.climsystems.com
Cost	There is a cost to the use of the software. Contact Peter Urich (see documentation).
Validity	The coastal impact model of SimClim is a possible tool to use in coastal zones.

Details of inundation due to sea level rise in the Manila Bay Area

Areas Affected in NCR	Hectares	Hectares (1m SLR)	Percentage	Hectares (2m SLR)	Percentage
Kalookan City	5,313.73138	52.60642	0.99	121.28848	2.28
Las Piñas City	3,210.85133	80.22217	2.50	152.13009	4.74
Makati City	3,197.35880	80.40882	2.51	172.40278	5.39
Malabon	1,596.97253	540.56369	33.85	817.06817	51.16
Mandaluyong City	1,117.02792	38.78709	3.47	79.97095	7.16
Manila	3,922.87489	762.48461	19.44	1,301.00798	33.16
Marikina City	2,265.28385	8.27971	0.37	20.69901	0.91
Muntinlupa City	3,872.87893	172.43011	4.45	225.94806	5.83
Navotas	1,150.62739	633.96731	55.10	849.64682	73.84
Parañaque City	4,524.53296	531.41664	11.75	708.87259	15.67
Pasay City	1,811.52704	299.03875	16.51	465.10293	25.67
Pasig City	3,182.29258	287.31608	9.03	531.36234	16.70
Pateros	195.12932	28.92334	14.82	55.28789	28.33
Quezon City	16,365.89966	5.46257	0.03	14.73542	0.09
San Juan	5,88.18735	5.75956	0.98	11.76588	2.00
Taguig	2,814.14055	978.38786	34.77	1,254.34391	44.57
Valenzuela City	4,453.79690	868.94358	19.51	1,085.02314	24.36

Areas Affected in Cavite	Hectares	Hectares (1m SLR)	Percentage	Hectares (2m SLR)	Percentage
Bacoor	4,741.71613	349.06965	7.36	546.47473	11.52
Cavite City	1,233.60388	303.75843	24.62	461.46444	37.41
General Trias	8,632.16653	3.05523	0.04	12.01211	0.14
Imus (Capital)	5,637.39721	47.43780	0.84	133.42755	2.37
Kawit	954.15118	468.65093	49.12	678.56638	71.12
Naic	7,710.78800	57.86315	0.75	153.09943	1.99
Noveleta	630.11350	235.19023	37.33	361.82539	57.42
Rosario	507.58830	58.03544	11.43	127.10235	25.04
Tanza	7,278.64095	40.90559	0.56	106.24891	1.46
Ternate	4,186.11302	44.99544	1.07	120.78047	2.89
Maragondon	14,880.59348	-	-	0.01527	0.00

Areas Affected in Bulacan	Hectares	Hectares (1m SLR)	Percentage	Hectares (2m SLR)	Percentage
Balagtas	1,804.83924	502.32464	27.83	826.88406	45.81
Baliuag	4,645.80282	1.00900	0.02	5.14430	0.11
Bocaue	1,863.38533	562.45769	30.18	808.06044	43.37
Bulacan	6,921.54700	5561.07929	80.34	6,172.00654	89.17
Calumpit	4,433.92470	1,195.81445	26.97	2,092.38890	47.19
Guiguinto	1,958.01703	396.84061	20.27	718.95793	36.72
Hagonoy	8,351.68859	6,140.98906	73.53	7,231.54216	86.59
Malolos	6,293.40098	2,527.09922	40.15	3,208.04763	50.97
Marilao	2,692.12199	247.64020	9.20	336.72986	12.51
Meycauyan	3,227.86809	1,162.55320	36.02	1,416.70972	43.89
Obando	1,617.35996	1,338.54606	82.76	1,484.11674	91.76
Paombong	3,848.66606	2,948.81654	76.62	3,413.33934	88.69
Plaridel	3,752.91474	50.52619	1.35	119.15856	3.18
Pulilan	3,568.29286	34.07160	0.95	71.91737	2.02
Santa Maria	8,552.43120	21.64082	0.25	61.93003	0.72
Pandi	4,099.14490	-	-	0.67654	0.02

