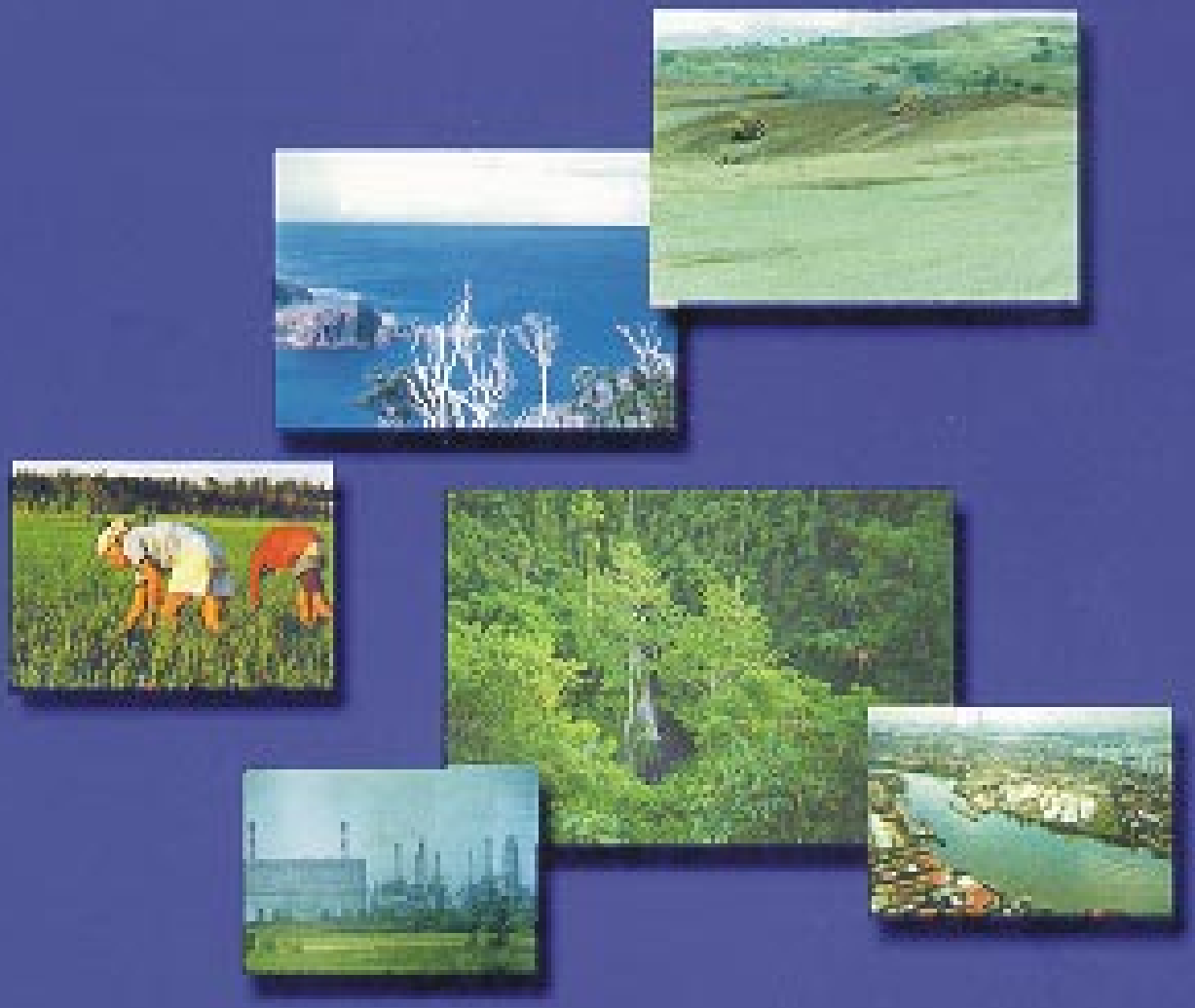
The Philippines' Initial National Communication on Climate Change



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ABBREVIATIONS OF AGENCIES AND ENTITIES

ADB - Asian Development Bank
AHAM - Association of Home Appliances Manufacturers
ANEC - Affiliated Non-Conventional Energy Centers
BEAP - Biomass Energy Association of the Philippines
BFAR - Bureau of Fisheries and Aquatic Resources
BPS - Bureau of Product Standards
CGSD - Coast and Geodetic Survey Department
COP - Conference of the Parties
DA - Department of Agriculture
DAR - Department of Agrarian Reform
DENR - Department of Environment and Natural Resources
DOE - Department of Energy
DOH - Department of Health
EMB - Environmental Management Bureau
FMB - Forest Management Bureau
GEF - Global Environment Facility

HIS	-	Health Intelligence Service
IACCC	-	Inter-Agency Committee on Climate Change
IPCC	-	Inter-Governmental Panel on Climate Change
IRRI	-	International Rice Research Institute
JICA	-	Japan International Cooperation Agency
NAMRIA	-	National Mapping Resources and Information Administration
NDRB	-	National Disaster Reduction Branch
PAGASA	-	Philippine Atmospheric, Geophysical and Astronomical Services Admistration
PSES	-	Philippinje Solar Energy Society
UNDP	-	United Nations Development Programme
UNEP	-	United Nations Environment Programme
UNFCCC	-	United nations Framework Convention on Climate Change
USAID	-	United States Agency for International Development
WEAP	-	Wind Energy Association of the Philippines
WMO	-	World Meteorological Organization

OTHER ACRONYMS/ABBREVIATIONS USED

ALGAS	-	Asia Least-Cost Greenhouse Gas Abatement Strategy
ASLR	-	Accelerated Sea Level Rise
BCF	-	Billion Cubic Feet
BFOE	-	Barrel of Fuel Oil Equivalent
BOD	-	Biochemical Oxygen Demand
^{o}C	-	Degree Centigrade
CCCM	-	Canadian Climate Center Model
CERES	-	Crop-Environment Resource Synthesis
CH	-	Methane
CO^{4}	-	Carbon Dioxide
DES^{2}	-	Decentralized Energy Systems
DSM	-	Deman Side Management
DSSAT	-	Decision Support System for Agrotechnology
EEZ	-	Exclusive Economic Zone
ENSO	-	El Niño-Southern Oscillation
E.O.	-	Executive Order
GCM	-	Global Circulation Model
GDP	-	Gross Domestic Product
GFDL	-	Geophysical Fluid Dynamic Laboratory Model
Gg	-	Gigagram
GHG	-	Greenhouse Gas
GISS	-	Goddard Institute for Space Studies
GNP	-	Gross National Product
GWH	-	Gigawatt-hour
GWP	-	Global Warming Potential

Ha	-	Hectares
HFC	-	Hydrofluorocarbons
HRIP	-	Heat Rate Improvement of Power Plants
IBSNAT	-	International Benchmark Sites Network for Agrotechnology
IEPC/EMS	-	Industrial Efficiency and Pollution Control/ Environmental Management Strategy
Ktons	-	Kilotons
KPA	-	Key Production Area
M	-	Meter
MCM	-	Million Cubic Meters
Mha	-	Million Hectares
MMBFOE	-	Million Barrels of Fuel Oil Equivalent
MMBO	-	Million Barrels of Oil
MMT	-	Million Metric Tons
MPFD	-	Master Plan for Forestry Development
MTADP	-	Medium Term Agriculatural Development Plan
MW	-	Megawatt
NAP	-	National Action Plan
NCR	-	National Capital Region
NMVOC	-	Non-Methane Volatile Organic Compound
N_2O	-	Nitrous Oxide
NOx	-	Nitrogen Oxides
NRE	-	New and Renewable Energy
PEP	-	Philippine Energy Plan
PHP	-	Philippine Pesos
PRCS	-	Philippine Road Classification Study
RA	-	Republic Act
RH	-	Relative Humidity
SIMRIW	-	Simulation Model for Rice-Weather Relations
SLR	-	Sea Level Rise
SLRP	-	System Loss Reduction Program
SO_2	-	Sulfur Dioxide
sq.km.	-	Square Kilometer
TLA	-	Timber License Agreement
TTED-DLF	-	Technology Transfer for Energy Development - Demonstration Loan Fund
UKMO	-	United Kingdom Meteorological Office
V & A	-	Vulnerability and Adaptation

Foreword

Climate change is a very emotional subject for the Philippines because the issue is viewed not only as causing additional economic burdens, but as a critical factor that would determine its survival as a nation. Many of its people are in the coastal areas and at risk from the impacts of extreme climatic events, sea level rise and degradation of marine ecosystems. The effects of climate change on agriculture, forestry and water resources will further encumber a country already reeling from a host of socio-economic and environmental problems.

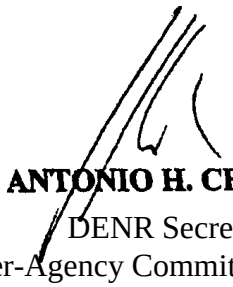
As a country Party to the United Nations Framework Convention on Climate Change (UNFCCC), however, the Philippines stands ready to comply with its obligations, foremost of which is the submission of its Initial National Communication. We are, therefore, very pleased to share the document with the international community, because it represents the collective efforts of the government and the private sector.

The report documents not only compliance to our main commitments, particularly the national greenhouse gas inventory, but also voluntary efforts on greenhouse gas abatement. The rest of the report gives a sampling of how vulnerable the Philippines is to the impacts of climate change based on initial studies, including the resource needs to adapt to these impending ecological changes.

We would like to underscore the fact that while significant gains have been made in terms of developing and strengthening the processes and institutions involved in producing the country's national communication, a lot of work still needs to be done. These would include: institutionalization of the greenhouse gas inventory process in the various concerned government agencies, harnessing the contribution of the academe, development and refinement of activity data and emission factors, as well as, conduct of more vulnerability and adaptation studies.

Obtaining a comprehensive picture on how the climate change problem is evolving, requires full disclosure of vital information from all parties of the Convention. For most, particularly the developing ones, this would mean a long and painstaking process, needing the establishment of mechanisms and utilization of precious resources.

But as the adage goes, a journey of a thousand miles starts with the first step. And the Philippines has taken the critical and most important one. Along with other committed country Parties of the UNFCCC, it stands ready to complete the process



ANTONIO H. CERILLES
DENR Secretary
Chair, Inter-Agency Committee on Climate Change

Executive Summary

As a country Party to the United Nations Framework Convention on Climate Change (UNFCCC), the Philippines is bound by its commitment to prepare and submit its National Communication on Climate Change. The preparation was made possible under the project PHI/97/G31 entitled "Enabling the Philippines to Prepare Its First National Communication in Response to Its Commitment to the UNFCCC," with financial assistance from the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP). The Initial National Communication contains a national inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases, a description of steps taken or envisaged by the country to implement its commitment, and other information relevant to the achievement of the objective of the Convention.

Geography and Topography

The Philippines, as an archipelago, is highly vulnerable to the potential impacts of climate change. Geographically, the country is considered a medium-size nation with a total area of 299,404 square kilometers. The Philippines lies between 5^{o} to 20^{o} north of the equator. It has 7,107 islands and rocks, 1,000 of which are inhabitable. There are three (3) major island groups in the country, namely: *Luzon*, *Visayas* and *Mindanao*. The country's topography is characterized by large mountainous terrain with narrow coastal plains and interior valleys and plains.

Climate and Weather

The Philippines has a humid equatorial climate marked by high temperatures and heavy annual rainfall. It is located within the region of ascending air and widespread equatorial cloudiness. Annual rainfall measures as much as 5,000 millimeters in the mountainous parts of the country, but less than 1,000 millimeters in some of the sheltered valleys. The mean annual temperature is about 27^{o}C. The hottest months are April, May and June while the coldest months are December, January and February. In general, the highest temperatures are observed in valleys and plains. The

highest temperature recorded in the Philippines was 42.2 °C while the absolute minimum temperature was 3.0°C. On the average, the prevailing wind in the Philippines from October to February is northeasterly (coming from the northeast, or *amihan*), easterly from March to May due to the Pacific trade winds, and southwesterly (*habagat*) from June to September. In terms of tropical cyclones, the Philippines experiences about 20 tropical cyclones annually.

Natural Resources

Forest Lands

The country has a total of about 15 million hectares of forest lands and 14.12 million hectares of alienable and disposal lands. Unfortunately, the Philippine forests, considered among the most diverse in the world, are also among the most endangered. The country's forest cover has been steadily dwindling, at an average rate of 2 percent per annum. As of 1997, the Philippines has only about 5.4 million hectares of remaining forests left, a mere 18 percent of the country's total land area. Of these, about 804,900 hectares of old growth forest remain, from the 27.5 million hectares in 1575.

Agricultural Lands

Agriculture is the country's economic lifeline, but agricultural production in the Philippines has been traditionally concentrated on only a few main crops, particularly, rice and corn. Coconut and sugar cane constitute important export commodities. Almost ninety percent (90%) of the alienable and disposable lands are devoted to agricultural production. An estimated 45% of these agricultural lands are located in the lowlands and 33 percent in the uplands. In 1996, of the 12.94 million hectares of agricultural lands, 30.5% are planted to rice; 21.1 % percent to corn; 23.9 % to coconut; and 25.5 % to sugar cane, cassava, banana, and others.

Wetlands

Philippine wetlands of international importance cover about 14,100 sq. km. consisting of 61 coastal wetlands, 22 lakes, and 8 freshwater swamps and marshes. Sixty-nine percent of these are in the moderately to highly threatened status.

Biological Diversity

The complex history of sedimentation, submergence, folding, metamorphism, igneous activity, uplift, and erosion has influenced the composition and distribution of present-day flora and fauna. There are at least 14,500 plant species, representing about five percent of the world's flora. The research conducted by various scientists between 1950 and 1995 show that there are about 185 species of mammals, 558 species of birds, 252 species of reptiles, 95 species of amphibians, 54 species of millipedes, 44 species of centipedes, 341 species of spiders, 2,782 species of mollusks, and more than 20,000 species of insects. Marine species include 488 species of corals, about 2,400 species of protozoans, and 6 species of seagrasses. As of 1991, 89 species of birds, 44 species of mammals, and 8 species of reptiles are internationally recognized as threatened. These species include the Philippine Eagle (*Pithecophaga jefferyi*) and the Tamaraw (*Bubalus mindorensis*).

Water Resources

The country is classified into 12 water resources regions, which are defined by hydrological boundaries, physiographic features and climate homogeneity. There are 343 independent principal river basins with areas of at least 40 sq. km.

each, covering a total of 199,637 sq. km. or 66.5 percent of the country's total land area. Of these, 20 are major river basins each covering at least 990 sq. km. These are sources of municipal and domestic water supply, irrigation, and power generation. Likewise, the Philippines has 61 lakes totaling more than 2,000 sq. km., 23 of which have areas more than 100 hectares. The country also has extensive groundwater resources estimated to cover an aggregate area of 50,000-sq. km. and storage of about 251,158 MCM.

Coastal Resources

Philippine marine territorial waters cover about 2.2 million sq. km., of which 267,000 sq. km. (12 percent) are coastal waters and 1.934 million sq. km. (88 percent) are oceanic waters within the exclusive economic zone (EEZ). There are about 185,000 sq. km. of shelf area within a 200-m depth. The country's total discontinuous coastline is approximately 32,400 kilometers with eighty percent of the provinces and 65 percent of the cities and municipalities sharing the coast. There are 20 landlocked straits and 61 natural harbors. The Philippine coral reefs cover about 27,000 sq. km. within a 15- to 30-m depth. These reefs yield 10-15 percent of the total annual fish production. Unfortunately, the Philippine coral reefs continue to be degraded and destroyed.

Demography/Population Trends

The national population was declared at 68,616,536 in 1995 and was estimated to be 73,527,000 in 1997. The country's population is projected to reach 126 million by 2020. The Philippines is considered the 9th most populous country in Asia and the 14th largest country in the world. Population density increased from 160 persons per square kilometer in 1980 to 228 in 1995. There are 28 provinces with 102 municipalities located in coastal areas occupying 129,114 hectares. The Philippines, still being predominantly rural, has more than half of its population residing in the rural areas. However, the proportion of the urban population increased from 37.44 percent in 1980 to 48.5 percent in 1990. In 1996, the total urban population constituted 55% of the total national population.

Health

During the period 1992-1997, life expectancy increased from 66.5 years to 68.0 years. The basic health indicators also improved over the span of (6) years. The morbidity and mortality trends of communicable diseases, in particular, acute respiratory infections such as pneumonia, bronchitis and influenza decreased in the past six (6) years. The incidence of sanitation-related diseases associated with unsafe water supply, poor sanitation coupled with improper food handling, i.e., diarrhea, cholera, typhoid and intestinal parasitism was also reduced. The incidence of measles, pertussis, neonatal tetanus and diphtheria likewise marked improvement. Chronic communicable diseases are also on the decline. Although there was an improvement in the incidence and prevalence of tuberculosis in the Philippines, it remains a serious public health problem. Leprosy also declined, its prevalence rate decreased from 2.39 to 1.2 per 10,000 population in 1997.

Economy

The gross national product and gross domestic product have recovered from the stagnation in 1991 and have been on an upward trend until 1996. GNP grew to 6.9% and GDP, 5.7% in 1996. Despite the Asian currency turmoil that surfaced in July 1997, the country still managed to have a 5.8% and 5.1% annual growth rate for GNP and GDP, respectively. In 1994, gross national product (GNP) was pegged at US$65.661 billion and gross domestic product (GDP) at US$ 64.018

billion. The GDP per capita was pegged at US$954.92. Exports reached a total of US$ 21.650 billion while imports were at US$ 25.688 billion.

Energy Production and Consumption

Imported coal and crude oil, accounting for 73.60% of the total energy supply in 1995 provide a bulk of the country's energy supply. Conventional (oil, coal, hydro, geothermal) and non-conventional indigenous sources (bagasse, agri-waste, others) comprise the remaining 26.40% of the total national energy supply. The Philippines has a number of indigenous resource options, but most of these remain largely unexplored and underexploited. The country has estimated reserves of about 400 million barrels of oil and 4.5 trillion standard cubic feet of natural gas. Geothermal energy is one indigenous resource that abounds in the country with potential reserves conservatively estimated at 4,000 MW. In terms of energy consumption, there was an upward trend from 1990 to 1995. Moderate growth was posted for the period, with a steep increase in energy consumption from 1993 to 1995. A total of 138.32 million barrels of fuel oil equivalent (MMBFOE) was consumed in 1993, 146.85 MMBFOE in 1994, and 159.85 MMBFOE in 1995. The energy to GDP ratio grew steadily from 0.17 BFOE/000 GDP in 1990 to 0.20 BFOE/000 GDP in 1995. During the same period, the country posted an average energy intensity of 0.18 BFOE per thousand GDP.

Political Units

Administratively, the country is divided into 16 political regions. As of April 1998, the Commission on Elections listed 78 provinces, 85 cities and 1,525 municipalities. The smallest political unit is the *barangay*, of which there are 41,925.

National Coordination Mechanism on Climate Change

The Philippines was among the first countries to respond to the challenge of the climate change phenomenon. As early as May 8, 1991 the Philippine government created the Inter-agency Committee on Climate Change (IACCC) by virtue of Administrative Order No. 220. The IACCC is composed of 15 government agencies and NGO representatives. The IACCC was established to coordinate various climate change related activities, propose climate change policies and prepare the Philippine positions to the UNFCCC negotiations. The IACCC is co-chaired by the Secretary of the Department of Environment and Natural Resources with the Secretary of the Department of Science and Technology.

1994 National GHG Inventory

In 1994, the Philippines released a total equivalent amount of 100,738 ktons of CO_2 into the atmosphere. This is due to the combined effect of GHG emissions from the four sectors of Energy, Industry, Agriculture, and Wastes, and the net uptake (sink) of GHGs from the LUCF sector. In the global context, this national amount is still minimal relative to the GHG emissions of other nations, especially those of developed country parties to the UNFCCC.

Without the contribution of the still controversial LUCF sector, the national GHG total amounts to 100,864 ktons of equivalent CO_2. Of the four non-LUCF sectors responsible for the country's sources of GHGs, the Energy sector is the most significant, accounting for about 49% of the national total. This is trailed closely by the Agriculture sector's contribution of about 33%. Industry and Wastes follow with respective con-

tributions of 11% and 7% of the total. In contrast with these four sectors which act as GHG sources, activities and processes associated with the LUCF sector are estimated to sequester about 126 ktons of CO_2, which is seemingly insignificant (0.1%), compared to the national total.

GHG Emissions Projections For 2008

The country's future GHG emissions for 2008 were calculated by projecting only those subsectors that had significant contributions to the sectoral subtotals. With all other emissions from the other subsectors pegged conservatively at their 1994 values, the national GHG emissions total from all five sectors is projected to increase to 195,091 ktons of equivalent CO_2. This constitutes a rise of 94% relative to the 1994 total of 100,738 ktons in a matter of 14 years, or an annual growth rate of 4.8%. Baseline and projected GHG emissions are shown in Figure 3.1. Because various subsectors were held constant at 1994 levels, this 2008 projection may be a conservative estimate.

General Description of Steps

The Philippines has adopted the Philippine Strategy for Sustainable Development (PSSD) which serves as the blueprint for the country's sustainable development efforts, as well as, the Philippine Agenda 21 (PA 21). The PA 21 "envisions a better quality of life for all, the development of a just, moral, creative, spiritual, economically vibrant, caring, diverse yet cohesive society characterized by appropriate productivity, participatory and democratic processes and living in harmony within the limits of the carrying capacity of nature and the integrity of creation."

For systematic observation on climate and weather, the Philippines has a number of network observation stations operated and maintained by Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). These networks include synoptic weather stations, upper-air stations, hydrometeorological/flood forecasting/storm surge stations, agrometeorological/climatological stations, marine observing systems and special observation stations for air quality including ozone monitoring. Completed climate related researches include: Epidemiological Study for Metro Manila Using Climate Variability; Country Study to Address Climate Change Issues and Concerns; and Investigation on Systems Responses to Sea Level Changes of Some Selected Locations in the Philippines. On-going researches are the Development of a Climate Information Monitoring and Prediction System, and Climatological Study on the Changes in the Tropical Cyclone Intensity in the Philippine Area of Responsibility. About six (6) research studies are envisioned to be undertaken in the future.

Many activities are likewise being undertaken for the education, training and awareness raising of the public on climate change issues. The government, industry and non-government organizations, with assistance from various international organizations, extending efforts to inform and educate the general public on the possible adverse impacts of climate change.