Areas Affected in Pampanga	Hectares	Hectares (1m SLR)	Percentage	Hectares (2m SLR)	Percentage
Apalit	6,532.80765	787.37463	12.05	1,682.48260	25.75
Arayat	15,387.40681	89.54873	0.58	278.95161	1.81
Bacolor	8,341.02749	480.60168	5.76	915.59347	10.98
Candaba	26,869.96674	454.68011	1.69	1,139.02055	4.24
Guagua	6,401.84089	2,072.43789	32.37	2,971.59490	46.42
Lubao	16,946.46958	6,648.26582	39.23	8,797.85120	51.92
Macabebe	4,357.83796	2,439.96565	55.99	3,220.45795	73.90
Masantol	9,113.51621	7,365.97713	80.82	8,352.15214	91.65
Mexico	11,884.34890	458.21178	3.86	1,134.92164	9.55
Minalin	4,483.96137	2,568.76403	57.29	3,569.15974	79.60
San Fernando	7,250.79449	857.36245	11.82	1,519.57493	20.96
San Luis	5,930.46127	85.91425	1.45	286.53228	4.83
San Simon	5,137.20462	583.46498	11.36	1,205.98972	23.48
Santa Ana	5,258.69729	187.49352	3.57	504.64367	9.60
Santa Rita	2,851.46992	23.07958	0.81	52.83226	1.85
Santo Tomas	1,424.71766	545.49968	38.29	858.16923	60.23
Sasmuan	5,789.04559	4,466.69746	77.16	5,104.64632	88.18

Areas Affected in Bataan	Hectares	Hectares (1m SLR)	Percentage	Hectares (2m SLR)	Percentage
Abucay	8,371.84277	552.12289	6.59	632.24854	7.55
Bagac	22,437.85258	9.94660	0.04	38.95722	0.17
Balanga (Capital)	8,098.22110	170.44663	2.10	253.25474	3.13
Hermosa	14,508.51937	735.85091	5.07	1,143.40667	7.88
Limay	7,423.06706	14.09006	0.19	34.81038	0.47
Mariveles	18,464.21730	49.75222	0.27	108.62841	0.59
Morong	25,017.49163	68.76829	0.27	174.19116	0.70
Orani	6,024.90622	475.35676	7.89	670.95752	11.14
Orion	5,893.12471	160.54935	2.72	258.38854	4.38
Pilar	4,120.32165	297.10575	7.21	364.62387	8.85
Samal	5,165.49828	275.09648	5.33	360.63324	6.98
Dinalupihan	9,376.60099	-	-	0.82776	0.01

Related Initiatives in the Coastal Zones

Coral Triangle Initiatives – Philippines National Plan of Actions

Vision:

A highly productive archipelagic state that is globally unique, resilient and a center of diversity, with vibrant ecological integrity, including all species assemblages, communities, habitats and ecological processes; that sustainably and equitably provides for the socioeconomic and cultural needs of human communities dependent on it, and adaptive to extreme weather events due to climate change; and, where biodiversity and productivity are sustained through the generations by collaborative and adaptive management across all political and cultural boundaries contributing to the vision, goals and objectives of the Sulu-Sulawesi Marine Eco-region and the Coral Triangle.

Mission:

To arrest the accelerating degradation of the natural environment and to conserve the country's biodiversity, in order to maintain ecosystem services, ensure food security, and improve human well- being through effective governance across all geo-political and cultural boundaries.

Framework:

Integrated Coastal Management and related approaches, such as coastal resource management or coastal zone management, shall be the national policy framework to promote sustainable development of the country's coastal and marine environment and resources in order to achieve food security, sustainable livelihood, poverty alleviation and reduction of vulnerability to natural hazards, while preserving ecological integrity.

Goals	Objectives	Strategies	National Actions (2012)
"Priority seascapes" designated and effectively managed effectively managed	"Priority seascape" programs identified, with management and investment plans developed and sequenced. [2010- 2020].	• Conduct rapid assessments of existing Seascape Programs. [2010]. [Note: Philippines agreed to base the definition on the six (6) biogeographic regions] • Conduct rapid assessments of potential new Seascape Programs. [2012]. • Conduct detailed and relevant scientific studies in the bio-physical and socio-economic areas. [2015].	• *Conduct prioritization exercise in support of selecting new seascape from South China Sea, Northeast Pacific Seaboard and Southeast Pacific Seaboard. • *Develop a master plan from which an investment plan will be prepared for the priority seascape. • *Document best practices for sharing with other CT countries.
	"Priority seascape" programs fully functional. [2020].	• Adopt a general "model" for a fully functional seascape program. [2010]. • Secure social and political support with accompanying legal and institutional mechanisms at varying governance levels. [2012]. • Promote ecosystem-based management. [2015]. • Engage private sector. [2015] • Mobilize financial resources necessary to support "priority seascape" programs (based on Seascape Investment Plans). [2015]. • Establish seascape capacity-building and learning mechanisms. [Ongoing]. • Conduct periodic monitoring and evaluation of existing seascape programs. [Ongoing]. • Ensure that Seascapes encompass key biodiversity areas and help protect threatened species [2012].	• Implement Sulu-Sulawesi Seas Action Plans on MPAs, fisheries and species. • Align existing seascape models with policy and legal framework of the Philippines • Implement Executive Order #533 (Adopting Integrated Coastal Management as a national strategy to ensure sustainable development of the country's coastal and marine environment and resources and establishing and supporting mechanisms for its implementation). • Support an effective communications campaign and replication of best practices in the SSME corridors • Support the establishment of MPA networks
Ecosystem approach to management of fisheries (EAFM) and other marine resources fully applied	Strong legislative, policy, and regulatory frameworks for EAFM in nearshore and pelagic fisheries developed. [2012].	• Identify ecological, social-cultural, economic and institutional elements of EAFM and their inter-relationships. [2012]. • Review and strengthen existing legislative, policy and regulatory frameworks. [2011]. • Institutionalize EAFM within the government [2012] • Determine fishing capacity and implement programs to reduce fishing over-capacity. [2015]. • Formulate and implement Phil-POA Regional Plan for IUU. [2015]. • Join together in negotiations of fishery access agreements. [2015].	• Review and update existing policies e.g. Republic Act 8550 (Fisheries Code of the Philippines), National Marine Policy taking into consideration Archipelagic Development Framework (ArchDevt) and Integrated Coastal Management (ICM) to achieve EAFM. • Implement Comprehensive National Fisheries Industry Development Plan (CNFIDP). • Undertake relevant research that will feed into EAFM policy processes e.g. studies on carrying capacity of the ecosystem. • Formulate appropriate implementing or enabling mechanisms.