The Philippines, being an archipelagic country with a prevailing tropical climate, would be highly vulnerable to the impacts of climate change. Based on this premise, vulnerability assessment(s) on some sectors have been undertaken. At least four Global Circulation Models (GCMs) at double CO_2 concentration scenario were used for these studies. In agriculture, the simulation results showed that while a general increase in yield for rice was noted, maturity period decreased. For corn, the simulation showed a decrease in yield. In the water resources sector, vulnerability studies were done on two major water resources, namely: the Angat reservoir and

Lanao Lake. Results showed that Angat reservoir is projected to be seriously affected. Similar results have been predicted for the Lanao Lake. Vulnerability assessment for coastal resources generally showed that given the existing situation, anthropogenic global warming due to increasing GHG emissions which may lead to accelerated sea level rise (ASLR) will exacerbate the vulnerability of the coastal ecosystems. Likewise, many areas along the coast will succumb to a one-meter sea level rise. In the forestry sector, prediction(s) indicate that changes in rainfall pattern may increase rate of conversion of forest(s) to agricultural lands due to human migration from areas degraded by drought and erosion to more productive forest lands. A decrease in soil moisture in drier areas may accelerate forest loss while an increase in precipitation beyond evaporation demand could increase runoff resulting in soil erosion and flood occurrences. The local biodiversity will also decrease through extinction and inhibition of reimmigration from adjacent areas. Preliminary results of the health study conducted showed that, indeed, there is an indicative trend of about 10% to 58% association between climate change (using crude measurement) and health (as indicated by disease incidence). However, the results need to be validated and, therefore, more studies must be undertaken.

Adaptation measures and strategies were initially identified based on the vulnerability assessments made in the various sectors to cope with the impending impacts of climate change in the country. The measures were derived from various sectoral consultations, as well as, a review of existing policies and measures within the respective sector.

Under the UNFCCC, although it is the developed country Parties which have the primary responsibility to adopt policies and measures to limit their anthropogenic emissions of greenhouse gases and report these to the Conference of the Parties for its review, the Philippine government has formulated and has started to implement mitigation measures to limit its GHG emissions. These measures are reflected in the various sectoral plans, particularly those of the Energy, Transport and Agriculture sectors, and the National Action Plan on Climate Change which is still to be adopted.

Financial, Technological Needs and Constraints

The Philippines is faced with many constraints in implementing its commitments under the Convention. On the national inventory of GHG emissions, among the main issues and concerns are the availability, reliability and variability of activity data and local emission factors, and institutionalization and linkages among government agencies of the inventory process.

Among the main issues confronting the Philippines involving mitigation of greenhouse gases is the affordability of the technologies it prefers to use, e.g. utilization of renewables in power production. In view of this, interventions in terms of overcoming market barriers for the widespread use of renewables need to be undertaken. Also, more applications should be implemented to gain field experience and additional operating data.

For vulnerability assessment and adaptation, the studies conducted were limited and, therefore, more in-depth studies must be undertaken to enable the country to prepare and develop appropriate measures and actions with regards to the possible impacts of climate change. Considering the current economic condition of the country, outside or international assistance is highly imperative to conduct these activities.

Introduction

Pursuant to Article 4 of the United Nations Framework Convention on Climate Change (UNFCCC), parties are to "communicate to the Conference of the Parties (COP) information related to the implementation of commitments, in accordance with Article 12." Article 12.5 of the UNFCCC specifies that developing country Parties shall submit their initial communication "within three years of entry into force of the Convention" or upon availability of financial resources in accordance with Article 4.3. The said provision cites that Annex II country Parties shall provide new and additional financial resources to meet the agreed full costs incurred by developing country Parties in preparing their national communications. The Philippines formally availed of such resources on April 1, 1998 from the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP) under the project PHI/97/G31 entitled "Enabling the Philippines to Prepare Its First National Communication Programme in Response to Its Commitment to the UNFCCC."

According to Article 12.1 of the Convention, the following general information are to be contained in the National Communications of non-Annex I country Parties to be submitted to the COP:

a.) a national inventory of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol;

b.) a general description of steps taken or envisaged by the Party to implement the Convention; and

c.) any other information that the Party considers relevant to the achievement of the objective of the Convention.

The Conference of Parties elucidated on this further through Decision 10/CP.2 on "Guidelines, Facilitation and Process for Consideration of Communications from Parties not included in Annex I to the Convention."

It must be underscored that this initial national communication, while drawing heavily on the results of PHI/97/G31, also took into consideration the outcomes of some earlier initiatives like the Country Studies Program, the National Action Plan on Climate Change, the Asia Least Cost Greenhouse Gas Abatement Strategy and the sectoral plans & programs, as well as, the Medium Term Development Plan and the Philippine Agenda 21.

Chapter I

NATIONAL CIRCUMSTANCES

The Philippines, as an archipelago, is highly vulnerable to the potential impacts of climate change. At the same time, the country's tropical climate, regional differences, land use patterns, high rate of population growth, poor economic conditions, political environment, and lifestyles all serve to create a high demand of energy, with its associated greenhouse gas (GHG) emissions.

Geography

Considered as a medium-size country, the Philippines ranks 57th in the world, with its 299,404 square kilometers constituting approximately 2 percent of the world's total land area.

The Philippine archipelago stretches 1,840 km north-south between 4°9' and 21°7' north of the equator. Its westernmost boundary is at longitude 116°4' E while the eastern territorial limit is along the 127° E meridian. The archipelago comprises a total of 7,107 islands spread over the 2.2 million sq. km. of water within its exclusive economic zone. Its long discontinuous coastline is approximately 32,400 km, second only to Indonesia with its more than 16,000 islands. Three seas bound the Philippines: the South China Sea on the west and north, the Pacific Ocean on the East, and the Celebes Sea and the coastal waters of Borneo on the south **(See Figure 1.1)**.

Of the Philippines' 7,107 islands and rocks, only 2,803 are named and nearly 1,000 islands are inhabited. The 16 largest islands are *Luzon, Mindanao, Palawan, Mindoro, Panay, Samar, Negros, Leyte, Cebu, Masbate, Bohol, Catanduanes, Basilan, Marinduque, Busuanga*, and *Sulu*.

Topography

The Philippines has not always been where it is and not all of its islands belong to one distinctly linked system. This archipelago has varied geologic origins and possesses unique biological attributes. By combining paleomagnetic and radiometric data, scientists are slowly piecing together the genesis of the Philippines. The emerging picture is not one of slow static accretion of material but rather of dynamic shifting and collision of plates, welded together in an island arc and punctuated by episodic and extensive magmatic activity.

Most of the archipelago belongs to the Philippine mobile belt, a composite strip of different lithospheric blocks that grew during the Ter-

Figure 1.1 Map of the Philippines

tiary period, about 65 million years ago. Other parts of the Philippine archipelago, including the *Palawan* Micro-continental block (*Palawan* and *Mindoro*) and *Zamboanga*, are marginal continental blocks of the Eurasian plate, which are colliding eastward with the Philippine mobile belt.

The Philippine mobile belt is mainly a result of the oblique convergence of the Eurasian and Philippine Sea plates. This convergence proceeds at a rate of about 8 cm per year.

Many islands were once situated elsewhere or came from diverse tectonic origins and scientists are still studying their geologic births. These findings may explain the differences in the island's physical features and endemic flora and fauna. They may also explain why the Philippines has features in common with its Southeast Asian neighbors. The geologic and tectonic evolution of the Philippines resulted from convergence and interaction among four major tectonic plates: the Continental Eurasian and Indian-Australian plates, and the Oceanic Pacific and Philippine Sea plates. The convergence of these plates destroys crusts, creates volcanic chains, causes earthquakes, produces trenches and troughs, and develops the geological stresses and distinctive character of the Philippine archipelago.

A largely mountainous terrain, with narrow coastal plains and interior valleys and plains mark the country's topography. The northern Luzon highlands, or *Cordillera* Central, rise to between 2,500 and 2,750 meters, and, together with the *Sierra Madre* in the northeastern portion of Luzon and the mountains of Mindanao, boast rain forests that provide refuge for numerous upland tribal groups.

The Philippine Fault is an active left-lateral strike-slip fault that stretches more than 1,200 km from northern Luzon to southern Mindanao, and it has splays, or branches that connect to several other faults. The presence of a major fault along the entire length of the archipelago accounts for dramatic features of the country's physical environment. The Philippine Fault is always in motion, moving at an average rate of 2 to 2.5 cm per year. This movement, however, is not smooth. It normally occurs as sudden episodes, or slips.

The recent explosive awakening of Mount *Pinatubo* in the province of *Zambales* suggests what sudden changes in global constitution can take place if the earth bursts into a volcanic aria. This particular volcanic activity injected huge amounts of particulates as high as 25 km up into the stratosphere. *Pinatubo's* eruption blanketed most of Southeast Asia with ash, creating a dust cloud that slightly cooled the earth. Particulates have long residence times in the stratosphere, hence, reduce the amount of solar radiation reaching the earth's surface, thereby causing global cooling.

Mt. Pinatubo eruption in 1991 which produced huge amount of ash.

Climate and Weather

Under the Koppen-Geiger regionalization of world climates, the Philippines has a humid equatorial climate, which is marked by high temperatures and heavy annual average rainfall. Most areas close to the equator belong to this type of climatic classification. The Philippines is located between 5° to 20° north of the equator.

The Philippines is located within the region of ascending air and widespread equatorial cloudiness. Annual rainfall measures as much as 5,000 millimeters in the mountainous parts of the country, but less than 1,000 millimeters in some of the sheltered valleys. The different rainfall-causing weather patterns are tropical cyclones, monsoon, the Inter-Tropical Convergence Zone, fronts; easterly waves, air stream, local convection, etc.

The Philippines generally has high temperature because of its tropical maritime setting and the warm air currents flowing over its land masses. The mean annual temperature is about 27 °C. The hottest months are April, May and June while the coldest months are December, January and February. In general, the highest temperatures are observed in valleys and plains. The highest temperature recorded in the Philippines was 42.2 °C in Tuguegarao, Cagayan Valley on April 29, 1912 and on May 11, 1969. The absolute minimum temperature of 3.0°C was recorded in January of 1903 in Baguio, which has an elevation of 1,482 m.

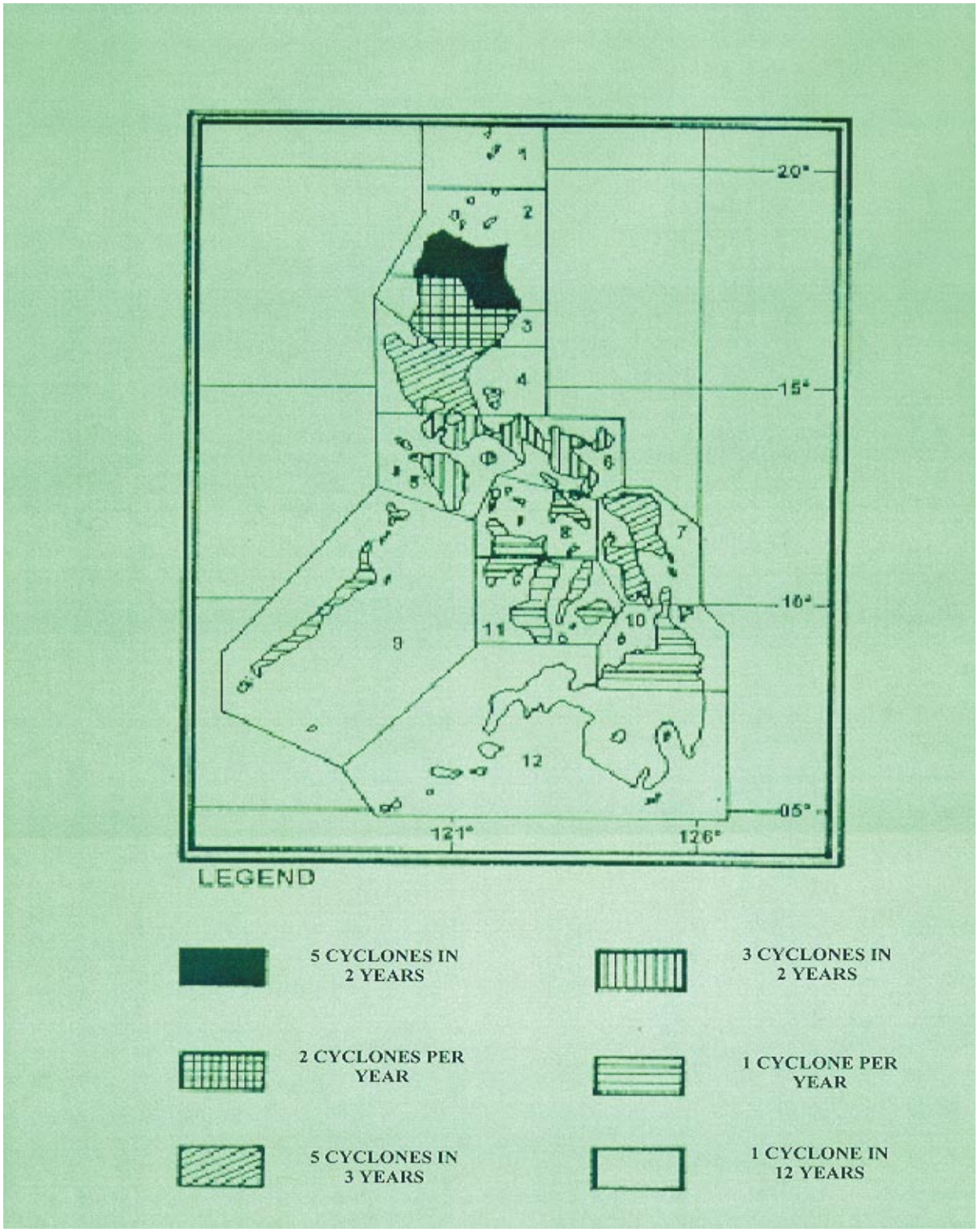
Bodies of water are sources of humidity, and, as a result, maritime regions have a more humid atmosphere. Because of the warm moist air streams flowing through the archipelago, its surrounding seas, rich vegetation and abundant rainfall, the humidity of the air throughout the country is high. The average annual relative humidity for the whole country is about 82 % and almost all weather stations record monthly averages higher than 70 % relative humidity. High values of relative humidity are usually observed at night and early morning; and low values, during the day and early evening except when it is raining.

On the average, the prevailing wind in the Philippines from October to February is northeasterly (coming from the northeast, or *amihan*), easterly from March to May due to Pacific trade winds, and southwesterly (*habagat*) from June to September. Changes in large-scale wind direction are due to the Asia monsoon, which is the change in air circulation over Asia due to differential heating between the Asian mainland centered over the Tibetan plateau and the surrounding oceans. However, local topography and diurnal effects may produce prevailing winds, which deviate somewhat from the winds that might be expected.

The northwest Pacific basin, where the Philippines is located, has the highest percentage of cyclone development, estimated to account for about 40 % of all cyclones globally. Tropical cyclones that affect the Philippines usually originate from low pressure areas over the Pacific Ocean. They can also form in the South China Sea. The Philippines experiences about 20 tropical cyclones annually. The tropical cyclone season is from June to December, with an average monthly frequency of more than one tropical cyclone. The months of July, August and September have the most frequent tropical cyclone occurrence with an average of more than three cyclones each month.

The geographical zones of the country have different frequencies of tropical cyclone passage as shown in **Figure 1.2**. Zone 2 which is located in extreme northern Luzon, has the most frequent passage of 5 tropical cyclones in 2 years. Zone 12 (Southern, Central and Western Mindanao regions) has the least number of tropical cyclone passage, with an occurrence of 1 cyclone in 12 years.

FIGURE 1.2 Frequency of Tropical Cyclone Passage Over Each of the Geographical Zones in the Philippines



The most destructive typhoon occurred in 1990 when *Ruping*, packing maximum winds of 240 km per hour, caused an estimated P 10.85 billion in damage. The strongest typhoon occurred in 1970 when wind speeds of around 275 km per hour were recorded near the center of Typhoon *Sening* when it passed over *Virac, Catanduanes.*

The inter-annual variability of the Philippine climate is also highly affected by the El Niño - Southern Oscillation (ENSO) phenomenon. Climatological studies showed that the major drought events in the country are associated with the occurrences of ENSO. An analysis of the indices that mark the ENSO phenomenon indicates that from 1935 to the present, eleven (11) ENSO events have occurred. Observation records show that rainfall deficiences or events associated with these ENSO episodes vary significantly in duration and magnitude. The drought events during earlier El Niño episodes, area affected and the degree of severity in the Philippines from the late 60s to the early 90s are presented in **Table 1.1.** The 1997-98 El Niño episode was the worst in the century and caused the most damage in the country.

Table 1.1 Drought Events-Areas Affected and Degree of Severity in the Philippines During the Last Four (4) Decades

EVENTS	SEVERE	MODERATE
1968-1969	Bicol	Rest of the Philippines Except Regions 1 & 2
1972-1973	Central Luzon	Visayas and Mindanao
1976-1977		Mindanao
1982-1983 a) Oct. 82-Mar. 83 b) Apr. 83-Sep. 83	 Central Luzon Southern Tagalog Northern Visayas Western Mindanao Region 2 and parts of Region 1	 Regions 1,2,3, and 5
1986-1987 a) Oct. 86-Mar. 87 b) Apr. 87-Sep. 87		 Western Luzon Bicol Region Most of Luzon Central Visayas Northeastern Mindanao
1989-1990 a) Oct. 89- Mar 90	 Cagayan Valley Panay Island Guimaras Northern Palawan Western Mindanao	
1991-1993	Comparable with that of 1982-1983	
1994-1995	Regions 1,2,3, NCR, 5 and Palawan	Visayas and Western Mindanao
1997-1998	The whole of Philippines	

Natural Resources

Forest Lands

Forestland is an area classified for forestry purposes, usually with a slope of more than 18 percent. It is a legal and technical land category and, like alienable or disposable land, may or may not actually have forest cover. As reported in 1997, the country has a total of about 15 million hectares of forestlands and 14.12 million hectares of alienable and disposal lands.

In the Philippines, forests are especially important as the country consists of thousands of islands, each a diverse, fragile ecosystem regularly buffeted by destructive typhoons and erosive monsoon rains. Philippine forests could be classified into: dipterocarp (65.6%), mossy (19.3%), sub-marginal (8.8%), pine (4.2%), and mangrove (2.1%).

Unfortunately, the Philippine forests, considered among the most diverse in the world, are also among the most endangered. The country's forest cover has been steadily dwindling, at an average rate of 2 percent per annum, resulting in adverse impacts to the environment and shortage in raw materials supply for the

wood-based industries. The principal causes have been illegal logging, shifting cultivation or *kaingin*, forest fires, natural calamities, as well as, conversion to agricultural lands, human settlements, and other land uses brought about by urbanization and increasing population pressure.

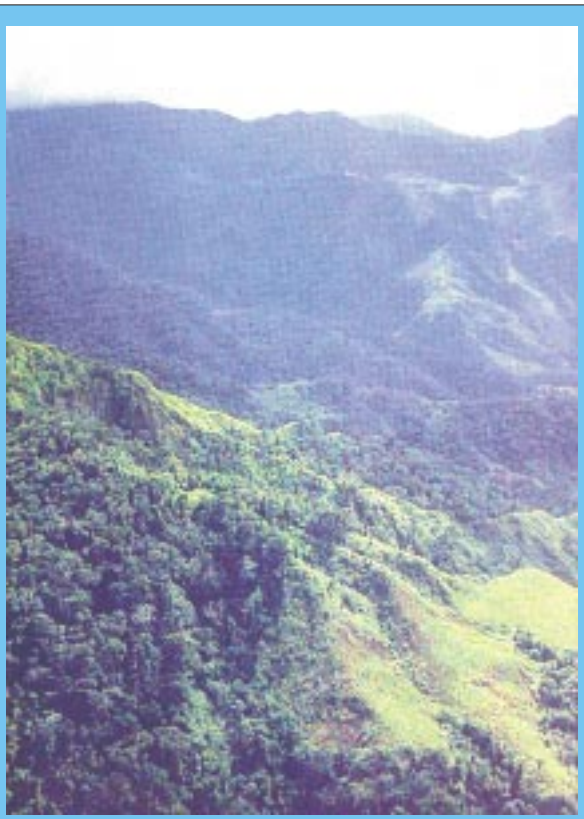
As of 1997, the Philippines has only about 5.4 million hectares of remaining forests, a mere 18 percent of the country's total land area. Of these, about 804,900 hectares are old growth forests from the 27.5 million hectares (virgin forests) in year 1575.

The remaining forest cover are as follows: Mangrove – 112,400 hectares; Old growth dipterocarp forests – 804,900 hectares; Residual dipterocarp forests - 2.73 million hectares; Pine forests – 227,900 hectares; Mossy forests - 1.04 million hectares; Sub-marginal lands – 475,100 hectares. For the other forestland classifications; Brushlands - 2.23 million hectares; Grasslands - 9.01 million hectares; and Lands suitable for plantation establishment - 7.05 million hectares. These forests sustain the watersheds, which contain the country's freshwater supply. There are 120 proclaimed watersheds within the country's forestlands with an aggregate area of more than 1.4 million hectares.

Only about 1.8 million hectares of second growth forest can remain in the timber production system for long-term sustained production. About one million hectares of this can be placed immediately under community forest management. Some 200,000 hectares are so degraded that they are best converted into forest plantations of rubber, rattan, and bamboo. About 400,000 hectares of second growth forests and the remaining 804,900 hectares of old growth forests are best set aside for biological diversity conservation and environmental protection.

Philippine forestry has gone through two stages of change and is now in a third stage. In the first stage, from the late Spanish period to the late 1950s, large expanses of forests were cleared to make way for the farms and settlements of the country's rapidly growing population. During the second stage, from the early 1960s to the mid 1970s, large-scale commercial logging and mining accelerated as the country attempted to develop its economy, based mainly on the export of natural resources, as well as, on agriculture.

From 1991 to 1995, the annual average rate of deforestation was 130,000 hectares. With the depletion of forest resources, local economies built on forest wealth were forced to shift to other sources of livelihood or else endure poverty. Forest protection, species conservation, and reforestation characterize the third stage. The government reversed its former policy of free market forest exploitation when it realized the acute impact of massive forest depletion and denudation of the uplands on the environment.



The country has only 804,900 hectares of old growth forests remaining.

The conversion of forest lands into farmlands and the extraction of forest resources were major economic policies of the Philippine government for quite sometime. During the third quarter of the century, the Philippines became known as the world's largest exporter of timber. Its fame, however, did not result in fortune for most Filipinos. Deforestation is the permanent scar left by badly managed forestry programs.

In the 1990s, the DENR completely banned logging in old growth forests. It is phasing out logging concessions under the timber license agreement (TLA) system while making more equitable the access and use of forest resources. Environmentally sustainable development of forest lands has become the government's guiding policy.

Agricultural Lands

Agriculture is the country's economic lifeline, but agricultural production in the Philippines has been traditionally concentrated on only a few main crops, particularly, rice and corn. Only coconut and sugar cane constitute important export commodities.

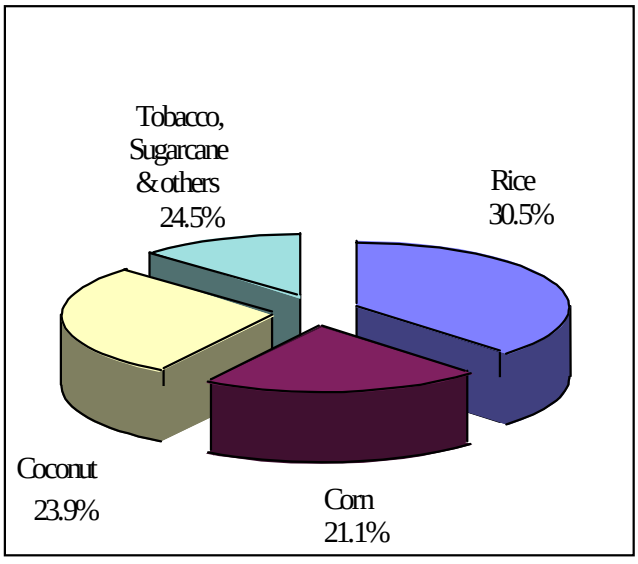
From 1960 – 1990, data showed that almost ninety percent (90%) of the alienable and disposable lands were devoted to agricultural production. Currently, a total of approximately 10.3 million hectares are devoted to agriculture. An estimated 45% of these agricultural lands are located in the lowlands and 33 percent in the uplands.

In 1996, of the 12.94 million hectares of agricultural land, 30.5 percent is planted to rice; 21.1 percent to corn; 23.9 percent to coconut; and 24.5 percent to sugar cane, cassava, banana, and others.

Rice, being the staple food of majority of the country's population (more than eighty percent) plays a dominant role in agriculture and the country's economy as a whole. At present, a total of 1.2 million hectares in 34 provinces are devoted to rice production. National figures indicate impressive increases in rice production from the late 1970s to the 1990s. During the 1990s, national yield average for rainfed areas is 1.9 tons per hectare while irrigated areas (56 percent of total rice lands) contribute a yearly production rate of 3.4 tons per hectare; thus, a combined national yield of 2.8 tons per hectare.

Rice production growth rate is at 2.33 percent compared to an almost similar growth rate of 2.4 percent in population. Projections are such that with an increase in the country's population and a per capita requirement of 105 kg, a total amount of 8,117 million tons of rice will be needed by the year 2000 (*Evangelista*, 1997). To meet this demand, 1,665 million hectares should be under irrigation, producing an average of 5 tons/hectare at 150% irrigation intensity. As a result, the country will most likely continue to depend on rice imports for about 5 percent of its national requirements translating to around one percent of the total national export.

Figure 1.3 1996 Agricultural Resources



Corn is the second most important crop. A total of 700,000 hectares in 17 provinces have been identified for corn. Corn is the staple food of about 12 million Filipinos, and it also accounts for about 70 percent of the ingredients of the mixed feeds for livestock. Moreover, corn production provides livelihood to about 600,000 farm households and to transport services, traders, processors and agricultural input suppliers. For the period 1995-2004, the composite demand of corn for food, feed and other industrial uses is projected to grow annually by 3.94 percent. On the other hand, average growth in corn production is expected to decrease annually by as much as 1.54 percent. If present productivity levels are not improved substantially, the country faces a shortage of about 3.26 MMT. The Department of Agriculture (DA) traces this to low/inadequate production levels, slow adoption rate of modern technologies, loss of land planted to corn by as much as 2.3% annually to growing demand for non-agricultural uses and other competing cash crops, inequitable policies that create price and supply imbalances, inadequate infrastructure support and other related causes.

Agriculture is the country's economic lifeline.

Rapid urbanization has resulted in the indiscriminate conversion of agricultural land to residential, industrial, and commercial uses and may undermine food security. Present statistics of legal land conversion show that from 1990 to 1997, some 50,720 hectares have been allowed for conversion from agricultural to other uses with 18,657 hectares of these having been approved by the Department of Agrarian Reform (DAR). In a 1991 nationwide study conducted by the Bureau of Soils and Water Management and the Department of Agriculture, it was found out that conversion of agricultural land was taking place very rapidly. The study estimated that irrigated rice lands were converted at an average rate of 2,267 hectares per annum. The estimation done by *Concepcion* (1993) postulates that a hectare of irrigated land is at least equivalent to 3 hectares of rainfed lands and 5 hectares of ecologically fragile rolling upland in terms of their capacity to produce the basic staples, feeds and other farm supplies. In 1991, therefore, around 33,000-5,500 hectares of rainfed/rolling uplands have to be placed under cultivation to replace losses due to conversion of irrigated rice lands.

Wetlands

Philippine wetlands of international importance cover about 14,100 sq. km. consisting of 61 coastal wetlands, 22 lakes, and 8 freshwater swamps and marshes. Sixty-nine percent (69%) of these are in the moderately to highly threatened status.

Biological Diversity

The biological diversity of the Philippines is the product of millions of years of gradual evolution. It traces its beginnings to the period when the earth's geophysical, climatological, and other conditions became conducive to the existence of life. Natural selection processes took place in response to environmental disturbances. The complex history of sedimentation, submergence, folding, metamorphism, igneous activity, uplift, and erosion is reflected in many parts of the present archipelago and has influenced the composition and distribution of present-day flora and fauna.

It is difficult to estimate how many species of Philippine flora and fauna there are because there is no comprehensive or current inventory of even the major biological niches and ecosystems of the country. However, based on available records, (many dating back to the early 1900s), at least 35,000 species of plants and animals are found in the archipelago.

There are at least 14,500 plant species, representing about five percent of the world's flora: more than 8,000 flowering plants, 33 species of gymnosperms, 1,011 ferns and fern allies, 625 mosses, 790 lichens, 3,000 fungi, and 1,145 algae. The research conducted by various scientists between 1950 and 1995 show that there are about 185 species of mammals, 558 species of birds, 252 species of reptiles, 95 species of amphibians, 54 species of millipedes, 44 species of centipedes, 341 species of spiders, 2,782 species of mollusks, and more than 20,000 species of insects. Marine species include 488 species of corals, about 2,400 species of protozoans, and 6 species of seagrasses.

In terms of endemicity, the Philippines has one of the highest numbers of endemic species of plants and animals. In fact, there are endemic species found only in certain parts of the same island. About 30 percent to 40 percent of the more than 8,000 species of flowering plants are endemic to the archipelago and are mostly found in primary forests. However, only 28 of the more than 1,500 genera of flowering plants are considered endemic.

Animal species, mostly insects, total about 170,000, about half of which are endemic. Terrestrial vertebrate species number about 960 species of which 43 percent are endemic. There are nine endemic bird areas in the Philippines identified by the Birdlife International: the Luzon mountains, the Luzon lowlands and foothills, *Mindoro, Negros* and *Panay, Cebu, Palawan, Samar, Leyte, Bohol* and Mindanao lowlands, Mindanao mountains, and the *Sulu* archipelago. An endemic bird area is one where two or more restricted range species of land birds are confined.

As of 1991, 89 species of birds, 44 species of mammals, and 8 species of reptiles are in-

The Philippines has one of the highest numbers of endemic species of plants and animals, many of which are endangered. Among these are: the Tamaraw and the Philippine Eagle.

ternationally recognized as threatened. These species include the Philippine Eagle (*Pithecophaga jefferyi*) and the Tamaraw (*Bubalus mindorensis*).

Water Resources

The country is classified into 12 water resource regions, which are defined by hydrological boundaries, physiographic features and climate homogeneity.

There are 343 independent principal river basins with areas of at least 40 sq. km. each, covering a total of 199,637 sq. km. or 66.5 percent of the country's total land area. Of these, 20 are major river basins each covering at least 990 sq. km. These are sources of municipal and domestic water supply, irrigation, and power generation. The country's most extensive river systems are the *Pulangi* (Rio Grande), which flows into the Mindanao River; the *Agusan*, in Mindanao which flows north into the Mindanao Sea; the *Cagayan* in northern Luzon; and the *Pampanga*, which flows south from east Central Luzon into Manila Bay. Only two rivers in the country, the *Cagayan* (Luzon) and Mindanao rivers, have drainage areas of more than 20,000-sq. km.

The Philippines has 61 lakes totaling more than 2,000 sq. km., 23 of which have areas more than 100 hectares. Laguna de Bay, located southeast of Manila Bay, is the largest freshwater lake in the Philippines and the second largest in Southeast Asia. It covers an approximate area of 90,000 hectares and is fed by 23 tributaries.

The country also has an extensive groundwater resource estimated to cover an aggregate area of 50,000-sq. km. and storage of about 251,158 MCM. The safe yield or the amount of groundwater available for abstraction without resorting to groundwater mining is estimated at 31,554 MCM per annum.

The dependable yield of the total water resources of the country add up to an aggregate of 975 MCM per day (MCM/day) coming from surface runoff (833 MCM/day) and groundwater safe yield (142 MCM/day). However, due to uneven distribution of rainfall and differences in climatic patterns, some regions in the country do not possess adequate water resources as compared with other regions.

Water demand is divided among three major water users: the agricultural sector, the commercial and industrial sectors, and domestic users. In 1997, the agricultural sector was the largest water user with demand amounting to 84 percent of the total demand or 23, 652 MCM per annum. The next largest user of water is the commercial and industrial sector representing 8.2 percent of total water demand or 2,234 MCM per year. However, this is a modest estimate as industries usually tap groundwater for their processing and cleaning operations. Domestic demand accounts for only 7.8 percent or 2, 187 MCM per annum. Given the rapid pace of development and the ever-increasing population, total demand is expected to increase by almost 8 percent per year to 35, 364 MCM per annum by the year 2000.

Coastal Resources

Coastal zones tend to be the most heavily used and abused part of the earth's geography. This is due to the numerous benefits and opportunities offered by coastal zones and the near-shore areas. The natural system in the coastal zone supports major economic activities, such as farming in the coastal lowlands, fishing and tourism, and provides human settlement with essential life support and development opportunities.

The Philippines' coastal resources are varied and diverse, providing food and employment for a majority of the populace. About one million

people or 5 percent of the country's labor force earn their living from fisheries. In 1994 alone, the fishing industry generated approximately 81.2 billion pesos, making the country the 12th largest fish producer in the world for that year.

Philippine marine territorial waters cover about 2.2 million sq. km.; 267,000 sq. km. (12 percent) of these are coastal waters and 1.934 million sq. km. (88 percent) are oceanic waters within the exclusive economic zone (EEZ). There are about 185,000 sq. km. of shelf area within a 200-m depth.

The country's total discontinuous coastline is approximately 32,400 kilometers, one of the longest in the world. Eighty percent of the provinces and 65 percent of cities and municipalities share the coast. There are 20 landlocked straits and 61 natural harbors (30 of which are developed and fully operational).

The Philippine coral reefs cover about 27,000 sq. km. within a 15- to 30-m depth, one of the largest in the world. These reefs yield 10-15 percent of the total annual fish production. The annual fish yield (excluding invertebrates) of Philippine reefs ranges from 5 to 24 metric tons per sq. km.

Philippine marine territorial waters cover about 2.2 million sq. km.

Unfortunately, the Philippine coral reefs continue to be degraded and destroyed. Only about 5.3 percent of the country's coral cover are considered in excellent condition (75-100% live coral cover), 25.2 percent in good condition (50-74% live coral cover), 39 percent in fair condition (25-49.9% live coral cover), and 30.5 percent are in poor condition (0-24% live coral cover).

The most important factors that negatively affect these ecosystems are siltation, deforestation, agricultural activities, and mine tailings, which produce high sediment load.

Demography/Population Trends

As in many developing countries, a high birth rate and gradually declining mortality rate characterize the Philippine population. Therefore, the growth in population is highly attributed to the natural increase or the excess of births over deaths.

At the beginning of the 19th century, the Philippines had a population of slightly over 1.5 million. At the turn of the century, the population ballooned to 7 million, and by the middle of the 1900s, it had reached 20 million. With an average annual growth rate of 2.52 percent for the period 1990-1995, the national population was declared at 68,616,536 in 1995 and was estimated to be 73,527,000 in 1997. According to the computer models developed by the Commission on Population, the University of the Philippines Population Institute and the Futures Group, the country's population is estimated to reach 126 million by 2020.

The Philippines is considered the 9th most populous country in Asia and the 14th in the world.

Only approximately 1,000 of its islands are populated, and less than one-half of these are larger than 2.5 square kilometers. Population density increased from 160 persons per square kilometer in 1980 to 228 in 1995. There are 28 provinces with 102 municipalities located in coastal areas occupying 129,114 hectares. In 1990, an estimated 2 million people were living in coastal communities and more than 9 million people are estimated to inhabit the country's forests.

The Philippines, still being predominantly rural, has more than half of its population residing in the rural areas. However, the proportion of the urban population increased from 37.44 percent in 1980 to 48.5 percent in 1990. In 1996, the total urban population constituted 55% of the total national population.

Though unsure of what lies ahead of them, rural migrants take their chances in the cities where wages are relatively higher, more educational opportunities exist for their children and utilities and basic services are readily available. This significant trend in migration from village to city affected population figures in the 1970s and the 1980s, which put extra stress on urban areas. In the early 1980s, thirty cities had 100,000 or more residents, up from twenty-one in 1970. For Metro Manila alone, its population was 5,924,563, up from 4,970,006 in 1975, marking an annual growth rate of 3.6 percent, which was far above the national average of 2.5 percent. Metro Manila's rate of migration steadily increased from 4.53 percent in 1981 to 5.7 percent in 1988. Metro Manila, which always posted the highest urban population in the country, was assessed by the United Nations as the 23rd largest city in the world and is expected to be the 16th largest by the year 2000.

During the last five years, Region IV (Southern Tagalog) has the highest annual average growth rate of 3.5 percent followed by NCR at 3.3 percent, Central Mindanao (2.8 percent) and Southern Mindanao (2.6 percent). On the other hand, the Ilocos Region and Western Visayas have the lowest annual average growth rate, both at 1.3 percent. Southern Tagalog has the highest share of the national population at 28.3 percent or an equivalent of 19.3 million Filipinos (NCR included). Other highly populated water resources regions are Central Luzon, Western Visayas, and Southern Mindanao.

Health

Major improvements in the health of the country's population have been scored during the last thirty years. However, their pace and scope are now at risk of being overwhelmed by a growing population, rapid urbanization, a constrained economy and the various challenges to service delivery.

During the period 1992-1997, life expectancy increased from 66.5 years to 68.0 years. The basic health indicators also improved over the span of (6) years. The crude birth rate declined to 28.4 per 1000 population from 31.12 in 1992 while the crude death rate decreased to 6.1 per 1000 population in 1997. Infant mortality rate also declined from 53.6 in 1992 to 45.8 per 1000 live births in 1997. Maternal mortality rate likewise decreased from 1.97 to 1.68 within the same period. Total fertility rate also declined from 4.08 to 3.61 births per woman.

The morbidity and mortality trends of communicable diseases, in particular, acute respiratory infections such as pneumonia, bronchitis and influenza decreased in the past six (6) years. The incidence of sanitation-related diseases associated with unsafe water supply, poor sanitation coupled with improper food handling, i.e., diarrhea, cholera, typhoid and intestinal parasitism was also re-

duced. The incidence of measles, pertussis, neonatal tetanus and diphtheria likewise marked improvement.

Chronic communicable diseases are also generally on the decline. However, although there was an improvement in the incidence and prevalence of tuberculosis in the Philippines, it remains a serious public health problem. Leprosy also declined, its prevalence rate decreased from 2.39 to 1.2 per 10,000 population in 1997.

Some insect-borne diseases though, such as dengue, have increased in some areas of the country but have been controlled because of the preventive health activities conducted by the DOH with the Local Government Units and the private sector. Malaria was eliminated in ten (10) provinces but is still endemic in sixty four (64) provinces. Control measures such as environmental sanitation, spraying and use of insecticide-impregnated mosquito nets have reduced the incidence of Malaria. The Malaria morbidity rate registered a decline from 147 in 1992 to 60 per 100,000 population in 1997. Schistosomiasis is endemic in twenty-four provinces. Its prevalence rate was reduced to 4.52% in 1997.

Tables 1.2 and 1.3 provide the 1994 ten leading causes of morbidity and mortality figures per 100,000 population in the Philippines compared with the 5-Year Average during the period 1989-1993.

Table 1.2 MORBIDITY: Ten Leading Causes, Number and Rate/ 100,000 Population, 1989-1993 Average and 1994

Leading Causes of Morbidity	5-year Average (1989-1993)		1994	
	Number	Rate	Number	Rate
1. Diarrheal Diseases	1,011,922	1,590.6	1,376.669	2006.1
2. Bronchitis	887,935	1,395.7	1,140,366	1661.8
3. Influenza	440,229	692.0	839,683	1223.6
4. Pnuemonia	281,263	442.1	614,353	895.2
5. Accidents	128,866	202.6	211,092	307.6
6. Tuberculosis, all forms	156,456	245.9	167,763	244.5
7. Diseases of the Heart	87,789	138.0	141,295	205.9
8. Varicella	35,305	55.5	76,526	111.5
9. Malaria	67,612	106.3	58,627	85.4
10. Malignant	33,740	53.0	49,531	72.2

Table 1.3 MORTALITY: Ten Leading Causes, Number and Rate/ 100,000 Population, 1989-1993 Average and 1994

Leading Causes of Mortality	5-Year Average (1989-1993)			1994		
	Number	Rate	% of Total Death	Number	Rate	% of Total Death
1. Diseases of the Heart	47,023	73.9	14.9	50,307	73.3	15.7
2. Diseases of the Vascular System	34,635	54.4	11.0	39,191	57.1	12.2
3. Pneumonias	40,374	63.5	12.8	28,132	41.0	8.8
4. Malignant Neoplasms	23,168	36.4	7.4	28,110	41.0	8.7
5. Tuberculosis	24,271	38.2	7.7	27,292	39.8	8.5
6. Accidents	10,295	16.2	3.2	14,752	21.5	4.6
7. Chronic Obstructive Pulmonary and Allied Conditions	7,725	12.1	2.5	11,405	16.6	3.5
8. Other Diseases of the Respiratory System	6,723	10.6	2.1	8,382	12.2	2.6
9. Diarrheal Diseases	6,939	10.9	2.2	6,383	9.3	2.0
10. Diabetes Mellitus	3,195	5.0	1.0	6,105	8.9	1.9

Economy

Composition and Growth

In 1994, gross national product (GNP) was pegged at US$65.661 billion and gross domestic product (GDP) at US$ 64.018 billion. The GDP per capita was pegged at US $954.92. Exports reached a total of US$ 21.650 billion while imports were at US$ 25.688 billion.

The gross national product and gross domestic product have recovered from stagnation in 1991 and have been on an upward trend until 1996. GNP grew to 6.9% in 1996 and GDP, 5.7%. Despite the Asian currency turmoil in July 1997, the country still managed to have a 5.8% and 5.1% annual growth rate for GNP and GDP, respectively.

The 45.46% or US$ 29.1 billion of the GDP is credited to the services sector with trade sharing US$ 8.72 billion; private services, US$ 5.56 billion; government services, US$ 4.81billion; ownership of dwellings and real estate, US$ 4.32billion; transportation, communication, and storage, US$ 3.13 billion; and finance US$ 2.55 billion.

The industrial sector shares US$ 20.82 billion or 32.52% of the GDP. Manufacturing has the greatest contribution in the sector (US$ 14.88 billion), followed by construction (US$ 3.61 billion), electricity, gas, and water (US$ 1.7 billion), and mining and quarrying (US$ 0.62 billion).

Industrial production is centered on processing and assembly operations of the following: food, beverages, tobacco, and rubber products; textiles, clothing and footwear; pharmaceuticals; paints; plywood and veneer; paper and paper products; small appliances; and electronics. Heavier industries are dominated by the production of cement, glass industrial chemicals, fertilizers, iron and steel, and refined petroleum products.

The industrial sector is concentrated in the urban areas, especially in the metropolitan Manila region and has only weak linkages to the rural economy. Inadequate infrastructure, transportation, communication, and electric power shortages have so far inhibited faster industrial growth.

Likewise, in 1994, agriculture, forestry, and fishing accounted for 22.02 percent or US$14.11 billion of the gross domestic product with agriculture and fishery totaling US$ 13.9 billion against the US$ 180 million of the forestry sector.

Energy Production and Consumption

Supply and Production

Imported coal and crude oil, accounting for 56.0% of the total primary energy supply in 1995 provide the bulk of the country's energy supply. Indigenous conventional (oil, coal, hydro, geothermal) and non-conventional sources comprise the remaining 44.0% of the total national energy supply.

The Philippines has a number of indigenous resource options, but most of these remain largely unexplored and underexploited. The country has estimated reserves of about 400 million barrels of oil and 4.5 trillion standard cubic feet of natural gas. Geothermal energy is one indigenous resource that abounds in the country with potential reserves conservatively estimated at 4,000 MW.

Since the start of production of the country's first oil field (*El Nido*) in 1979, about

40 million barrels of oil have been produced. The oil production considerably increased from a low 1.73 million barrels in 1990 to 3.32 million barrels in 1993. This trend was made possible by the discovery of major oil fields from 1990 to the present. These include West *Linapacan*, with estimated recoverable reserves of 90 million barrels of oil (MMBO), the Octon structure with recoverable reserves initially placed at 10 to 15 MMBO, and *Malampaya* with 2.5 to 4.5 trillion cubic feet of recoverable gas reserves. However, in 1994 and 1995, there was a sharp decline in the country's oil production, which amounted to 1.66 million barrels and 0.95 million barrels, respectively. The decline was largely due to the continuous, unarrested water intrusion problem in the West *Linapacan* oil field.