Goals	Objectives	Strategies	National Actions (2012)
		• Review and redirect perverse economic subsidies and other economic barriers in the fishery sector. [2015]. • Engage the fishing industry in supporting EAFM [2015] • Monitor conservation status of all major fisheries species to determine if they are threatened. [2012]. • Improve functional implementation of fisheries management within municipal waters. [2017].	• Disseminate and implement the National Plan of Action for IUU fishing. • Review projects and focus on integration of resource management policies and projects. • Enforcement and IECC for the seasonal regulation of gears, areas, and species within municipal waters.
	Objective #2 (1). Improved income, livelihoods and food security of coastal communities across the region through a new sustainable coastal fisheries and poverty reduction initiative ("COASTFISH")	• Define and map Poverty and Fisheries Zones to be targeted. [2011]. • Design and launch a national CTI COASTFISH Initiative. [2012]. • Collaborate around the mobilization of significant new financial investments to support COASTFISH. [Ongoing]. • Collaborate around technology and information sharing, lessons learned, and joint marketing of common products. [Ongoing]. • Promote best practices on sustainable full-cycle mariculture and aquaculture practices. [Ongoing]. • Address over-capacity for resource use and attendant health concerns, causing or as an effect of coastal resource management (CRM), as needed. [Ongoing]. • Provide safety nets for overexploitation through provision of sustainable livelihood opportunities.	• Document and review lessons learned from past and current projects on coastal and marine resources management, e.g., FSP/FRMP, FISH Project, Mindanao Rural Development Project, Sustainable Management of Coastal Resources in the Bicol and CaragaRegions (SUMACORE), Integrated Coastal Resource Management Project (ICRMP). • Implement the national integrated coastal management policy. • Conduct value chain analysis of fishery products e.g., tuna, reef fish and small pelagics. • Mobilize financial and technical resources to support national implementation of COASTFISH. • Assist League of Municipalities of the Philippines (LMP) in mainstreaming EAFM through capacity building activities. • Implement sustainable livelihood programs for priority poverty zones (e.g., marginalized fishing communities).
	Sustainable management of shared tuna stocks achieved for all species of tuna exploited in the region, with special attention to spawning areas and juvenile growth stages. [2020].	• Develop collaborative research, information-sharing, strategies for protection of spawning and juvenile growth areas, and financing mechanisms [2010]. • Establish a National Forum on Tuna Governance. [2010].	• Implement National Tuna Management Plan and other management plans for other species e.g. small pelagics, etc. • Formulate national implementing rules and regulations on fishing capacity, vessel monitoring system, fish aggregating device, observer program, etc.

Goals	Objectives	Strategies	National Actions (2012)
		• Develop a comprehensive plan on the markets and trade of tunas and explore ways to utilize its potential to get due benefits with other global trading partners. [2012]. • Mobilize private sector leaders. [Ongoing].	• Refine national vessel registry. • Monitor conservation status of Tunas using IUCN Red List Criteria and Categories.
	A more effective management and more sustainable trade in live-reef fish and reef-based ornamentals achieved. [2020].	• Develop a collaborative work program on management of and international trade in coral reef- based fish and ornamentals (i.e., jointly supported research, information-sharing, system analysis, and strategies for addressing the supply and demand sides of the trade). [2010]. • Establish a CTI Forum on International Trade in Coral Reef-based Organisms. [2010].	• Develop and implement sustainable live reef fish trade (LRFT) management plans in Palawan and Surigao • Update RA 8550 that will reflect a sustainable live reef fish trade (LRFT) in the Philippines • Conduct studies on reef fish spawning aggregation and implement seasonal closure of spawning areas. • Develop mariculture projects for live reef fish species. • Monitor conservation status of live reef and ornamental species using IUCN Red List Criteria.
Marine protected areas (MPAs) established and effectively managed	Objective #1. Coral Triangle-Philippines MPA System (CT-Phil MPAS) in place and fully functional[2020].	• Coral Triangle-Philippines MPA System (CT- Phil MPAS) in place and fully functional [2010]. • Complete and endorse a comprehensive map and corresponding geo-referenced database of MPA networks to be included in CT-Phil MPAS (i.e., local MPAs and NIPAS). [2012]. • Collaborate to build capacity for effective management of the CT-Phil MPAS. [Ongoing]. • Strategy #4. Collaborate around mobilizing sustainable financing for the CT-Phil MPAS. [2010]. • Collaborate on the establishment of effectively managed MPAs and network of MPAs.[Ongoing]. • Establish a public / private partnerships or Working Group for engaging the relevant industries, primarily tourism and travel, oil and gas industries industry, in supporting CTMPAS. [2010].	• Support the adoption and implementation of the Philippine marine sanctuary strategy • Support the implementation of the SSME MPA Sub-Committee Work Plan • Identify priority marine key biodiversity areas (mKBA) in the Philippines with at least one operational MPA network in each mKBA, develop management plans and necessary policy studies and recommendations. • Link, network and develop new marine national Centers of Excellence that will serve the country. • Strengthen capacity of local government units and support services of the national government agencies on MPA management • Implement effective management of Tubbataha Reef National Park and Cagayancillo, Turtle Island Wildlife Sanctuary. • Implement the Coastal Resources and Fisheries Conservation Project (CRFC)