Coal used by the country's power plants, meanwhile, mostly come from outside sources. A total of 2,010,305 metric tons of coal were imported from countries like Australia, Indonesia, Vietnam, China, and Russia. Domestic coal production showed a steady increase from 1,243,013 metric tons in 1990 to 1,660,660 metric tons in 1992. However, from 1993 to 1995, coal production decreased, dropping by 8.4% in 1994 and 10.1 percent in 1995. The bulk of local coal supply comes from the *Semirara* Coal Mine, which is the biggest coal producer in the country, yielding 749.7 MMT in 1995.

In 1990, the hydroelectric power installed capacity was placed at 2,153 MW, displacing about 10.45 million barrels of fuel oil equivalent. Installed capacity slightly increased from 1991 to 1995. An additional 103 MW capacity was installed between 1990 and 1995 as part of the policy to develop energy resources with minimal environmental impact. Thus, development was focused on the installation of small hydro facilities.

Power generated by geothermal power plants totaled 35,044 gigawatt-hours (GWH) during the period 1990-1995. The total geothermal production slipped by 2.9 percent from 6,320 GWH in 1994 to 6,135 GWH in 1995. The *Makban* geothermal field, the country's leading producer, decreased its production due to the plant's load curtailment from September to December of 1995. The *Tiwi* geothermal field likewise posted a decrease due to the damage brought by typhoon "*Rosing*." The *Makban* geothermal field, the country's leading producer, recorded lower production levels to stabilize reserves and ensure the sustainability of the resource in the long-term. Plant rehabilitation likewise affected its operations considering the age of the facilities

Affordability and accesibility of NRES for households drove the steady utilization of non-conventional energy resources between 1990-1995. The non-conventional sector contributed roughly 11.47% of the total national energy requirements. Agri-wastes consistently contributed a large part of the non-conventional energy supply.

Consumption

There was an upward trend in the consumption of energy from 1990 to 1995. Moderate growth was posted for the period, with a steep increase in energy consumption from 1993 to 1995. A total of 131.10 million barrels of fuel oil equivalent (MMBFOE) was consumed in 1993, 146.54 MMBFOE in 1994, and 209.75 MMBFOE in 1995. For the period 1990-1995, the country's average commercial energy consumption per capita stood at 2.48 barrels of fuel oil equivalent (BFOE). The energy-to-GDP ratio or energy intensity grew steadily from 0.17 BFOE/'000 GDP in 1990 to 0.26 BFOE/'000 GDP in 1995. During the same period, the country posted an average energy intensity of 0.19 BFOE/'000 GDP.

The consumption of petroleum products, mainly fuel oil and diesel, steadily increased from

1990 to 1995. In 1995, about 15,942 thousand barrels of premium and regular gasoline, 38,602 million barrels of diesel, and 45,733 million barrels of fuel oil were consumed. Among the industrial consumers of petroleum products, the power generation sector was consistently the highest, averaging 25.9 million barrels annually. Unleaded gasoline was introduced in the market in February, 1994 and registered a total sale of 1,047 thousand barrels at the end of the year. In 1995, 1,799 thousand barrels were consumed, equivalent to a 71.82% increase in the consumption of unleaded gasoline.

Electricity sales showed an upward trend from 1990 to 1992. However, in 1993, electricity sales slightly dropped by 1.13 percent. In 1994 and 1995, due to a stabilized power situation, there was a substantial increase in the electricity consumption by the industrial (13.72% in 1994, 4.78% in 1995) and commercial (24.13% in 1994, 8.66% in 1995) sectors. Over all, the biggest consumer of electricity was the industrial sector at 11,195 GWH in 1995, followed by the residential sector, which consumed a total of 8,308 GWH for the same year.

Political Units

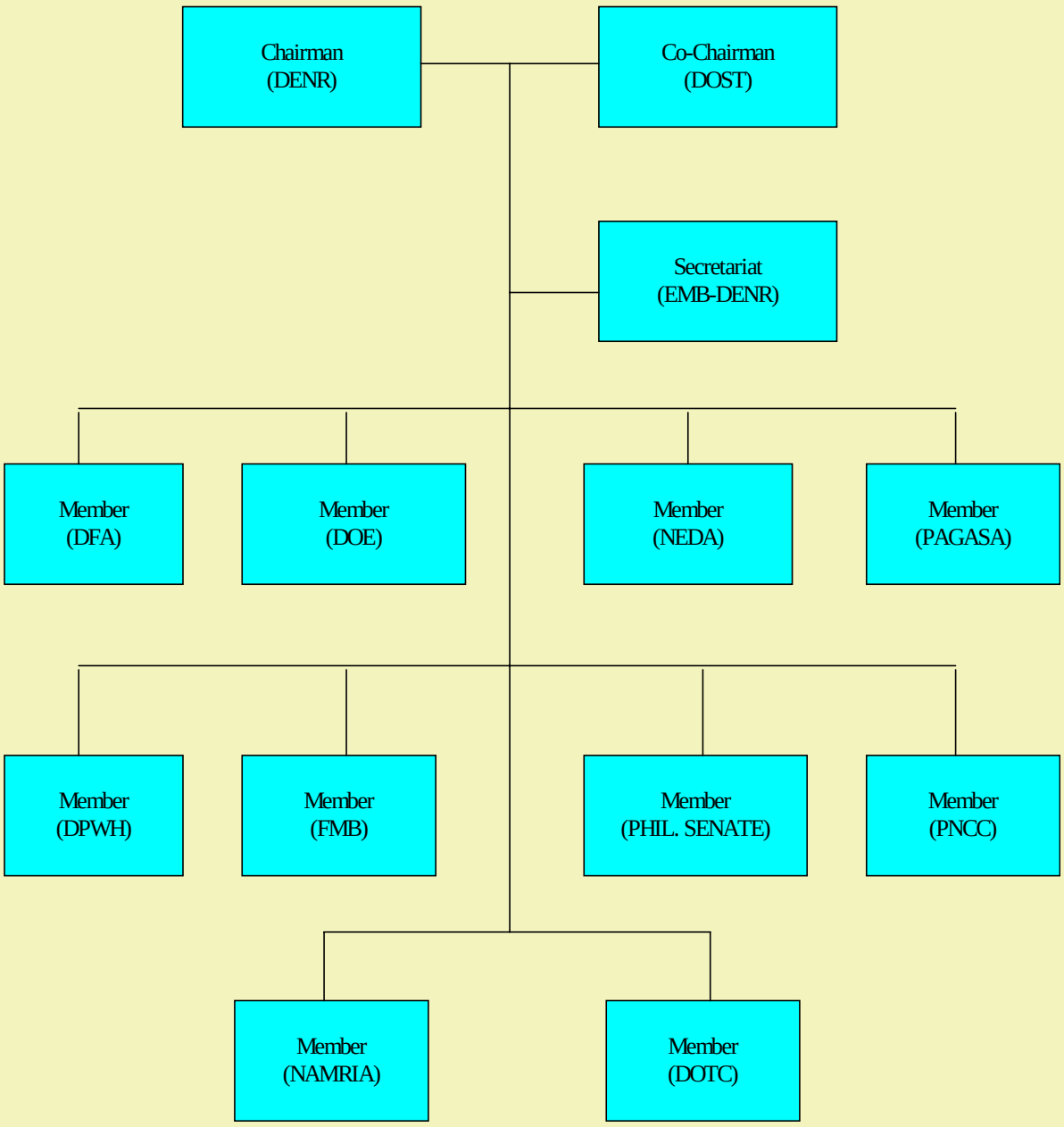
Administratively, the country is divided into 16 political regions. As of April 1998, the Commission on Elections listed 78 provinces, 85 cities, and 1,525 municipalities. The smallest political unit is the *barangay*, of which there are 41,925.

National Coordination Mechanism on Climate Change

The Philippines was among the first countries to respond to the challenge of the climate change phenomenon. As early as May 8, 1991 the Philippine government created the Inter-agency Committee on Climate Change (IACCC) by virtue of Administrative Order No. 220. The IACCC is composed of 15 government agencies and NGO representatives. The IACCC was established to coordinate various climate change related activities, propose climate change policies and prepare the Philippine positions to the UNFCCC negotiations.

The IACCC is chaired by the Secretary of the Department of Environment and Natural Resources and co-chaired by the Secretary of the Department of Science and Technology. Among its members are the representatives of the Philippine Atmospheric, Geo-Physical, and Astronomical Services Administration, the Department of Foreign Affairs, the Environment Committees of the two houses of the Philippine Congress, the Department of Energy, the Department of Transportation and Communication, the Department of Agriculture, the National Economic and Development Authority, and the Philippine Network on Climate Change, representing the non-government organizations. The Environmental Management Bureau acts as the Secretariat to the IACCC. **Figure 1.4** shows the IACCC organizational structure.

FIGURE 1.4 IACCC ORGANIZATIONAL STRUCTURE



Chapter II

1994 NATIONAL GHG INVENTORY

The Philippines has conducted two national greenhouse gas inventories, one for 1990 and the other, for 1994. The 1990 GHG Inventory was initially undertaken under the U.S. Country Studies Program, where the Philippines was a participating country.

Pursuant to decision 10 CP/2, however, non-Annex I countries are required to report their 1994 National GHG Inventory as contained in their Initial National Communication. Hence, the Philippines generated this inventory through the Enabling Activity Project funded by the GEF through the UNDP.

Methodology

The 1994 GHG inventory of the Philippines is a result of the application of inventory procedures stipulated by the Revised 1996 IPCC Guidelines. While these guidelines provide activity data and emission factors for the various sectors of concern, local values were used in place of these data whenever possible. The following discussion enumerates these non-IPCC procedures and data that were adopted per sector in the process of preparing an inventory of the country's GHG emissions.

Energy

The Energy sector applied most of the recommended procedures and default data provided by the IPCC. Emission factors supplied by the IPCC were used all throughout the inventory although further refinement of the data is now possible with the availability of local emission factors especially from the transport sector.

The other local modification was in the classification of fuel used in the Philippines. **Table 2.1** lists these local fuel types and the corresponding IPCC equivalent.

Calculations in the Energy sector also indicate an expected difference between the results

Table 2.1 IPCC Equivalent of Local Fuel Types

Local Fuel Type	IPCC Equivalent
Coal	Sub Bituminous Coal
Crude Oil	Crude Oil
Premium Gasoline	Gasoline
Regular Gasoline	Gasoline
Unleaded Gasoline	Gasoline
Kerosene	Other Kerosene
Diesel	Gas/Diesel Oil
Fuel Oil	Residual Fuel Oil

of the top-down and bottom-up (or sectoral) approaches:

Top-down Approach: 50,010 ktons CO_2
Bottom-up Approach: 47,335 ktons CO_2.

The difference is attributed to the variations in data reporting by the fuel end-users and organizational units designed to manage the flow of data within the DOE.

Industry

GHG emissions from the Industry sector are largely based on production and the transformation of raw materials. The methods that were used to estimate GHG emissions from these processes were based on the Revised 1996 IPCC Guidelines. Because the IPCC guidelines are generic, there were some cases when they could not be directly applied. In these cases, the industrial inventory used methods that involved applied chemistry. For example, in the determination of NMVOC emissions from the food and beverage sub-sector, physical chemistry was applied to approximate the quantities of beverages. The calculations for NMVOC were then based on these approximations.

Agriculture

Owing to the lack of the necessary input data, the IPCC-based methodology for Agriculture can not be fully adopted. Some existing data, moreover, are not available in the format required by the IPCC (1996) methodology.

The method for estimating methane emissions, for example, is based on the IRRI-conducted local experiments on methane emissions from rice fields. IRRI's method for approximating methane emissions from rice paddy cultivation is a straightforward calculation which needs readily available input data. This method requires (for each type of water management regime) statistics on the harvested area of rice, season length, and emission factor. The water management regime describes the degree of flooding and is classified as either irrigated or rainfed.

The IRRI study used the following equation for determining methane emissions from rice paddy cultivation:

$$M_W = (A_W \times S_W \times EF_W)/1000$$

where:

W	=	Water management (either irrigated or rainfed)
M_W	=	Methane emissions from water management regime "w" (Gg/yr
A_W	=	Harvested area of rice underwater management regime "w" ('000 hectares)
S_W	=	Season length for water management regime "w" (days)
EF_W	=	Emission factor for water management regime "w" (kg/ha/day)

Data for these various parameters are given in **Table 2.2**. The estimated total methane emissions is calculated by adding the methane emissions from the two water management regimes.

Table 2.2 IRRI Default Parameter Values and Methane Emission Factor for Rice Paddy Cultivation

Water Management Regime	Season Length (days)	Methane Emission Factor (kg/ha/day)
Irrigated	114	2.3
Rainfed	113	0.4

Wastes

The Wastes sector derived methane and nitrous oxide emissions mainly from population data and assumptions regarding the organic content of urban and industrial wastes. Most of the calculations relied on several studies such as the Industrial Efficiency and Pollution Control Project and Environmental Management Strategy (IEPC/EMS, 1992) and the JICA-sponsored research on urban waste management. A major limitation of all these studies is that the National Capital Region (of Metro Manila) was the focus of urban and domestic/industrial wastes research alone.

An estimate of the organic content of urban solid wastes was not possible because of the absence of data. Degradable organic carbon, therefore, had to be estimated by assuming a major contribution from food and non-food organic putrescibles.

The calculation of BOD values for industrial wastewater was not based on the IPCC recommendation (which derived BOD from production data) since these were already provided by IEPC.

Moreover, **Table 2.3** shows the local values adopted in the inventory that were based on the IEPC/EMS study in place of the IPCC default values used for methane emissions from domestic/commercial wastewater treatment.

Emissions from sludge and waste incineration were not included due to the absence of such waste handling systems and data.

Table 2.3 Local values for Methane Emissions from Domestic/Commercial Wastewater - Based on the IEPC/EMS Study

PARAMETER	LOCAL VALUE	IPCC DEFAULT
Degradable Organic Component (kg BOD/1000 persons/day) Fraction of Waste Water	12,775	14,600
Fraction of wastewater treated by handling system	60% (Septic tanks)	5%

Land Use Change and Forestry (LUCF)

The general framework provided by the revised 1996 IPCC Guidelines was used all throughout the calculations in this sector. Although default values were provided by various tables in the IPCC Reference and Workbook manuals, local values were obtained from the Forestry Development Center of the University of the Philippines at *Los Baños*. The main source of data on biomass growth rates, densities, and carbon content is:

> Lasco, R.D. and F.B. Pulhin, 1999: Forest land use change in the Philippines and climate change mitigation. *Mitigation and Adaptation Strategies for Global Change*.

Another central issue of concern is the derivation of forest/non-forest land areas and their temporal changes. Elementary exponential extrapolation was used wherever gaps existed or wherever the administrative classification of forest biomass types (such as old growth dipterocarp forests) did not reflect the reality. The various fates of biomass resulting from the conversion of land were likewise inferred from studies such as the ESMAP survey of the UNDP.

Calculations of carbon emissions from

soil and abandoned lands were not done due to the absence of data such as the IPCC recommended 20-year time horizon for these data sets.

Summary of the 1994 GHG Emissions Inventory

The presence of human-induced or anthropogenic greenhouse gases (GHGs) in our atmosphere can be attributed to activities and processes associated mainly with five important sectors: Energy, Industry, Agriculture, Land Use Change/ Forestry (LUCF), and Wastes. In 1994, the Philippines released a total equivalent amount of 100,738 ktons of CO_2 into the atmosphere. This is due to the combined effect of GHG emissions from the four sectors of Energy, Industry, Agriculture, and Wastes, and the net uptake (sink) of GHGs from the LUCF sector. In the global context, this national amount is still minimal relative to the GHG emissions of other nations, especially those of developed country parties to the UNFCCC.

Without the contribution of the still controversial LUCF sector, the national GHG total amounts to 100,864 ktons of equivalent CO_2. Of the four non-LUCF sectors responsible for the country's sources of GHGs, the Energy sector is the most significant, accounting for about 49% of the national total. This is trailed closely by the Agriculture sector's contribution of about 33%. Industry and Wastes follow with respective contributions of 11% and 7% of the total. **Figure 2.1** shows the relative contributions of these four non-LUCF sectors to the national GHG emissions total. In contrast with these four sectors which act as GHG sources, activities and processes associated with the LUCF sector are estimated to sequester about 126 ktons of CO_2, which is seemingly insignificant (0.1%) when compared with the national total (see **Figure 2.2**).

The GHGs of concern in the Philippines from the 5 previously mentioned sectors are mainly

Figure 2.1. 1994 GHG Emissions from the Four Non-LUCF Sectors of Energy, Agriculture, Industry, and Waste .

SECTOR	CO_2 Emissions (ktons))
Energy	50,038
Industry	10,603
Agriculture	33,130
Wastes	7,094
TOTAL	100,864

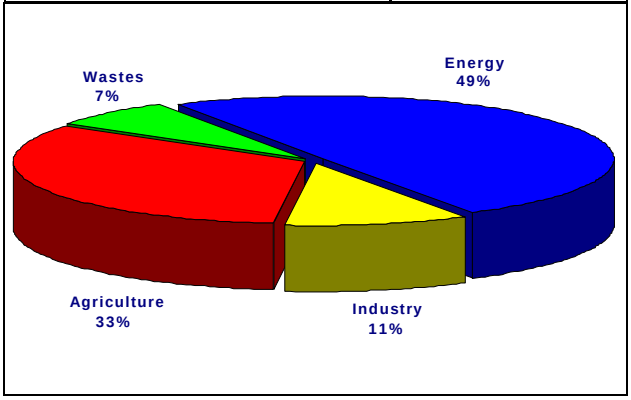
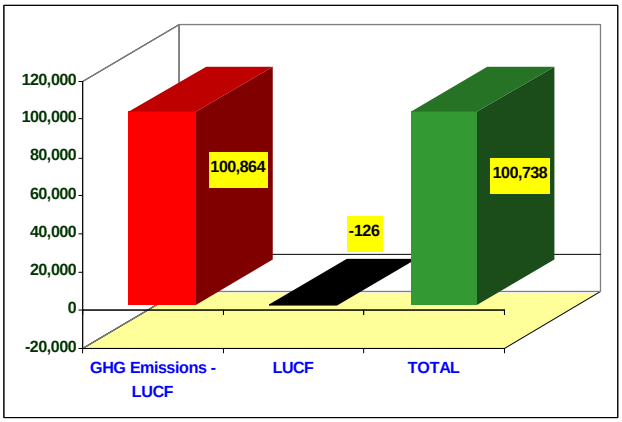


Figure 2.2. Net GHG Emissions with the LUCF Sector.



Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Hydrofluoro-carbons (HFCs). To effectively compare the global warming impact of the non-CO_2 gases with that of CO_2, global warming potential (GWP) calculations were applied to each of these non-CO_2 GHGs. The GWP takes into account the varying efficacy of different GHGs in warming the planet relative to that of CO_2. For example, within a time horizon of 100 years, the current IPCC recommendation for the GWPs of CH_4 and N_2O are 21 and 310, respectively. The CO_2 equivalents are computed by multiplying the actual emissions of non-CO_2 GHGs

(e.g. of CH_4 and N_2O) with their respective GWPs. Hence, for example, the potential global warming impact of 100 ktons of CH_4 is equivalent to that of 2,100 ktons of CO_2. The total of GHG emissions cited above is in terms of equivalent CO_2 (to take into account the contribution of non-CO_2 GHGs).

GHG emissions from the Energy sector are dominated by power generation and transport while in Agriculture, rice paddy cultivation and domestic livestock are the primary sources of GHG release. Industry's GHG sources are found mainly in the cement and metal processing industries while CH4 emissions are largely from solid wastes. The apparently low net emissions from the LUCF sector is due to the combined effect of large values in biomass growth and forest land use change/conversion. A more complete breakdown of these various subsectoral contributions is explained in the following section.

Sectoral Contributions

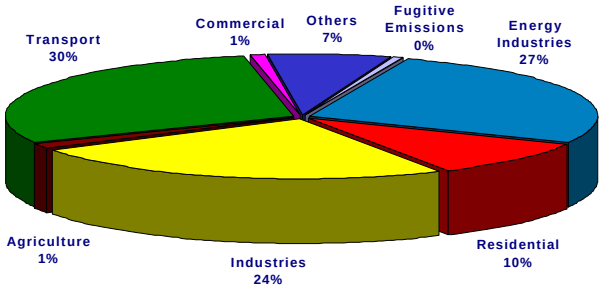
The individual contributions of the five sectors to the national GHG emissions total may be further resolved into more specific subsectors of GHG sources and sinks per sector.

Energy

The GHG emissions in the energy sector (which is largely CO_2) come mainly from fuel combustion. This sector alone emitted 50,038 ktons of equivalent CO_2 in 1994. The subsector contributions to this total are tabulated and illustrated in **Figure 2.3**. A significant portion of these emissions (about 82%) is from three major end users of fuel: the power generating industries, transportation, and the manufacturing industries. The main fuel types used in these subsectors are conventional fossil fuels such as oil and coal which are found to contribute substantially to GHG emissions. These

Figure 2.3. GHG Emissions from the Energy Sector.

Sub Sector	CO_2 Emissions (ktons)
Power Generation	15,508
Residential	4,359
Industries	9,497
Agriculture	1,189
Transport	15,888
Commercial	3,370
Fugitive Emissions	227
TOTAL	50,038



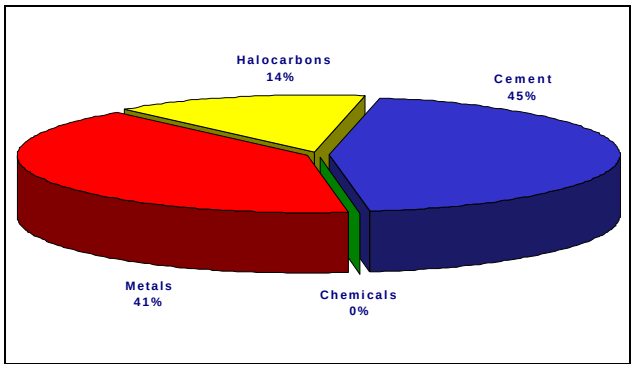
conventional fuel types continue to dominate the current and projected energy mix of the country: 76% in 1994 and 67.5% by the year 2008. New and renewable energy sources (NREs) such as hydroelectric power, geothermal, bio-mass, wind, and solar systems are projected to comprise 32.5% of the energy mix in 2008 [Philippine Energy Plan, Dept. of Energy, 1999]. Biomass contributes the greater share among these NREs. GHG emissions from these NREs are assumed to be insignificant.