Goals	Objectives	Strategies/	National Actions (2012)
Climate change adaptation measures achieved	Region-wide Early Action Climate Change Adaptation Plan for the near-shore marine and coastal environment developed and small island ecosystems developed and implemented. [2011].	• Complete assessment of current climate trends and future projections, vulnerabilities based on current climate risks and trends and formulated strategies to reduce vulnerabilities to climate risks. [2011]. • Conduct assessment on current capacities to establish baseline and identify priority gaps and develop capacity-building programs. [2012]. • Develop country specific plan of action to address the most important *and immediate* adaptation measures based primarily on analyses using existing models. [2011]. • Mobilize resources to finance the implementation of the climate change adaptation measures [2011].	• Identify coastal areas and communities in the country that are most at risk to climate change impacts. • Assess the presumptive climate change impacts on biodiversity, fisheries productivity, ecology of coastal and marine habitats and ecosystem services • Identify, document and implement immediate adaptation measures to climate change of the coastal communities to sea level rise, flooding, storm surges, etc. • Mainstream early warning systems for vulnerable coastal settlements as a result of impacts of climate change. • Formulate a national (Philippines) climate change Adaptation Plan and mobilize resources for implementation • Identify species and areas most resilient to climate change and target these for conservation action.
	Networked National Centers of Excellence on Climate Change Adaptation for marine and coastal environments are established and in full operation. Identify the most important and immediate adaptation measures that should be taken across all Coral Triangle countries, based primarily on analyses using existing models. [2013].	• Design and implement a Pilot Phase for National Centers of Excellence. [2012]. • Support scientific researches, economic analysis and valuation studies on climate change impacts including studies of the economic cost of action and inaction. [2012]. • Develop and Implement communications and information management strategies. [2012]. • Enhance the current mandate and terms of reference of designated "focal point" to incorporate regional sharing of ideas, models, and information, and organize discussion on policies and practices, among others on climate change adaptation on coastal and marine. [2012].	National Actions [2012]: • Identify the appropriate institutional mechanism to coordinate activities on climate change adaptation and mobilize financial and technical resources • Evaluate costs and benefits of actions and inactions to climate change impacts in the coastal zones • Mobilize financial and technical resources to support the national center of excellence, if needed • Develop appropriate communication messages on climate change adaptation and incorporate these in formal and non-formal education channels.