Industry

In the Industry sector, 10,603 ktons of CO_2 were released in 1994. A major fraction (86%) of the industrial CO_2 emissions comes from the cement and metal industries (see **Figure 2.4**). These emissions arise directly from industrial processes associated with manufacturing cement and metals, and are not due to the power generation activities of these industries which are already accounted for in the Energy sector. In 1994, the Philippines produced around 239 million bags of cement and 2.669 million tons of steel corresponding to CO_2 emissions of 4,771 and 4,318 ktons, respectively.

Figure 2.4. GHG Emissions from the Industry Sector.

Sub Sector	CO_2 Emissions (ktons)
Cement	4,771
Chemicals	7
Metals	4,318
Halocarbons	1,507
TOTAL	10,603

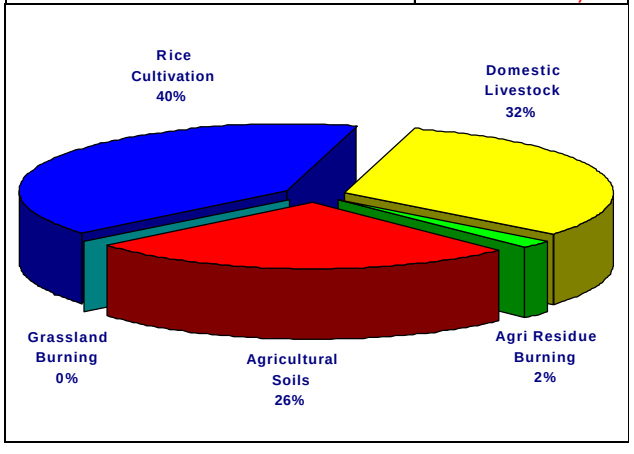


Agriculture

In the other sectors of Agriculture and Wastes, CH_4 and N_2O, rather than CO_2, are the significant GHGs emitted. **Figure 2.5** shows the equivalent CO_2 emissions attributed to Agriculture. In this sector, non-CO_2 GHGs are emitted mostly from rice cultivation, domestic livestock, and agricultural soils. CH_4 emissions from rice paddies comprise about 40% and are due mostly to the anaerobic decomposition of organic matter in these aquatic environments. Emissions from domestic livestock are derived mainly from enteric fermentation and manure management of animals such as buffalo, cattle, and swine. The total of 33,130 ktons of equivalent CO_2 released from Agriculture (about 33% of the non-LUCF total of GHG emissions) indicates that next to Energy, this sector is a significant source of GHGs for the country.

Figure 2.5 GHG Emissions from the Agriculture Sector.

Sub Sector	CO_2 Emissions (ktons)
Rice Cultivation	13,364
Domestic Livestock	10,498
Agri Residue Burning	581
Agricultural Soils	8,680
Grassland Burning	6
TOTAL	33,130

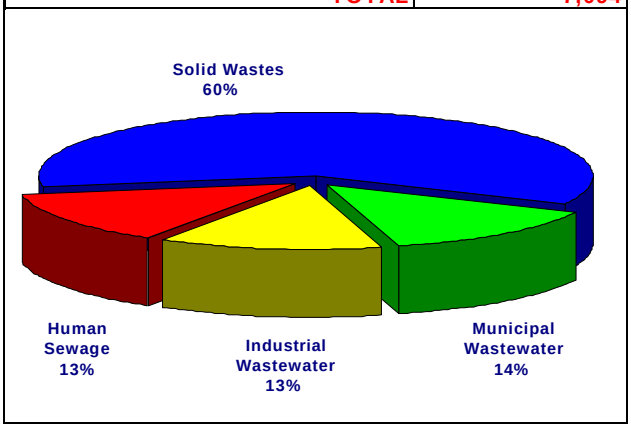


Wastes

GHG emissions from the Wastes sector come from solid wastes, domestic and industrial wastewater, and human sewage. About 60% of the CH_4 emissions in this sector is from solid wastes as shown in **Figure 2.6**. In 1994, an estimated 4,200 ktons of solid wastes were brought to solid wastes disposal sites. This amount does not consider the wastes that were either uncollected or indiscriminately dumped in streams or urban waterways. The dumping of this amount of solid

Figure 2.6 GHG Emissions from the Wastes Sector.

Sub Sector	CO_2 Emissions (ktons)
Solid Wastes	4,253
Municipal Wastewater	966
Industrial Wastewater	920
Human Sewage	954
TOTAL	7,094



wastes released about 203 ktons of CH_4, equivalent to emitting around 4,253 ktons of CO_2 into the atmosphere (using current GWP assumptions). Industrial wastewater, municipal wastewater, and human sewage share almost equally the other 40% of GHG emissions from this sector.

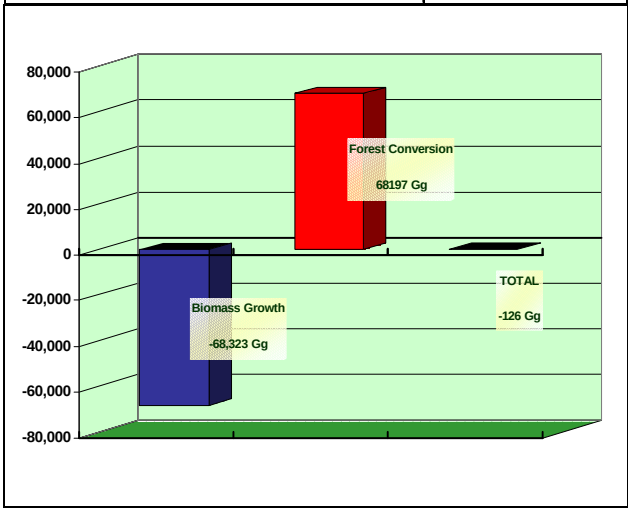
Land Use Change and Forestry

The 126 ktons of CO_2 estimated to be sequestered by the LUCF sector is attributed to the net impact of non-negligible changes in biomass growth and land use/forest conversion. This is shown in **Figure 2.7**.

Biomass growth alone from the country's forested lands and other land use categories is cited as a major factor in bringing GHGs from the atmosphere back into the biosphere. This sink, however, is offset by biomass loss associated with forest harvest and deforestation. In 1994, the total land use area was about 16 Mha and the biomass growth of these land areas resulted in an estimated cumulative uptake of 110,704 ktons CO_2. However, carbon sequestered by the annual growth of these different vegetative types is offset by the yearly removal of biomass via harvest and deforestation. Roundwood/Fuelwood harvests in 1994 account for 42,381 ktons of CO_2 emitted. Additionally, forest loss and land use conversion released a total of 68,197 ktons CO_2. This includes emissions from activities such as on site burning (for clearing purposes), off site burning (for domestic/industrial fuelwood), and biomass decay.

Figure 2.7 GHG Emissions and Sinks in the LUCF Sector.

Sub Sector	CO_2 Emissions(+) and Uptake(-) (ktons)
Change in Forest/Woody Biomass	**-68,323**
Biomass Growth	-110,704
Roundwood/Fuelwood Harvests	42,381
Forest/Land Use Change	**68,197**
On Site Burning	28,868
Off Site Burning	6,555
Decay	32,774
TOTAL	-126



The net LUCF contribution is still not complete since biomass growth and loss are not the only determining components of this total. The still unknown impact of Philippine soil carbon and biomass growth in abandoned lands, together with uncertainties in local biomass densities and growth rates make it difficult to obtain a more complete value for the contribution of the LUCF sector to the national GHG emissions total. Despite the uncertainties, present calculations suggest that for the Philippines in 1994, LUCF is an insignificant sink rather than a source of GHGs in the atmosphere.

Table 2.4 shows a summary table of the 1994 Philippine GHG Emissions Inventory for the five sectors of Energy, Agriculture, Industry, Land Use Change/Forestry, and Wastes.

GHG Emission Projections for 2008

Energy

The energy sector plays a dominant role in determining the GHG emissions of the country. In

Table 2.4 1994 Philippine GHG Inventory Results

SECTOR and SOURCE CATEGORIES	CO_2	CH_4	N_2O	NOx	CO	NMVOC	SO_2
I. ENERGY							
A. Fuel Combustion Activities							433.36
1. Energy Industries	15,458	0.51	0.13	38.47	2.83	0.91	
2. Manufacturing Industries	8,980	8.08	1.12	60.93	986.71	13.81	
3. Transport	15,801	2.15	0.14	167.37	719.44	136.77	
4. Commercial/Institutional	3,368	0.06	0.00	0.63	0.13	0.03	
5. Residential	2,544	72.83	0.92	29.22	1,356.21	133.02	
6. Agriculture	1,185	0.11	0.01	1.08	0.22	0.05	
B. Fugitive Emissions from Fuels							
1. Coal Mining		10.32					
2. Oil		0.47		0.62	16.83	7.61	8.94
C. Biomass Emissions*	48,490						
TOTAL EMISSIONS FROM ENERGY	47,335	94.53	2.31	298.00	3,082.00	292.00	442.00
CO_2 EQUIVALENT	47,335	1,985.22	717.16				
TOTAL CO_2 EQUIVALENT	**50,038**						
II. INDUSTRY							
A. Cement	4,771						2.87
B. Chemicals		0.33		0.01	0.22	1.46	9.81
C. Asphalt				0.00	0.00	0.00	0.00
D. Food and Beverages						16.35	
E. Pulp and Paper				0.12	0.44	0.29	0.56
F. Metals	4,318			0.11	0.00	0.08	2.99
G. Halocarbons	1,507						
TOTAL EMISSIONS FROM INDUSTRY	10,596	0.33	0.00	0.24	0.66	18.18	16.22
CO_2 EQUIVALENT	10,596	6.95	0.00				
TOTAL CO_2 EQUIVALENT	**10,603**						
III. AGRICULTURE							
A. Domestic Livestock		333.47	11.27				
B. Rice Cultivation		636.40					
C. Grassland Burning		0.30	0.00	0.14	7.94		
D. Agriculture Residue Burning		20.30	0.50	18.10	427.30		
E. Agricultural Soils			28.00				
TOTAL EMISSIONS FROM AGRICULTURE		990.47	39.77	18.24	435.24		
CO_2 EQUIVALENT		20,799.89	12,329.63				
TOTAL CO_2 EQUIVALENT	**33,130**						
IV. WASTES							
A. Solid Wastes		202.53					
B. Domestic/Commercial Wastewater		46.02					
C. Industrial Wastewater		43.83					
D. Human Sewage			3.08				
TOTAL EMISSIONS FROM WASTES		292.38	3.08				
CO_2 EQUIVALENT		6,140.06	953.94				
TOTAL CO_2 EQUIVALENT	**7,094**						
V. LAND USE CHANGE AND FORESTRY							
A. Change in Forest/Woody Biomass	-68,323						
B. Forest/Land Use Change	65,549	114.41	0.79	28.43	1,001.11		
TOTAL EMISSIONS FROM LUCF	-2,774	114.41	0.79				
CO_2 EQUIVALENT	-2,774	2,403.00	245.00				
TOTAL CO_2 EQUIVALENT	**-126**						
TOTAL NAT'L GHG EMISSIONS	**55,157**	**1,492.00**	**46.00**	**317.00**	**3,518.00**	**310.00**	**459.00**
EQUIVALENT CO_2	**55,581**	**31,335.00**	**14,246.00**				
TOTAL NAT'L EQUIVALENT CO_2 EMISSIONS	**100,738**						

1994, Philippine energy activities alone emitted about 50,038 ktons of CO_2, approximately half of the national GHG total from the four non-LUCF sectors. The amount of CO_2 that is forecast for 2008 is based on the projected energy mix reported in the Department of Energy's Philippine Energy Plan (PEP, 1999). On the basis of this energy mix, future national consumption of coal, oil, and natural gas will emit 122,344 ktons of CO_2 by 2008 **(Table 2.5)**. This is more than double the 1994 CO_2 emissions associated with energy.

Table 2.5 Projected Consumption of Coal, Oil and Natural Gas and the Corresponding CO_2 Emissions by the Year 2000

	Coal	Oil	Natural Gas	Total
Consumption (MMBFOE)	56.99	195.3	28.74	281.03
CO2 Emissions (ktons)	31,055	80,840	9,699	122,344

Industry

Greenhouse gas emissions for 2008 from the industry sector are calculated using production data from 1991 to 1995 as the baseline and extrapolated using regression methods. For each data set, linear trends were evaluated against annual production trends and the gross domestic product (GDP) values. The averages of these two trending mechanisms are taken as the forecast values for this sector. **Table 2.6** summarizes the results of the GHG projections to 2008 for cement and steel.

Table 2.6 Projected CO2 Emissions From Cement and Steel Industries by the Year 2008 (in ktons).

	Projections to 2008		
	Based on Annual Trends	Based on GDP Trends	Average
Cement	7,665	7,399	7,532
Iron and Steel	12,877	12,902	12,890
Ferro-Alloys	65	92	78

Agriculture

For the year 2008, the Philippines is predicted to have 3,451,933 hectares of irrigated rice fields and 1,232,676 hectares of rainfed rice fields. The statistics for the two types of rice ecosystems are estimated using linear regression on existing BAS statistics on the harvested area of rice (1981-1997). Applying IRRI's method for approximating CH4 emissions from rice paddy cultivation, the projected values correspond to a net emission of 960.8 ktons of CH4 (905.1 and 55.7 ktons for irrigated and rain-fed, respectively). This corresponds to an equivalent amount of 20,177 ktons CO2 in 2008 which is a 51% increase relative to the 1994 value of 13,364 ktons of equivalent CO2 from rice cultivation.

Land Use Change and Forestry

The LUCF sector is projected to be a net source of 4,492 ktons CO_2 by the year 2008. This is a noticeable increase of emissions from the –126 ktons of CO_2 sequestered in 1994. The projection is based on an exponential extrapolation procedure applied to estimate land use areas for various years beyond the 1987-1996 range that is officially available from the Forest Management Bureau (FMB) statistics book. In the procedure, the progressive decrease in total forest land area suggests a depletion rate of 2.02% per year that agrees well with a previous study carried out by the Asian Development Bank (ADB).

Wastes

Urban population in 1994 was estimated by the Food and Agriculture Organization (FAO) to be 53.29% of the national population. By 2008, this fraction is estimated to increase to 68.82%. Using the projections of the National Statistics Office (NSO) of 88.72 million people by 2008, [1995

Census-based National and Regional Population Projections of the NSO], urban population will correspondingly increase from 35.6 million in 1994 to 60.6 million by the year 2008.

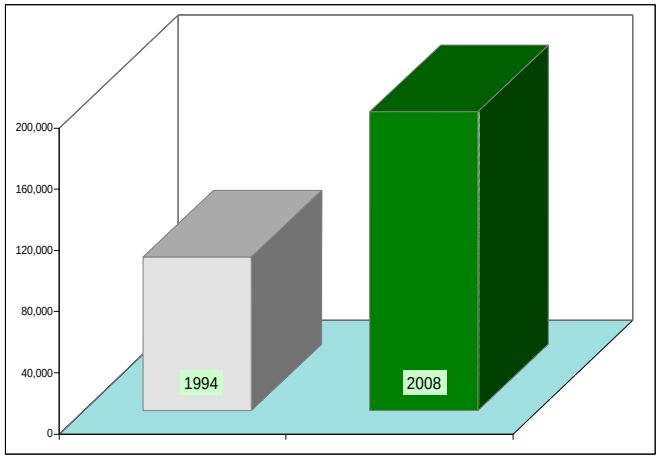
This increase in urban population will lead to an increase in CH_4 emissions from solid wastes, domestic/commercial wastewater, and human sewage. **Table 2.7** shows the 1994 equivalent CO_2 emissions from these three subsectors and the projected increase in emissions by the year 2008.

As evident from the above discussion, the country's future GHG emissions for 2008 were calculated by projecting only those subsectors that had significant contributions to the sectoral subtotals. With all other emissions from the other subsectors pegged conservatively at their 1994 values, the national GHG emissions total from all five sectors is projected to increase to 195,091 ktons of equivalent CO_2. This constitutes a rise of 94% relative to the 1994 total of 100,738 ktons in a matter of 14 years, or an annual growth rate of 4.8%. Baseline and projected GHG emissions are shown in **Figure 2.8**. Because various subsectors were held constant at 1994 levels, this 2008 projection may be a conservative estimate.

Table 2.7 Baseline and Projected Waste Emissions (in ktons)

Wastes Subsector	1994	2008
Solid Wastes	4,253	6,727
Domestic/Commercial Wastewater	966	1,658
Human Sewage	954	1,259
Total	6,173	9,644

Figure 2.8 Philippine GHG Emissions for 1994 and 2008 (ktons equiv CO)



Chapter III

GENERAL DESCRIPTION OF STEPS

The Philippines has started to undertake and is planning to implement a number of measures to fulfill its commitments as a country Party to the Convention. These include undertakings related to its pursuit of sustainable development, research and systematic observation, awareness raising, education and training, adaptation measures and capacity building, among others.

Sustainable Development Programs

The Philippine Strategy for Sustainable Development (PSSD) and PA 21

The Philippines was among the first countries to embrace the sustainable development paradigm, adopting the Philippine Strategy for Sustainable Development (PSSD) in 1989. The PSSD comprises of a ten-pronged strategy, as follows:

a. Integration of environmental consideration in decision-making;
b. Proper pricing of natural resources
c. Property rights reform
d. Conservation of biodiversity
e. Rehabilitation of degraded ecosystem(s)
f. Strengthening of residuals management
g. Control of population growth and human resources development
h. Inducing growth in rural areas
i. Promotion of environmental education
j. Strengthening citizens' participation

Pursuant to the PSSD, the Philippine Agenda 21, which serves as the blueprint for the country's sustainable development efforts, was completed in September, 1996. It "envisions a better quality of life for all, the development of a just, moral, creative, spiritual, economically vibrant, caring, diverse yet cohesive society characterized by appropriate productivity, participatory and democratic processes and living in harmony within the limits of the carrying capacity of nature and the integrity of creation."

The PA 21 is anchored on the following principles:

1. Primacy of developing the full human potential, which puts people at the center of the development focus.

2. Holistic science and appropriate technology, which promotes the use of holistic rather than reductionist science in finding solutions to development problems.

3. Cultural, moral and spiritual sensitivity which encourages the nurturing of local and indigenous knowledge and respect for the diversity of culture, moral standards and spiritual nature of the Filipino society.

4. Self determination, which advocates respect for the rights and capability of people to decide on their development course.

5. National sovereignty.

6. Gender sensitivity.

7. Peace, order, and national unity.

8. Social justice, inter- and intra-generational, as well as, spatial equity.

9. Participatory democracy.
10. Institutional viability.

11. Viable, sound and broad-based economic development.

12. Sustainable population.

13. Ecological soundness.

14. Bio-geographical equity and community-based resource management.

The PA 21 likewise details the initiatives needed to shift to sustainable development. These include creating the enabling conditions for sustainable development, implementing actions for the country's various ecosystems, and actions for critical resources.

The entity which coordinated the preparation of the PA 21 and will oversee its implementation is the Philippine Council for Sustainable Development (PCSD) which embodies the partnership of government with the non-government organizations.

The PCSD is chaired by the Director-General of the National Economic and Development Authority (NEDA), and vice-chaired by the Secretary of the Department of Environment and Natural Resources (DENR). Some 14 government departments and seven (7) non-government/ people's organizations are members of the Council. A composite secretariat serves the PCSD, comprising of the NEDA, DENR, and the NGO group. For the last, the Civil Society Counterpart on Sustainable Development (CSCSD) serves as the NGO counterpart secretariat to the PCSD.

The PCSD operates through its four committees, and their respective sub-committees. The Committees correspond to the major chapter concerns of the Global Agenda 21. **Figure 3.1** depicts the structure of the Council.

Systematic Observation and Research

Data Collection and Systematic Observations

The Philippines has a number of network observation stations currently operated and maintained by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). These are:

Synoptic Stations Network

Synoptic stations are the basic stations observing the weather elements at the surface. **Figure 3.2** shows the location(s) of the present synoptic stations (44), the proposed automatic weather stations (AWSs) and data collection platforms (DCPs) (5) throughout the country. While this synoptic network of stations seem adequate for large-scale weather systems, around fifteen (15) more AWSs and DCPs are expected to be commissioned

FIGURE 3.1 ORGANIZATIONAL STRUCTURE OF THE PCSD

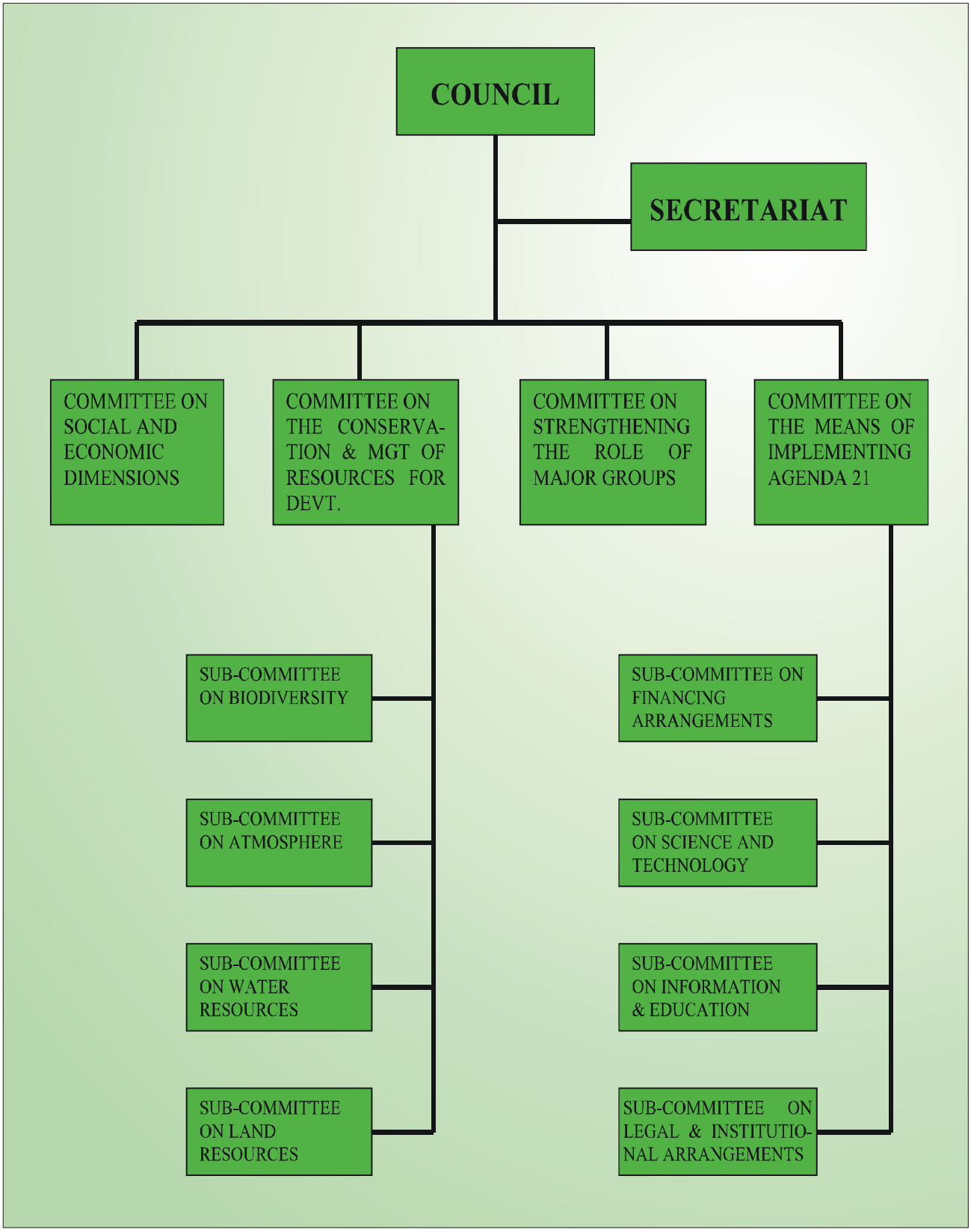
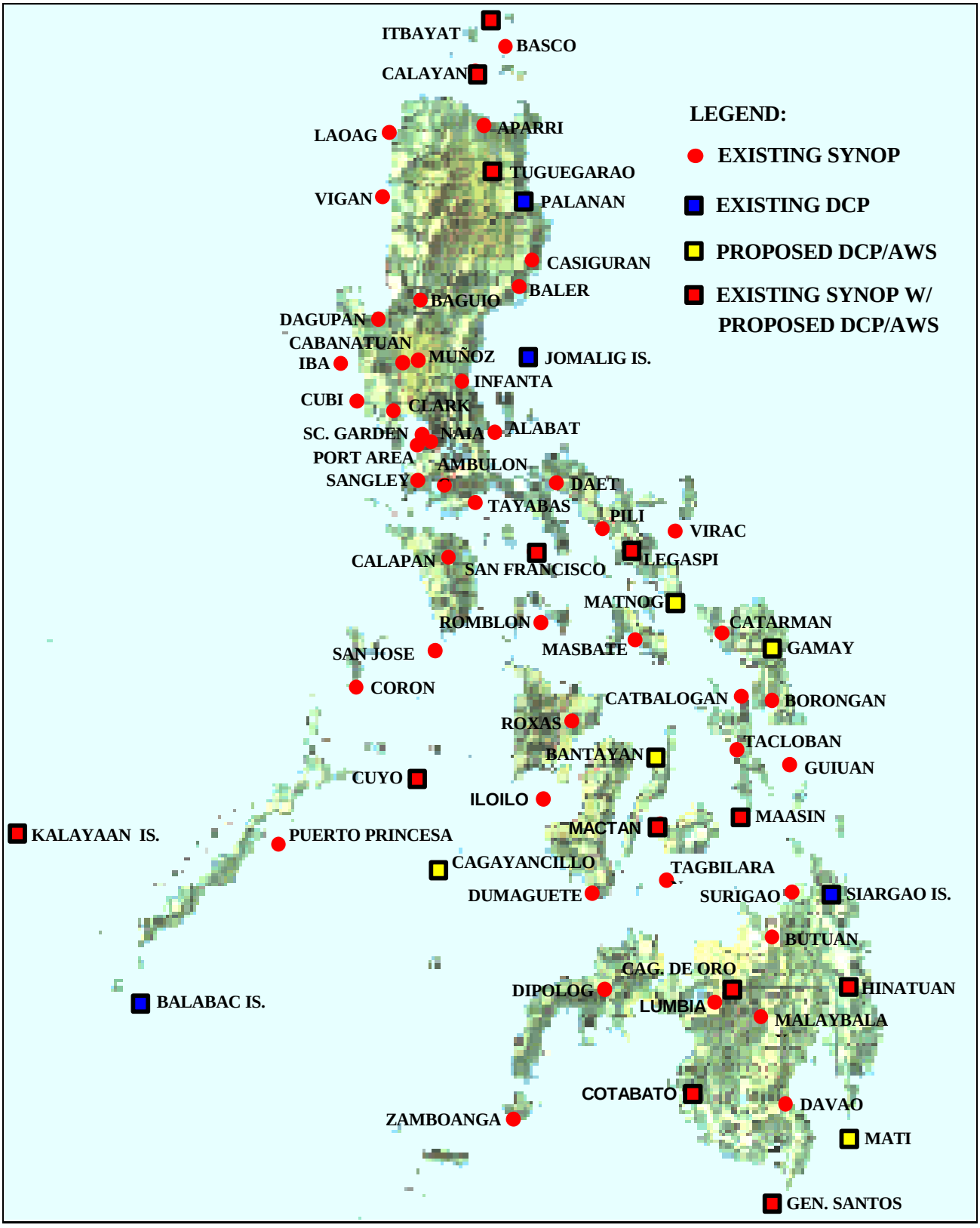


FIGURE 3.2. Location of PAGASA Synoptic Stations.



to fill data gaps in very remote areas and as an initial step towards the automation of weather observations, eventually leading to the reduction of manpower services.

Upper-Air Stations Network

Upper-air stations observe basic weather elements aloft and those to define the vertical structure of the atmosphere, normally advantageous for aviation safety and economy, as well as, for the improvement of weather analyses, forecasting and warning capabilities. Upper-air observation data on pressure, temperature, humidity and wind are also essential inputs for ocean-atmosphere interaction studies and research activities. **Figure 3.3** depicts the present upper-air stations (4) and the proposed rawinsonde (3) and radiowind (5) stations. The rawinsonde station will use a disposable weather sensor with electronic transmitter brought up by a meteorological balloon, sending weather information at different levels of the atmosphere to a ground receiver facility. The data generated will give a 3-dimensional description of the weather conditions of the upper atmosphere and are essential in the analysis and forecasting of the present and future development and movement of weather systems. This will replace the old pilot balloon method, wherein an optical theodolite (telescope) is used to determine positions of a meteorological balloon as it rises to the atmosphere. However, this method obviously has a big disadvantage in a cloudy/hazy environment and is non-functional during typhoons and other severe weather conditions, when upper-air data are needed most.

Meteorological balloon with electronic transmitter that sends weather information at different levels of the atmosphere.

Hydrometeorological/Flood Forecasting/Storm Surge Stations

Flood forecasting is only currently being done in four major river basins in Luzon, namely Agno, Bicol, Cagayan and Pampanga. The goal, however, is to reach-out to all people living in or close to flood plain areas. Fifteen to twenty (15-20) additional automatic stations are projected to be put on-line, strategically located in three (3) major rivers in Mindanao, namely: Agusan, Mindanao (Cotabato) and Davao; and in Panay Island and Samar.

In addition, while a few storm surge-monitoring stations are in-place, most of them are still in the research mode. Storm surge forecasting is relatively new in the PAGASA. To shift these into full operational mode, automatic-gauging stations will have to be established (**Figure 3.4**).

Agrometeorological/ Climatological Stations Network

In agrometeorological (AGROMET) stations, observations are made of the various weather elements essential to crop-weather relationship studies that aim to help farmers and farm operators determine the best crops suited to the locality and

FIGURE 3.3. Location of PAGASA Upper-Air Observation Stations

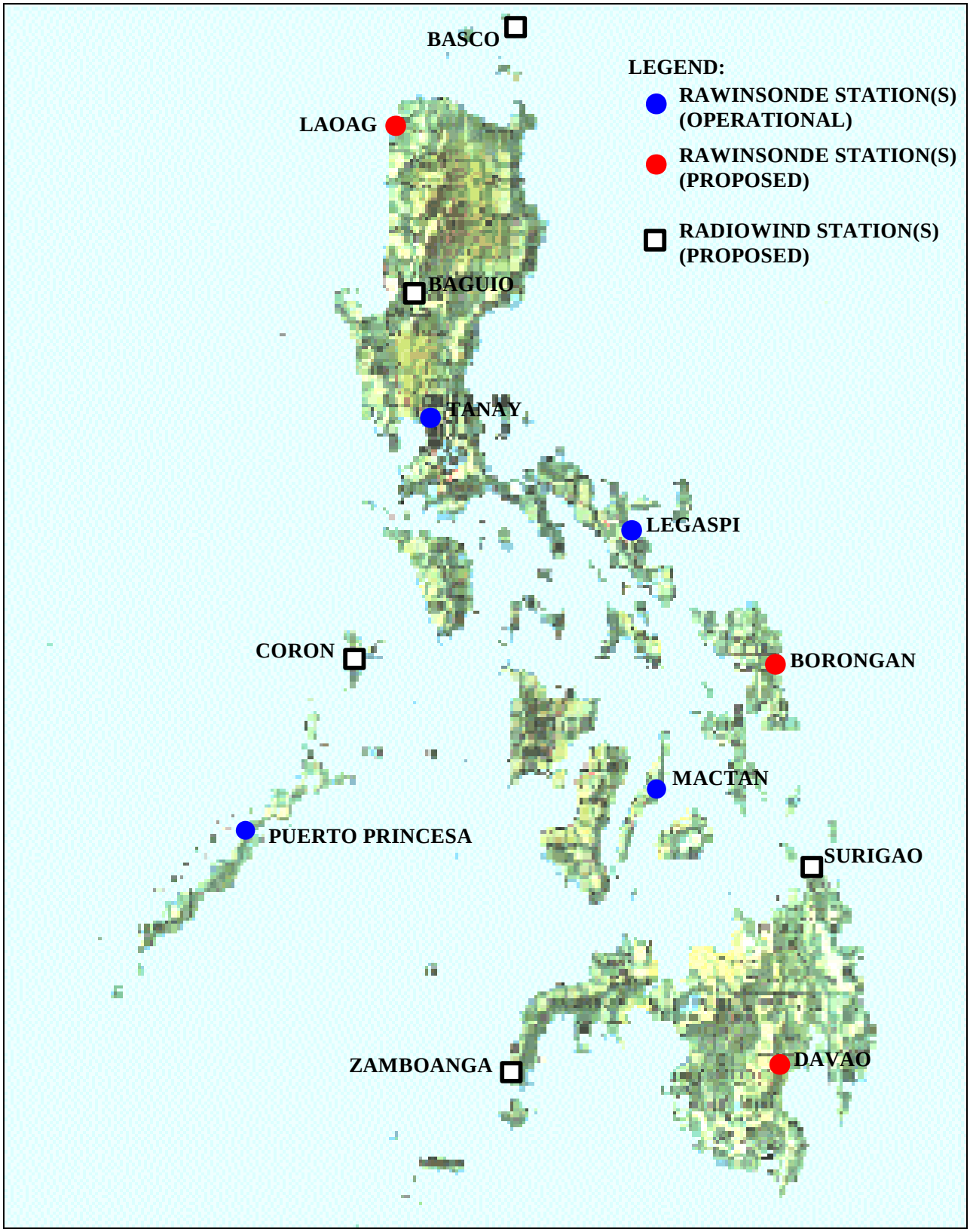
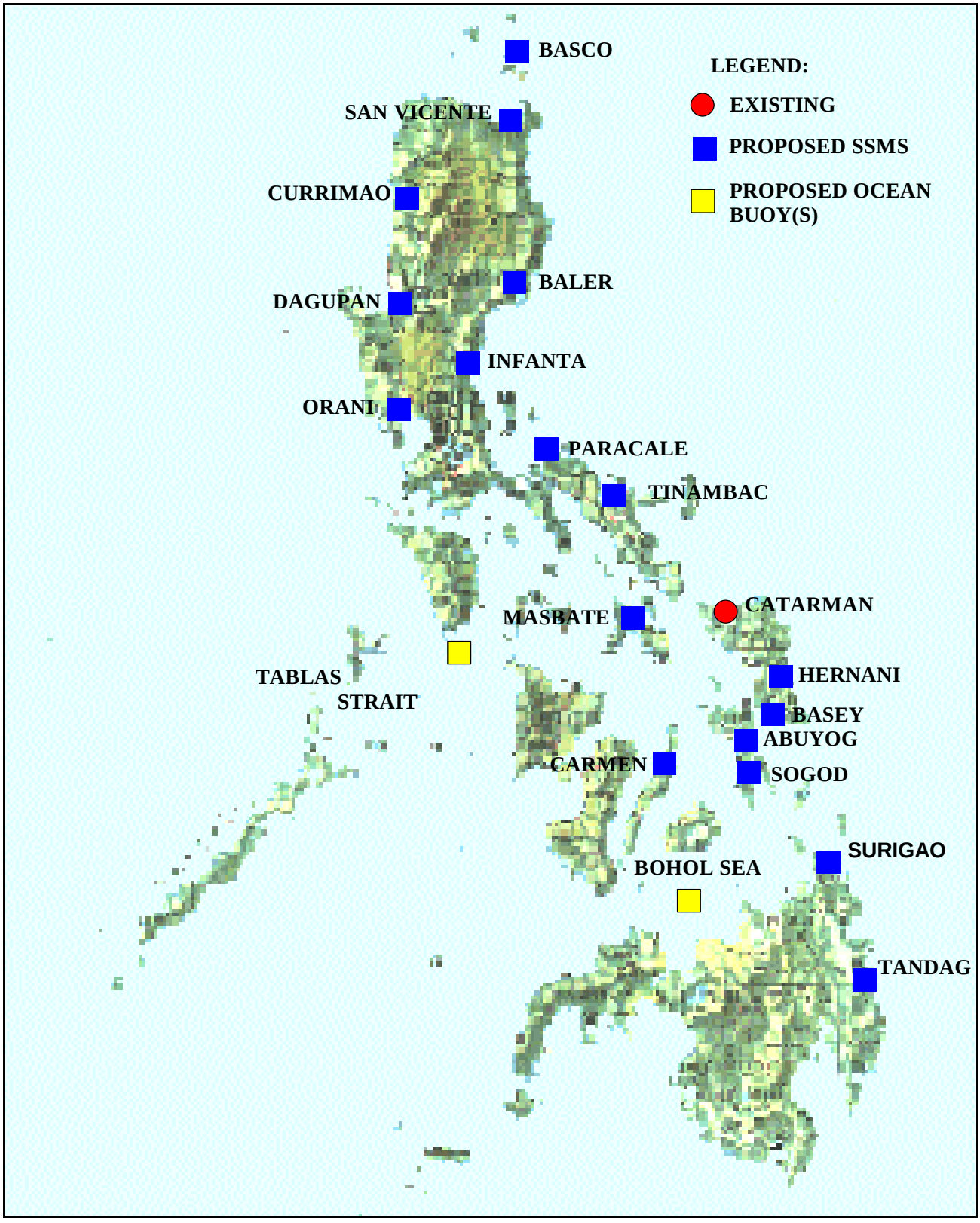


FIGURE 3.4 Location of Storm Surge Monitoring Stations (SSMS) and Ocean Buoys.



the best time to plant for optimum crop yield. Meanwhile, selected weather parameters such as temperature, cloud cover, and rainfall are observed and recorded at climatological (CLIMAT) stations. Although not necessarily used for weather forecasting, these information are important to long-range climate monitoring and predictions and for research activities to benefit agriculture.

Expansion and upgrading of the network of AGROMET and CLIMAT stations (**Figure 3.5**) would enhance PAGASA's specialized weather services for agriculture, in terms of acquiring the necessary weather data, in finer detail and on a near real-time basis, for use in the detection and spread of pests and diseases, the determination of appropriate cropping calendars, the preparation of weather-based crop advisories for the proper scheduling of day-to-day activities of farmers, farm operators and other agricultural entities, among others.

An automatic weather station which has a solar panel that generates power for the system.

Marine Observing System

The marine observing system is intended to provide real-time observation data in support of the domestic marine forecast service. These data will also be useful for the verification of wave forecasts and in the calibration of the wave model coefficients. The system will consist of moored ocean buoys that are equipped with sensors for measurement of wave height and frequency, ocean current, sea surface temperature and other important physical parameters in the ocean surface. The real time transmission of observed data to the main Forecast Center will be through satellite communication.

Special Observation Stations

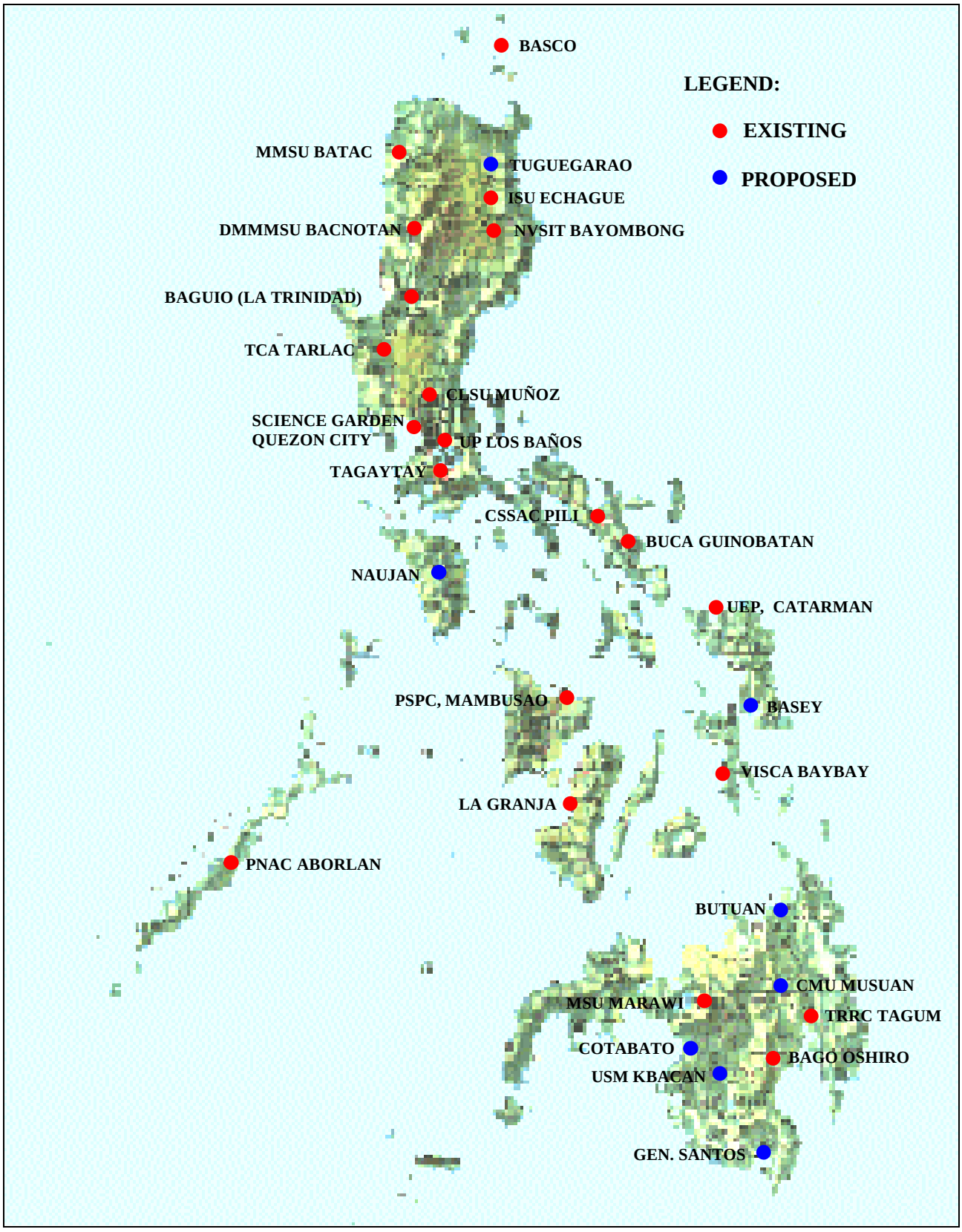
A. Background Air Pollution Monitoring Station (BAPMon)

The Philippines has one BAPMon station located in Mt. Sto. Tomas in Tuba, Benguet. Currently, it observes rainfall acidity, concentration of SO_2, particulate matter and electrical conductivity. Considering its objective, the station should be far from major sources of pollutants due to human activities. To this end, there is a plan to relocate the present site to Mindanao where the level of pollution is perceived to be minimal. The chemical analyses involved require very sensitive equipment to adequately measure the concentration of the pollutants. This poses a big constraint, aside from the appropriateness of the site.

B. Ozone Monitoring Station

The country has a single ozone monitoring station which is an integral part of the Global Ozone Monitoring Network. It regularly observes the total ozone amount and is located at the PAGASA Science Garden in Quezon City.

Figure 3.5 Location of PAGASA Agro-meteorological Stations



Researches

The Philippines has many researches which could be considered climate-related. Among the main ones are:

Finished Researches

1. Epidemiological Study for Metro Manila Using Climatic Variability
2. Country Study to Address Climate Change Issues and Concerns
   - GHG emissions inventory
   - Vulnerability assessments and adaptation analysis on water resources, coastal resources and agriculture
   - Mitigation activities to reduce GHG emissions
3. An Investigation on Systems Responses to Sea Level Changes of Some Selected Locations in the Philippines

On-Going Researches

1. Development of a Climate Information, Monitoring and Prediction System (CLIMPS), being undertaken by PAGASA in collaboration with the Department of Agriculture (DA) and the Department of Environmental and Natural Resources (DENR). It will have the capability to predict and issue with sufficient lead-time, advisories on extreme climate events such as during episodes of El Niño and La Niña, as well as, seasonal to inter-annual climate forecasts.
2. Climatological Study on the Changes in the Tropical Cyclone Intensity in the Philippine Area of Responsibility

Future Researches

1. Forecasting of the UV Index in Four Regional Stations of the Philippines
2. Crop Yield Information in Selected Areas
3. Development of an Operational Agrometeorological Crop Monitoring and Weather-based Crop Production Forecasting
4. Feasibility Study on the Use of Passive Samplers for Background Monitoring of Gases
5. Vegetation and Soil Moisture Index Mapping using AATSR, ASAR and MWR Data from ENVISAT
6. Bio-climatic Mapping of the Philippines

Education, Training and Public Awareness

Pursuant to Article 6 of the UNFCCC, country Parties have the responsibility to inform their people about climate change and its impacts.