Goals	Objectives	Strategies	National Actions (2012)
Threatened species status identified and identified and improved	Improved status of sharks, sea turtles, seabirds, marine mammals, corals, seagrasses, mangroves and other threatened marine flora and fauna placed on the IUCN Red List of Threatened Species will no longer be declining (2015), followed by a clear trajectory toward an improved status (2020), as key steps for preventing their extinction and supporting healthier overall marine ecosystems. [2020].	• Assess species status by supporting ongoing and new assessment programs. [2012]. • Complete and implement the Philippines' National Shark Action Plan. [2012]. • Complete and implement Philippines' National Sea Turtles Conservation Action Plan. [2012]. • Complete and implement Philippines' National Seabird Conservation Action Plan • Complete and implement Philippines' National Marine Mammal (Cetaceans and Dugong) Conservation Action Plan. [2012]. • Complete and implement region-wide Conservation and Active Recovery Action Plan for Targeted Reef Fish and Invertebrate Species that are threatened • Complete and implement Philippines National Plan of Action on Invasive Alien Species (RPOA-IAS). • Adopt and strengthen (i) local and national legislative, policy and regulatory frameworks and (ii) regional and international agreements on threatened species, and put in place supporting networks and information management systems. [2013]. • Jointly develop and implement capacity building activities that support the above actions on threatened species	• Red list assessments of priority marine species in the Philippines under Global Marine Species Assessment (GMSA)[Note: currently in proposal stage; to include sharks, corals, sea grasses, mangroves, and other taxocoenes(select invertebrates, commercial and endemic teleosts, seasnakes, macro-algae, cetaceans, dugong)]. • Endorsement and implementation of the National Plan of Action for the Conservation and Management of Sharks and other Cartilaginous Fishes. • Support establishment of National Red List Committees on marine turtles, cetaceans and dugong, and adopt National Action Plans (NPOAs) for the Conservation and Management of Sea Turtles, Cetaceans and Dugong. • Survey and monitoring ofseabirds in priority marine key biodiversity areas (mKBAs) in the Philippines • Conduct stock assessments, evaluate catch trends of commercially important species, and propose management recommendations for overexploited fish species/ populations by BFAR/NFRDI/NSAP (National Stock Assessment Program of the Bureau of Fisheries and Aquatic Resources - National Fisheries Research and Development Institute). • Support IUCN Red List training for local/national experts and species specialists (from academia and government agencies). • Develop National Plan of Action for Invasive Alien Species.

Major Science and Information Needs for Management

- Seascapes: Rapid Assessment Techniques at seascape level
- EAFM: Carrying capacity of ecosystems; Fisheries data banking; Observer program; Hatchery techniques for high-value organisms
- MPA: marine KBA;MPA connectivity; GIS modeling of gene flow;
- Climate Change: Species vulnerability and resiliency from global climate change; Disaster risk management and preparedness; simulation modeling;
- Threatened Species: Taxonomy; Biodiversity monitoring; Threat identification, quantification and mapping; Fisheries interaction (bycatch); Monitoring and mapping of trade routes; genetic “bar coding”; NDF (non-detrimental findings) methods/protocols; Biological pollution control (e.g., Invasive Alien Species).
- Cross-ref: Standardize scientific data storage and retrieval system; valuation of natural resources and ecological services

Major Governance and Institutional Needs

- Institutional networking (Species, MPAs, Seascapes)
- Harmonization of local, national, regional and international policies and laws
- Law enforcement (national and transboundary)
- Sustainable financing mechanisms
- Local governance capacity building
- Piracy
- Foreign poaching
- Zoning of and within municipal waters/ of municipal waters in off-shore islands
- Navigational lanes for large vessels (oil tankers)

REFERENCES

Bureau of Fisheries and Aquatic Resources, Department of Agriculture (BFAR). 2005.

Cabanilla. 1996:4

Corfee-Morlot, J., L. Kamal-Chaoui, M.G. Donovan, I. Cochran, A. Robert and P.J. Teasdale. 2009. "Cities, Climate Change and Multilevel Governance." OECD Environmental Working Papers N° 14, 2009, OECD publishing, OECD.

Curran, S., Kumar, A., Lutz, W., and Williams, M., 2002. Interactions between coastal and marine ecosystems and human perspectives on how consumption mediates this interaction." Ambio 31- 4.

David, L., R. Borja and C. Villanoy. 2011. Coastal Sector Vulnerability Assessment for the MDGF Project.

David. 2010.

DENR. n.d. "Mainstreaming CRMP in local governance: CRMP Experience DENR." Available at: http://siteresources.worldbank.org/INTPHILIPPINES/Resources/jatulanmainstreamingCRMBeachEcoWatchProgram2.pdf

Department of Environment and Natural Resources – Philippines (DENR). 2002. Philippine Biodiversity Conservation Priorities, A Second Iteration of the National Biodiversity Strategy and Action Plan, Ong, PS, L.E. Afuang and RG Rosell-Ambal (eds.),Department of Environment and Natural Resources – Protected Areas and Wildlife Bureau, Conservation International Philippines, Biodiversity Conservation Program, University of the Philippines Center for Integrative and Developmental Studies, and Foundation for the Philippine Environment, Quezon City, Philippines.