Even prior to the adoption of the UNFCCC at the Earth Summit in Rio, in 1992, the Philippines has already been undertaking information dissemination on the climate change issue.

The results of the ADB funded Regional Study on Global Environmental Issues which generated a rapid assessment of the Philippines' vulnerability to climate change initially served as the basis for alerting the general population to the possible impacts of climate change in the country.

The Philippine Network on Climate Change (PNCC), as a member of the Climate Action Network of Southeast Asia (CANSEA) and the Earth Savers' Movement, were among the first groups to actively undertake information campaign(s) about the climate change issue and the climate negotiations.

The executive branch of government, as part of its mandate to continually inform and educate the public about environmental issues like climate change, has come up with a National

Strategy for Environmental Education (NSEE) which later evolved into the National Environmental Education Action Plan (NEEAP). Through the Environmental Management Bureau of the DENR and guided by the Strategy and the NEEAP, information dissemination and education activities were undertaken such as:

- Publication and dissemination of poster calendar(s) on climate change and global warming.

- Organization and conduct of symposia, focused group consultation and workshops. These were attended by representatives from the government and non-government organizations, private sector and the academe.

- Conduct of exhibits on climate change.

Even the legislative branch was active in raising awareness on the climate change issue. The Senate Committee on Environment, chaired by then Senator Heherson T. Alvarez, who also founded the EarthSavers Movement in 1989, co-sponsored a series of Asia Pacific and national conferences to popularize and place Climate Change and its adverse impacts on the national agenda. These are: the 1st Asia Pacific Conference on Climate Change in the House of Representatives with UNESCO and UNDP in 1992; the Global Youth EarthSaving Summit with the House of Representatives in 1993; the Asia Pacific Leaders Ministerial Conference with Malacañang and East Asia Pacific Parliamentarians Committee on Environment and Development in 1995; and, the National Conference on El Niño and La Niña in the National Library with the Presidential Task Force on El Niño and La Niña in 1997.

The preparation of the National Action Plan (NAP) on Climate Change likewise served as an opportunity for awareness raising and more in-depth discussions among stakeholders on climate mitigation and adaptation. Several regional and national consultations were conducted. Also, focused sectoral group discussions and meetings were conducted to further level off on the understanding of and generate consensus on the country's response to the challenge of the UNFCCC.

The NAP process was also a means of raising awareness on climate change at the local level, especially among the local government executives and non-government organizations.

Training/Workshops on Local Action Planning on Climate Change

Under the Enabling Activity Project, public consultations continued and even expanded. These consultations were intended to raise the awareness level of various sectors on the threats of climate change impacts and the different mitigation and adaptation strategies.

A number of training/workshops on "Local Action Planning on Climate Change" were likewise organized by the Institute for Climate, Energy and the Environment (ICEE) still under the Enabling Activity Project in selected provinces in the country with the local government units and other stakeholders as participants. Areas covered were those at high risk from climate change like sea level rise and its subsequent coastal degradation/inundation. The activity aimed not only to create awareness among the various stakeholders in the area but also to provide the necessary guidance in the formulation of local action plans on climate change. Most of the participants were planning officers from the provincial, city, and municipal governments, environment and natural resources officers and representatives from the NGOs, academe and the business sectors.

Promotion of Energy Efficiency and Conservation

To promote energy efficiency and conservation, the Department of Energy has undertaken a number of information campaigns, as follows:

- The *Power Patrol Program* is an energy information awareness and education program covering the residential, industrial, commercial and education sectors. It promotes efficiency in the electricity and gasoline fuel use of these sectors through the tri-media. The campaign has reached approximately 1 million households so far.

- The *Road Transport Patrol Program* was launched on 17 April 1998 focusing on information dissemination regarding proper operation and maintenance practices to reduce fuel consumption. The program is expected to contribute to the reduction in oil importation and environmental emissions as a result of the reduction in fuel consumption in the transport sector.

Climate Change Information Center

In a bid to better position itself to receive international information on climate change and climate friendly technologies and to disseminate these systematically to local stakeholders, the Climate Change Information Center (CCIC) was established.

The Philippine Climate Change Information Center began its operations in June 1999 and is housed in the Manila Observatory at the Ateneo de Manila University. The CCIC is symbolic of the government, academe, NGOs and international (USAID) partnership and is a testament of the academe's commitment to the climate change issues.

The CCIC has a collection of books on climate change, as well as, atmospheric science and pollution. Access to compact discs and various multi-media including videotapes on the various topics of climate change is possible. It also carries the current contents on CD. The CCIC is accessible 24 hours through the internet, e-mail, fax, and an electronic bulletin board.

The *Buhay* Recognition Awards for Greenhouse Gases Abatement

The *Buhay* Awards is part of the country's initiatives to promote and recognize voluntary efforts on GHG mitigation. The *Buhay* Awards for greenhouse gases abatement were presented for the first time in 1998. The Awards process intends to recognize individuals, companies, other institutions and groups that have undertaken

President Joseph E. Estrada poses with the Buhay Awardees. At the background (from left to right) are: DENR Sec. Antonio Cerilles, DOE Sec. Mario Tiaoqui and Executive Sec. Ronaldo Zamora

significant voluntary efforts to reduce generation of greenhouse gases in the Philippines. The awards seek to promote the concept of voluntary energy efficiency and other greenhouse gas abatement measures that are beneficial both to business and the environment. Such also aim to promote increased investments in greenhouse gas abatement technologies such as energy efficiency, clean technologies, renewable energy and demand-side management. There were about fifteen (15) recipients of the *Buhay* awards in 1998. These were companies from various industrial sectors that have initiated successful efforts to achieve energy efficiency, which is recognized as an effective means of reducing greenhouse gases.

Contributions from Non-Government Organizations (NGOs)

The non-government organizations play an important role in raising public awareness. As previously cited, they were among the first ones to raise public awareness on the global warming problem. They continue to play an active and pivotal role not only in increasing the general public's knowledge about this issue but in shaping government policies and positions.

The Philippine Network on Climate Change, an umbrella organization of some eight (8) national environmental NGOs, is involved in several information dissemination activities in schools, regularly organizing workshops to raise awareness on climate change issues among students and teachers. It is also continuously producing multimedia materials like brochures, t-shirts and documentary films on climate change.

Under the Philippine Climate Change Program Development, the Foundation for the Philippine Environment (FPE), in coordination with the Institute for Climate, Energy and Environment (ICEE), has produced IEC materials and is raising awareness, as well as, training local government units and other stakeholders on local action planning on climate change.

Climate Awareness Survey

The Philippines, in April 1998, through the Inter-Agency Committee on Climate Change Secretariat, conducted a survey on climate awareness in the various sectors. The survey was done in collaboration with and with support from the United Nations Environment Programme (UNEP). The main aim of the survey is to assess the levels of awareness of leaders/representatives of various sectors of society which include the business sector, government, media, NGOs and the academe. The results of the survey will be used to develop a country program that would address the gaps and constraints in raising the awareness of the populace on climate change.

Vulnerability Assessment

Climate is expected to continue to change in the future. Warmer temperatures will lead to a number of impacts both on man and environment, including agricultural resources. A more vigorous hydrological cycle will translate to prospects of more severe droughts/floods in some places and less severe climatic events in others. On the one hand, the increase in rainfall intensity suggest possibilities for more extreme rainfall events. On the other hand, changes in rainfall distribution and increases in evapotranspiration could increase the probability, intensity and duration of drought in currently drought-prone areas. And, more importantly, frequent occurrence of drought episodes could damage drainage and irrigation systems which will certainly affect agricultural production in terms of reduced yield. The Philippines, being an archipelagic country with a prevailing tropical

climate, would be highly vulnerable to the impacts of climate change.

To prepare the country for the onset of climate change, the Philippines started to prepare a National Action Plan (NAP) on Climate Change in 1997. Consolidation of vulnerability studies earlier conducted was done under the NAP process. The results of some of the studies used for purposes of producing the NAP are presented here to provide a picture of the vulnerability of some sectors and ecosystems to climate change.

Simulation Models Used

To assess the potential impacts of climate change on the country, predictive models of the climate system were employed.

Spatial and temporal variations in temperature and rainfall due to the doubling of carbon dioxide were derived using the simulation results of four general circulation models (GCMs) namely; the Canadian Climate Center Model (CCCM), the United Kingdom Meteorological Office Model (UKMO), the Geophysical Fluids Dynamic Laboratory Model (GFDL). The Goddard Institute for Space Studies (GISS) Model was also used as an additional model for the agriculture sector.

In selecting the appropriate GCMs, estimates of precipitation and temperature under 1 x CO_2 (present condition) from these models were compared with existing climatic normals. Comparisons were based on large-scale temporal and spatial distribution of precipitation and temperature. Results of comparisons show that the UKMO, GFDL, and CCC models all provide good estimates of the present condition of the region. However, only the outputs from the Canadian Climate Center Model were used as the basis for climate change scenarios.

Projected Impacts

Temperature and Rainfall

For a 2 x CO_2 scenario, the general circulation models predict an average increase of 2 to 3°C in annual temperature. Major impact areas include eastern Mindanao, portions of *Samar*, *Quezon*, western Luzon, Metro Manila, and other highly urbanized areas.

Based on the outputs of the GCMs, rainfall is likewise expected to increase in many areas of the country. A 60 to 100 percent increase in annual rainfall is projected in the Central Visayas and Southern *Tagalog* provinces, including Metro Manila. An increase of 50 percent or less is predicted in the other areas of Luzon, *Samar*, and the central and western parts of Mindanao. However, for other sections of the country such as northern and eastern Mindanao and parts of western Luzon, a decrease in annual rainfall is expected. These predictions imply dramatic changes in spatial and temporal distribution of rainfall, which could have significant impacts on the country's water resources.

Temperature change and rainfall ratios of the water resources regions of the Philippines based on the Canadian model are given in **Table 3.1**.

Based on this table, a 2 to 3°C increase in annual temperature in most water resources regions of the country is to be expected. Regions I and II will have an increase of less than 2°C while a significant change in the annual temperature will be expected in Eastern Mindanao. The expected increase in temperature will surely have an effect on the expected domestic consumption although a quantitative analysis has yet to be undertaken. The water requirement of the agricultural sector

Table 3.1 Temperature Change and Rainfall Ratio by Water Resource Region Based on the Canadian Climate Center Model (2 x CO_2 Scenario)

Name of Water Resource Regions		Temperature Change (^oC)	Rainfall Ratio
I	Ilocos	<2	1.0-1.5
II	Cagayan Valley	<2	1.0-1.5
III	Central Luzon	2-3	1.0-2.0
IV	Southern Tagalog	2-3	1.6-2.0
V	Bicol	2-3	1.0-1.5
VI	Western Visayas	2-3	1.6-2.0
VII	Central Visayas	2-3	1.6-2.0
VIII	Eastern Visayas	2-3	1.0-2.0
IX	Western Mindanao	2-3	1.0-1.5
X	Northern Mindanao	2-3	<1.0-1.5
XI	Eastern Mindanao	>3	<1.0
XII	Southern Mindanao	2-3	1.0-1.5

will likewise be impacted due to increased crop activity brought about by enhanced solar radiation. Global warming will also have an impact on the industrial use of water. Soil degradation, pollution and other environmental degradation are projected to be enhanced by the expected temperature increase. Increase in temperature will also affect water quality in some of the reservoirs and lakes due to enhanced growth of algae which could degrade water quality.

Rainfall analysis showed that annual rainfall total is expected to double in some water resources regions such as Central Luzon, Southern Tagalog, and all regions in the Visayas. For other regions like northern and eastern Mindanao, a decrease in the annual rainfall can be expected. These changes in rainfall patterns will likewise affect the availability of water resources in the country. Occurrence of intense rainfall, particularly over denuded watersheds, will aggravate the soil erosion problem. Flooding due to the passage of tropical cyclones is a likely scene due to the inability of existing reservoirs, that serve as flood controls, to contain water from the accumulated rains.

Agriculture

Vulnerability of selected crops (rice and corn) to the impacts of climate change were comparatively assessed using the results from four global circulation models (GCM), in tandem with the following crop models: the Crop-Environment Resource Synthesis (CERES)-Rice and Corn Models of the Decision Support System for Agrotechnology Transfer (DSSAT) version 3, the modified version of the CERES-Rice International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT Crop Model), the ORYZA 1 rice model and the Simulation Model for Rice-Weather relations (SIMRIW) model. The list of the six study sites, the four GCM models used in the crop-growth simulations, change in yield and maturity period of crops in all six sites are shown in **Tables 3.2 and 3.3**.

A. The Philippine Country Study on Six Major Rice and Corn Growing Areas of the Philippines.

Table 3.2 List of Sites Used in Simulations for the Vulnerability Assessment for Rice and Corn Production (Philippine Country Study Project)

Location	Coordinates	Elevation (m)	Record of Weather Data (years)	Soil Taxonomy	Crop for Assessment
ISU, Isabela State University, Echague, Isabela	16.710N 121.670E	83.24	1977-1990	Typic HAPLUSTALF	Corn
CLSU, Central Luzon State University, Munoz, Nueva Ecija	15.720N 120.90E	76.00	1974-1990	ENTIC PELLUSTERT	Rice
UPLB, University of the Philippines Los Banos, Laguna	14.700N 121.250E	21.70	1977-1990	Typic PELLUDERT	Rice
CSSAC, Camarines Sur State Agricultural College, Pili, Camarines Sur	13.570N 121.270E	35.70	1975-1990	Typic PELEUDULT	Rice
CMU, Central Mindanao University Musuan, Bukidnon	7.930N 125.070E	302.00	1978-1990	Typic HAPLUSTALF	Rice & Corn
USM, University of Southern Mindanao	7.120N 121.830E	52.00	1969-1990	Typic HAPLUSTALF	Rice & Corn

Climate change scenarios at double CO_2 concentration (2 x CO_2) were created from the four (4) GCMs. Climate characteristics of these climate scenarios consisted of rainfall, solar radiation and maximum and minimum temperatures. The seasonal (first and second cropping seasons of each crop) base climate and GCM doubled-CO_2 climate scenarios were inputted into the Crop-Environment Resource Synthesis (CERES) - Rice-and-Corn models of the DSSAT version 3 to capture the impact of climate change on these crops. The crop models were validated using the base climate and yield data from each site using the current (1995) CO_2 concentration.

Assuming rainfed conditions, the procedure was repeatedly run using all GCM scenarios, crops and planting dates in all the sites. Preliminary results of the study are the following:

- All the four GCMs indicated the same increasing trend in maximum and minimum temperatures, whereas only one gave a decrease in solar radiation amount. There was more variation, however, in the estimated change in total rainfall among sites, seasons and GCMs; although all GCM climate scenarios simulated a decrease in the maturity period for the two rice varieties used. The decrease ranged from 2.56 to 13.79 % corresponding to about 3 to 6-day decreases in the maturity period. This indicates that climate change or an increase in the CO_2 concentration will cause a decrease in maturity period for the crops.

- The results of the initial crop simulations showed that the impact of doubled-CO_2 concentration on two rice crop varieties

Table 3.3 Change in Yield and Maturity Period for Selected Climate Scenarios (IV and A Assessment for Rice and Corn Production)

Study Sites	Rice Varieties	Cropping Season	Yield Base (1 ha-1)	Change in yield (%)			
				CCCM	GFDL	GISS	UKMO
A. Rice							
CLSU	IR 64	First	4.76	3.78	6.09	2.73	4.2
		Second	3.02	7.28	1.99	7.28	-5.63
	IR 72	First	3.86	1.55	3.63	-6.73	0.26
		Second	2.82	0	-2.84	4.26	-10.28
UPLB	IR 64	First	4.71	7.64	11.46	9.13	-12.1
		Second	4.42	3.85	8.6	-13.12	-6.56
	IR 72	First	3.51	6.27	11.4	9.67	-21.65
		Second	4.61	1.95	6.72	-13.67	-7.38
CSSAC	IR 64	First	5.14	3.89	8.37	-22.37	4.47
		Second	4.23	4.49	8.51	-13.95	-9.46
	IR 72	First	3.46	1.73	7.8	-27.17	-0.058
		Second	4.3	3.02	6.51	-14.19	-9.77
CMU	IR 64	First	5.22	1.92	1.53	1.92	-6.51
		Second	3.81	11.29	18.11	7.61	5.25
	IR 72	First	4.5	7.56	6.89	2.44	-4.44
		Second	3.63	12.95	16.53	6.34	3.03
USM	IR 64	First	4	-1.5	10.5	-84	10.25
		Second	5.2	0	23.27	-12.31	16.73
	IR 72	First	3.28	-7.01	14.02	-85.06	10.37
		Second	4.97	-2.01	20.72	-16.5	15.29
B. Com							
ISU	P3228	First	6.73	-11.41	-8.62	-13.08	-5.79
		Second	5.71	-3.68	0.35	-11.21	-2.98
	SWEET	First	5.63	-10.48	-8.88	-11.37	-6.75
		Second	4.91	-7.94	-4.68	-17.72	-9.16
CMU	P3228	First	9.54	-11.43	-8.39	-13.1	-12.68
		Second	7.96	-1.38	4.65	-7.16	2.67
	SWEET	First	8.49	-11.66	-8.95	-12.25	-12.37
		Second	7.42	-8.36	-1.75	-15.09	-2.02
USM	P3228	First	7.14	-15.27	-17.93	-17.79	-14.57
		Second	6.94	-16.14	-16.14	-17.29	-8.07
	SWEET	First	5.99	-15.86	-22.87	-18.36	-15.86
		Second	5.61	-18.18	-18.72	-18.18	-6.6

varied. For rice, the simulations showed generally positive increases in yield, except in the case where the GISS scenarios were used. Under the Canadian Climate Center Model (CCCM) climate scenarios, simulated yield at 2 x CO_2 show average increases of 3.15 % and 5.38 % for the first and second crops, respectively, of the IR 64 variety; and average increases of 2.02 % and 3.18 % for the first and second crops of IR 72. The results for the sweet and PS 3228 corn crops showed a decrease in yield

under all climate change scenarios. For the CCCM scenarios, average decreases of 12.64 % and 7.07 % for the first and second crops for the PS 3228 variety, respectively, were indicated. Average decreases of 19.0 % and 11.49 % for the first and second crops of sweet corn, were also noted.

The differences in responses between rice and corn in the simulations could be accounted by the fact that:

a) rice, being a C3 plant would respond to the direct effects of CO_2 both in photosynthetic carbon assimilation and in regulating the gaseous exchange of CO_2 and water vapor through the stomata, thereby contributing to the estimate of mixed impacts on rice yields since it is possible that the crop would grow more leaves but won't increase grain yield; and

b) corn, being a C4 plant would not respond positively to the direct effects of CO_2 but would be more affected by the increase in air temperature which would enhance respiration and shorten the maturity period, thereby decreasing the yield (WMO Technical Note No. 196, *Buan* 1995).

B. Parallel Studies on Potential Impacts of Climate Change on Rice and Corn Production.

1. An earlier parallel study done by *L.V. Buendia* at the International Rice Research Institute using the GCM climate change scenarios and a modified version of the CERES-Rice International Benchmark Sites Network for Agrotechnology Transfer or IBSNAT Crop Model gave interesting results. Under a scenario of climate change (increase in temperature) alone, there is an average reduction of 22% in rice baseline yield. However, under the same climate change with physiological effects (or greenhouse gas-driven), an increase in baseline yield of 1% was obtained.

2. On the other hand, results of studies done by *Centeno* et. al. (published in 1995) to simulate effects of climate change on rice production in the country making use of two process-based rice production models namely, the ORYZA 1 and the Simulation Model for Rice-Weather Relations (SIMRIW), indicate that overall, the national rice production in the Philippines would change by +6.6 %, -14.0 % and +1.1 % for the GFDL, GISS, and UKMO doubled – CO_2 scenarios, respectively. **Table 3.4** shows the details of the estimated changes in rice production for the whole country. Most of the changes reflect the effect of the scenarios on the wet-season rice production which presently contributes an average of 80 % in the annual production. Results of the simulations for the production during the dry and transition seasons, however, showed some dramatic increases in yield.

   The decline in yield under the GISS scenario are due to higher temperatures predicted by the model which would significantly reduce spikelet fertility. The modelers further indicated that a warmer climate might allow a third rice crop in relatively cooler regions of the country.

3. To consider the impacts of projected increase in mean temperature and CO_2 concentration, the results of a comprehensive study done by a team of experts at IRRI (*Ingram et al*, 1995) on effects of high temperatures and increased CO_2 concentrations on crop production indicate that overall rice production could still respond positively to the projected changes both in temperature and CO_2 concentrations, although corn may be adversely affected.

4. Studies on responses to high temperatures indicate that once threshold values are exceeded, rice crops will be adversely affected.

Table 3.4 Estimated Changes in Rice Production from Each of the Administrative Regions in the Philippines and from the Whole Country. Proportional Changes are the Averages of those Predicted for All Stations in Each of the Administrative Regions.