Heinz, H. John III. 2002. Center for Science, Economics and the Environment. www.heinzctr.org/Major_Reports_files/Human%20Links%20to%20Coastal%20Disasters.pdf

Housing and Land Use Regulatory Board (HLURB). 2011. Status of Provinces, Cities and Municipalities with and without Approved CLUPs. Available at: http://hlurb.gov.ph/uploads/lgu/STATUSCLUPDec2011.pdf and http://hlurb.gov.ph/services/local-government-units/status-list-of-clup-preparation

IPCC. 2007.

Jacinto, G.S., Velasquez, I.B., San Diego-McGlone,M.L.,Villanoy, C.L. and Siringan, F.B. 2006."Biophysical Environment of Manila Bay–Then and Now", in Wolanski, E.(ed.). The Environment in AsiaPacific Harbours.Springer:Dordrecht,The Netherlands. p. 293-307.

Kay, R. 2006. Handout materials during the CGE Hands-on training workshop on Vulnerability and Adaptation Assessments for the Latin America and the Caribbean Region Asuncion, Paraguay, 14 to 18 August 2006

Manila Bay Environmental Management Project (MBEMP). 2001. Manila Bay Coastal Strategy. Available at: http://emb.gov.ph/mbemp/dloads/mbcs%2001bgd.pdf and http://beta.pemsea.org/publications/manila-bay-coastal-strategy.

MBEMP. 2005. Initial Valuation of Selected Uses and Habitats and Damage Assessment of Manila Bay. http://pemsea.org/pdf-documents/initial_valuation_mb.pdf

Metro Manila Development Authority (MMDA). www.gov.ph/section/briefing-room/metro-manila-development-authority.

Muto, M., 2010: Impacts of Climate Change upon Asian Coastal Areas: The Case of Metro Manila JICA Research Institute, 154 pages

Nicholls, R.J. 2011. Planning for the impacts of sea level rise. Oceanography (24(2): 144-157, doi:10.5670/oceanog.2011.34

Nicholls. 1995.

Nicholls. 2002.

Partnerships in Environmental Management for the Seas of East Asia (PEMSEA). 2009. Manila Declaration on Strengthening the Implementation of the Integrated Coastal Management for Sustainable Development and Climate Change Adaptation in the Seas of East Asia Region. http://beta.pemsea.org/publications/manila-declaration

Perez, RT, LA Amadore and RB Feir. 1999. Climate Change Impacts and Responses in the Philippine Coastal Sector. Climate Research Vol. 12: 97-107. 27 August 1999.

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). 2000. Storm Surge Occurrences in the Philippines, Quezon City.

Porio E., 2011: Vulnerability, Adaptation, and Resilience to Floods and Climate Change-Related Risks among Marginal, Riverine Communities in Metro-Manila. Asian Journal of Social Science 39 (2011): 425-445.

Rodolfo, K. and Siringan F. P. 2006. "Global sea-level rise is recognized, but flooding from anthropogenic land subsidence is ignored around northern Manila Bay, Philippines." Disasters, 2006, 30(1): 118−139. © Overseas Development Institute, Published by Blackwell Publishing, 9600 Garsington Road, Oxford, OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA.

Siringan, F. P., Y.Y. Sta. Maria1, C.L. Villanoy, M.Martin, L.T.David, R. Borja, J. Aggangan, R. Capistrano. 2010. Sea-level changes in the Philippines: causes and some consequences.

The Manila Observatory. 2011. www.observatory.ph.

UNEP-UNISDR. 2007.