Region	Current (tons)	GFDL		GISS		UKMO	
		% Change	tons	% Change	tons	% Change	tons
NCR	152,559	2.6	156,476	-11.1	135,669	16.9	178,319
I	898,584	-3.8	864,238	-17.0	745,538	2.2	918,241
II	1,033,615	-3.8	994,108	-17.0	857,571	2.2	1,056,226
III	1,748,491	2.6	1,793,379	-11.1	1,554,911	16.9	2,043,730
IV	1,118,085	10.2	1,232,604	-6.2	1,048,730	-0.4	1,113,437
V	744,223	5.4	784,357	-32.0	506,260	-20.5	591,716
VI	1,183,887	11.9	1,324,583	-11.1	1,053,064	-7.4	1,096,816
VII	207,700	11.9	232,384	-11.1	184,749	-7.4	192,424
VIII	382,954	11.9	428,465	-11.1	340,637	-7.4	354,789
IX	399,038	18.5	473,040	5.7	421,617	11.1	443,166
X	531,777	10.5	587,861	-22.1	414,386	-39.5	321,605
XI	688,302	13.3	779,593	-16.9	571,880	-1.4	678,580
XII	584,047	13.3	661,510	-16.9	485,259	-1.4	575,798
Total	9,673,262		10,312,598		8,320,271		9,564,847
% Change from the Current			6.6		-14.0		-1.1

High temperatures reduce crop productivity in two ways: through more acute high-stress events and through chronic effects of higher average temperatures.

a) Acute heat-stress injury

Temperature values	Effects
day time temperature of ≥38°C	impaired flowering and fertilization
daytime temperature up to 41°C	very little direct impact on leaf CO2 assimilation (with direct benefit)

b) Chronic high-temperature effects

Temperature values	Effects
29/21°C to 37/29°C	no significant difference in rate of tiller appearance and no. of tillers at 72 days after sowing; further increase to 41/33°C significantly reduced tiller development

c) Growth and development

Temperature values	Effects
29/21°C to 41/33°C	shoot dry weight at flowering decreased for all culti vars except IR 72
29/21°C to 33/25°C	root dry weight decreased (by as much as 50%) for IR 20, IR 46, IR 64

5. On the other hand, in the case of elevated atmospheric CO_2, the following are the known effects:

- Increased growth rate and yield through enhanced photosynthesis (*Imai et al*, 1995)
- Above 500 mL/L, positive response diminishes
- Upper limit of increased atmospheric CO_2: 660 mL/L

Table 3.5 indicates the threshold values of CO_2 concentrations at different growth stages of rice crops.

Vulnerability of Other Sectors

Water Resources

Table 3.5 CO_2 Concentration Values at Different Growth Stages

Growth Stage	Values of CO2 Concentrations	
Tiller development	350 mL/L increase for all cultivars	425-750 mL/L no further increase for all cultivars
Time from sowing to flowering	Greatest at 425 mL/L	Decline at higher and lower levels
Shoot dry weight	Greatest at 425-500 mL/L for all cultivars other than IR30	Decrease at higher levels
Root dry weight	Trends to double as CO2 increase from 350-425 mL/L	Decline above 425 mL/L

For interactive effects of elevated atmospheric CO_2 and temperature, both are likely to change crop yields and results of experiments indicate that:

- Indica rice produced more tiller than Tropical Japonica for all combinations of temperature and CO_2;
- For Indica rice, increased CO_2 shortened the time for panicle emergence at 37/29°C but delayed panicle emergence at 29/21°C. In upland cultivar, there was no significant interaction between CO_2 and temperature on time for panicle emergence; and
- Indica rice was generally photoperiod-insensitive.

Table 3.6 shows the results of the Imai study in 1995.

In spite of its relatively abundant water resources, the country, particularly the urban areas, periodically experienced water crises over the past years. Causes of these water supply problems are the rapid increase in population, fast growing demands of agriculture and industry, the expanding urbanization, unabated pollution of the water bodies and the effect of extreme climatic variability.

The large requirements of households, industries and agriculture increasingly exceed available water supplies. Metro Manila, as an example, has had several experiences of water scarcity in the past due to prolonged drought associated with climatic variability. Months of low rainfall have shown the inability of the Angat reservoir to supply the growing water requirements, not only of the city's ballooning population, but even the other sectors like agriculture, as well.

The water requirement of the agricultural sector will be impacted due to increased crop activity brought about by enhanced solar radiation. Both rainfed and irrigated crops will require more water in a warmer world. A U.S. study (McCabe and Wolock, 1992) indicates that, for a broad range of increases in temperature and precipitation, annual irrigation demand increases, even with a 20% increase in precipitation.

Table 3.6 Response of Rice to Elevated CO_2 and Temperature (Imai, 1995)

	CO_2 Concentration	Temperature
Photosynthesis	30-50% increase at 700-1000 ml/L but higher levels, photosynthetic acclimation (decline from expected rates)	
Respiration	At 160-900 ml/L, there is suppressed specific dark respiration and increased net production of rice	
Transpiration and water use efficiency	At high levels, transpiration decreases and water use efficiency is increased	
Vegetative growth a) Leaf development	Increased leaf weight at high levels	At moderately high temperature (33/26 ^{o}C) ontogenesis is shortened and yield reduced
b) Tillering	At high levels, more tillers	At high nightime temperature with high CO2 levels, late tillering-lower harvest index
c) Rooting	With elevated CO2, length of crown roots increased and water and nutrient absorption improved	
d) Production of dry matter	At elevated CO2 level, more dry matter production	Increased temperature promotes net assimilation rate and leaf area
Yield components (effective tiller, filled grains/panicle and grain weight)	High CO2 reduces quality of rice (but could be corrected by cultural practices)	High CO_2 combined with high night time temperature result to decline of maturity percentage and yield. Spikelet fertility is highly sensitive to values below 20 ^{o}C and above 33 ^{o}C.
Grain quality	High CO2 reduces quality of rice (but could be corrected by cultural practices)	

The expected increase in temperature will surely have an effect on the future domestic water demand although a quantitative analysis has yet to be undertaken. Kindler and Russel (1984) observed that per residence, water is positively correlated with average temperature. Little work has been completed on the impact of long-term climate change on domestic water use. Most analyses, to date, have drawn information from the water users' responses to short-term drought or warm episodes. Short-term responses of water use could be much different when users are faced with permanent acceptance of water restrictions and possible lifestyle changes. Results of other studies undertaken in some developed countries showed that an additional 5% increase in domestic demand

could be expected due to global warming (Kaczmarek and Kindler, 1989; Hanaki, 1993). For developing countries like the Philippines, little is known about the impact of climate change on domestic water use.

Initial efforts were undertaken to understand the impact of climate change/variability and other human activities on the country's water resources. *Jose, et al* (1993) examined long term trends of atmospheric data such as rainfall and temperature which are known to be affected by climate change. Year-to-year variations of annual and seasonal inflows at various major water reservoirs in the Philippines were examined. Results indicated decreasing inflows in all of the reservoirs. Minimal and maximal inflows were found to be associated with the activity of the El Nino-Southern Oscillation (ENSO). This extreme variability and the decreasing trend of inflows have significant socio-economic impacts and possible adverse implications on the water resource management of the country.

One of the studies made was the vulnerability analysis of the *Angat* reservoir to the expected climate change. The *Angat* Reservoir is one of the main sources of drinking water for Metro Manila. As part of the Philippine Country Study to Address Climate Change, *Angat's* vulnerability to climate change was assessed and possible adaptation measures identified. Based on historical hydrologic data, *Angat's* inflow is very much dependent on rainfall. Periods of low rainfall over the watershed areas resulted in low inflows (translated to low water level for the reservoir) while years of high rainfall yielded high water levels for *Angat* dam. Based on this relationship and with the expected changes in rainfall distribution under the doubling of CO_2 scenario, the *Angat* reservoir is projected to be seriously affected. Results showed that changes in precipitation rather than changes in temperature would directly affect changes in *Angat's* runoff. The changes in precipitation and temperature and the corresponding changes in runoff based on the climate change scenarios generated by three General Circulation Models (GCMs); the Canadian Climate Center (CCC), the United Kingdom Meteorological Office (UKMO) and the Geophysical Fluid Dynamics Laboratory (GFDL) are shown in **Table 3.7**. The UKMO and GFDL models showed an increase in runoff by 5 and 32%, respectively. The increase in runoff is attributable to an increase in precipitation predicted by the two models. The GFDL has the highest percent change in runoff; it has 15% increase in precipitation coupled with a 2.4°C increase in temperature. The UKMO model predicted only a small increase in precipitation but predicted a higher increase in temperature than the other models. Under the CCCM scenario, a 12% annual runoff reduction is estimated based on the estimated decrease in annual rainfall and increase in temperature.

Runoff simulation results indicate that the expected rise in temperature in the future will not be a significant factor in *Angat's* runoff variability, although the impacts of temperature increase could be manifested in water demand. The great variability in rainfall with respect to time, as suggested by the model results, will likewise have significant implications particularly on water availability. Very high rainfall estimates during the rainy season (May to September) could result to the overflowing of reservoirs (floods) while lower

Table 3.7 Changes in Precipitation, Temperature, and Runoff for Angat Water Reservoir Based on the Three GCMs ($2xCO_2$ Scenario)

GCM	Change in Precipitation	Change in Temperature (^0C)	Change in Runoff
CCCM	-6%	+2.0	-12%
UKMO	3%	+3.1	5%
GFDL	15%	+2.4	32%

rainfall estimates during the dry season, compared with actual conditions, could mean water shortages/crises. The threat to *Angat* reservoir from climate change could be aggravated by the increasing population, which translates to more demand for water, and the degradation of the physical environment, which could affect, to some extent, the hydrology of the area.

Vulnerability analysis of Lake *Lanao* (which is also a subject of the Philippine Country Study to Address Climate Change) also showed similar results. Global warming in the future will affect the lake's inflow significantly, thus making it highly susceptible to climate change impacts. Changes in the seasonal rainfall pattern will likewise have similar effects. Based on incremental climate change scenarios, runoff is much more sensitive to rainfall than temperature. With no change in temperature and a decrease in rainfall by 10% and 20%, there will be a corresponding decrease in runoff by 1.88% and 17.51%, respectively. A 2°C increase in temperature and again a 10% and 20% decrease in rainfall would translate to a 2.5% and 18.16% decrease in runoff. Likewise, further increasing the temperature to 4°C with a 10% and 20% decrease in rainfall would result to 3.14% and 18.77% decrease in runoff, respectively. Based on historical data, Lake *Lanao* has experienced significant decrease in runoff (18% or more) due to decrease in rainfall which were associated with the El Nino - Southern Oscillation (ENSO) related drought events. These results simply indicate that runoff is more sensitive to precipitation variability compared to temperature changes.

Lake Lanao will be significantly affected by the impacts of climate change.

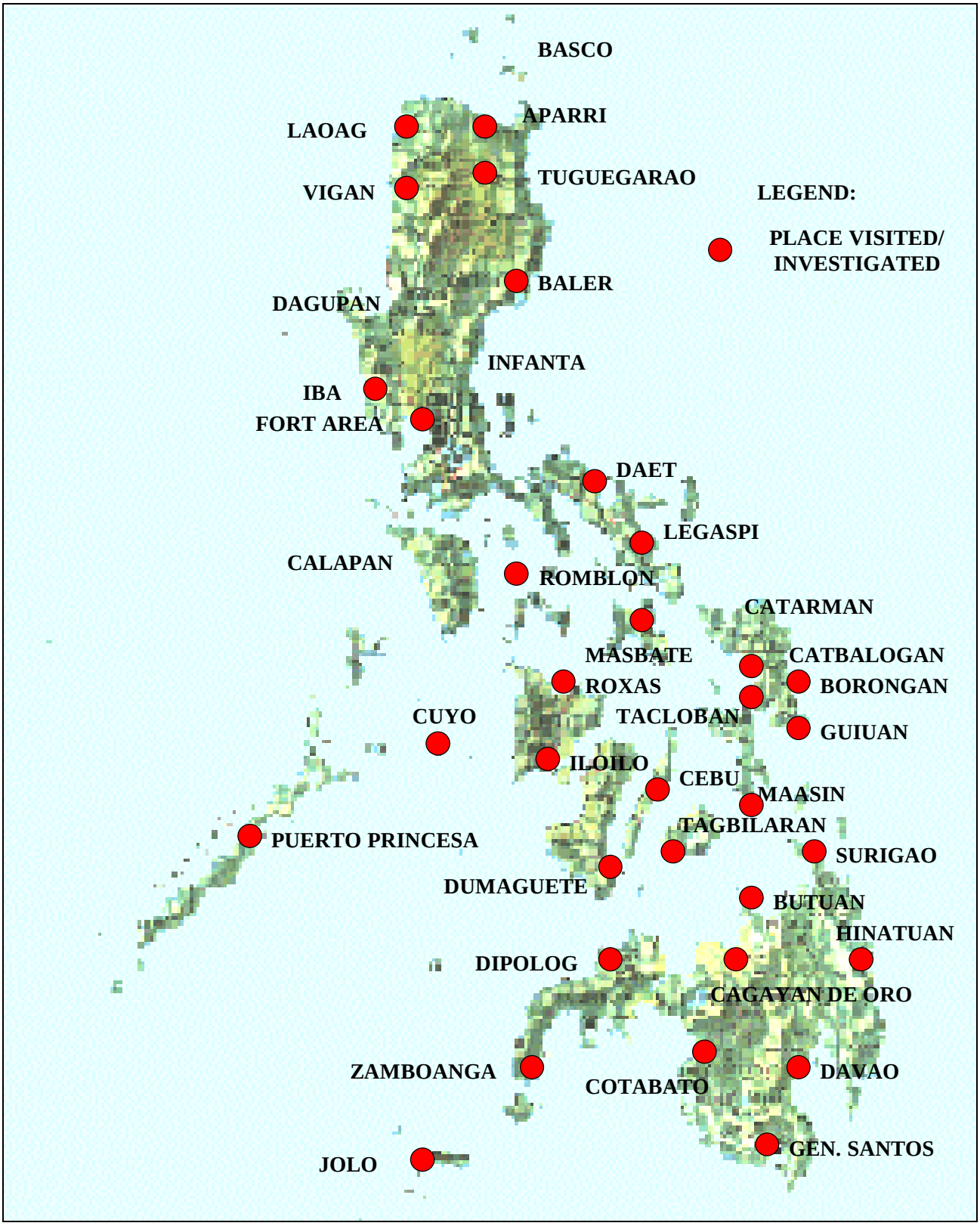
Coastal Resources

Climate change may aggravate existing coastal problems. It may lead to a range of impacts including sea level rise and changes in storminess, precipitation and freshwater availability. Accelerated sea level rise (ASLR) will affect coastal areas and the physical and biological systems. It will also affect port and coastal infrastructure, as well as, traditional lifestyles and culture in the coastal zones.

The Natural Disaster Reduction Branch (NDRB) of PAGASA has conducted an investigation of the responses of the physical characteristics and natural systems to sea level changes of some coastal places in the Philippines (NDRB, 1996). This consisted of limited site surveys and interviews to note the type of coast (e.g., rocky, sandy), system responses (such as erosion, saltwater intrusion), coastal disaster history, vegetation and socio-economic information. This activity has contributed a lot to the inventory of baseline information on the physical and natural systems of different coastal areas in the country. **Figure 3.6** shows these coastal areas. The basis of area selection is its being predisposed to flooding.

Tidal and current data of the Philippine waters are recorded and analyzed by the Coast and

Figure 3.6 Areas Inventoried for Physical and Natural Systems Responses (Also Identified as Low Lying Areas of the Philippines)



Geodetic Survey Department (CGSD) of the National Mapping and Resource Information Administration (NAMRIA). Although there are 10 primary tidal gauge stations, only five stations record almost continuous observations since 1950. The secondary stations make special observations only. **Figure 3.7** shows the locations of these stations while **Figure 3.8** depicts the mean sea level for the five primary stations namely: Manila, *Cebu, Davao, Legazpi* and *Jolo*. Except for *Jolo*, all stations indicate an increasing trend.

Records show that starting 1964, there has been a slightly increasing trend in the sea level. The Manila Bay area was observed to have a very steep rise. *Carandang* (1992), in his study of the variation of sea level in the Manila Bay, indicated that there was no reason to believe that the area is influenced by subsidence. However, deforestation in the upstream of the bay's tributaries contributed to the sediment load of the bay. Also, the lahar and other volcanic materials resulting from the eruption of Mt. *Pinatubo* in 1991, has contributed much to the siltation of the Bay waters. Other places showed a more gradual increase in mean sea level. **Table 3.8** shows trends in the annual mean sea level of the five stations.

Table 3.8 reveals that an increasing trend in annual mean sea level generally occurred in the 1970s, except for Manila which started in the 1960s. Although the absolute mean sea level values for Manila are higher, the increase(s) for *Legazpi* and *Davao* are slightly more than the change registered for Manila. However, what is alarming is that except for *Cebu* and *Jolo*, all stations showed an increase near 15 cm, the lowest expected sea level rise (SLR) set by IPCC, at the end of the next century. This could be an indication that SLR is now occurring in the Philippines.

In 1992, using the topography as the sole basis for evaluation, NAMRIA prepared a list of places in the Philippines which will be endangered in case of a projected SLR of 100 cm (or 1m). The list consisted of 28 locations (provinces) with 102 municipalities (towns or cities). Based on 1990 statistics, a total area of 129,114 ha. will be affected with a total population of approximately 2 million **(See Table 3.9)**.

Data on coastal ecological resources indicate dwindling figures. Some of the causes are:

- The conversion of mangrove forests into fishponds, saltbeds, rice paddies and even for residential, commercial and industrial purposes;
- Over-exploitation of mangroves for timber use, firewood, and tanbarks;
- Pollution due to mining and dumping of mine tailings and solid wastes;
- Siltation due to agricultural cultivation and mining; Natural causes like storm surges, tsunami and volcanic activity affect the productivity and lifespan of sea grasses;
- Bleaching of coral reefs; and
- Illegal fishing methods; Fishponds may temporarily increase aquaculture yield, however, such will compromise the replenishment of coastal fish stocks.

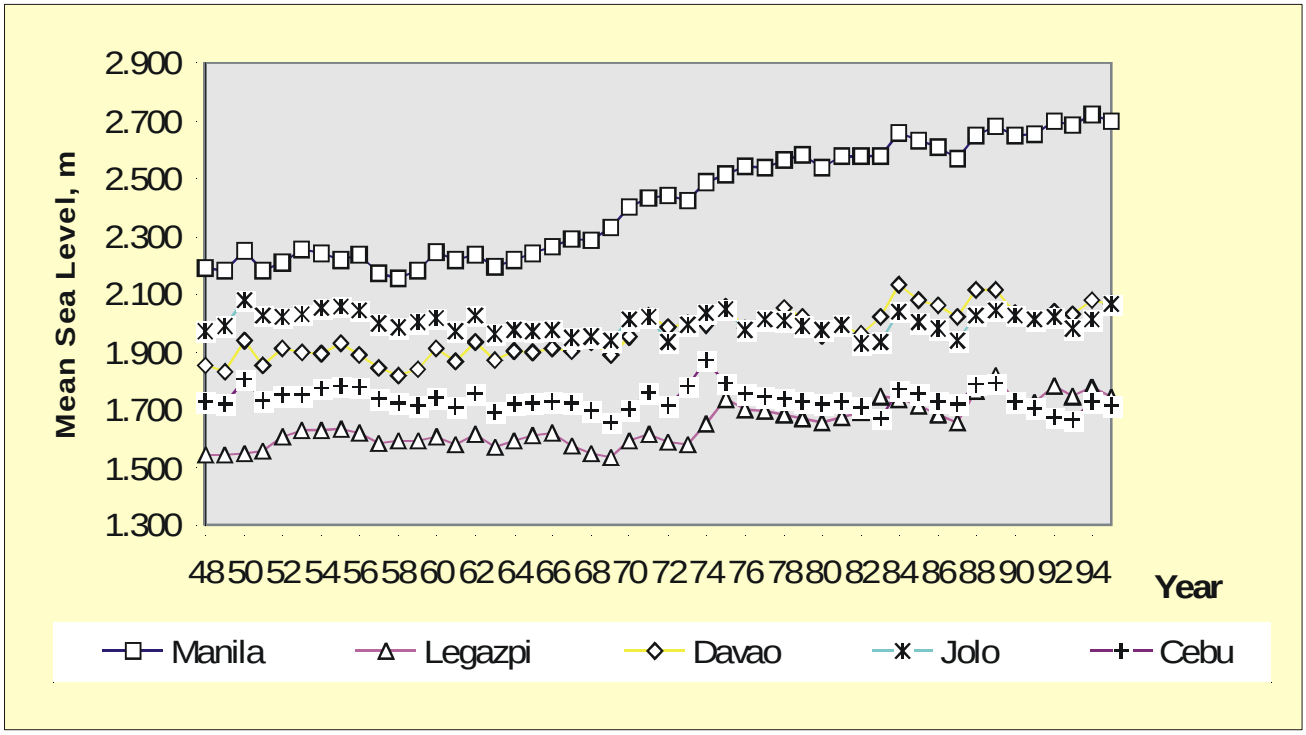
The decline of wetlands/freshwater swamps may be traced to the lack of a coherent policy on the proper use and management of such sites and to the fact that these have been declared as built-up areas.

Given the existing situation, anthropogenic global warming due to increasing GHG emissions which may lead to ASLR, will exacerbate the vulnerability of the coastal ecosystems which are already heavily stressed.

The most significant impact of climate change on coastal ecosystems is the accelerated sea level rise (ASLR). ASLR can lead to the increased erosion of beaches and cliffs and the direct inundation of low-lying lands; higher water tables resulting in floods and water logging after

FIGURE 3.7 Location of Tide Gauge Stations in the Philippines

Figure 3.8 Annual Mean Sea Level for Five Primary Stations



heavy rains; increased risk of flood and storm damage; changes in tides of rivers and bays; and changes in sediment deposition affecting tidal flats and wetlands.

Most areas along the coast will succumb to a one-meter sea level rise and densely populated coastal areas will be very vulnerable to storm surges. Coral reefs and wetlands that are already heavily stressed may not be able to keep pace with changes in sea level and mangroves may not survive changes in sediments and salinity.

The Philippine Country Study to address climate change issues and concerns under the sponsorship of the US government conducted a V & A study on coastal resources with respect to ASLR, with particular emphasis on the Manila Bay coastal area. The basis of selection is the availability of pertinent data and the highly vulnerable state of the place. Sea level scenarios used were 0.3 m and 1.0 m to represent the low and high scenarios of IPCC, and a 2 m ASLR as a worst case scenario. Among the preliminary findings (Perez, et. al., 1996) include:

- Manila Bay Area is vulnerable to sea level rise from both physical and socioeconomic standpoints

- Most areas along the coast will succumb to a one-meter sea level rise, specially *Navotas, Malabon, Parañaque, Las Piñas, Manila* and *Pasay* in Metro Manila; and the provinces of *Bulacan* [*Hagonoy, Paombong, Ma-*

Table 3.8 Trend in Annual Mean Sea Level (in meters)

STATION	1950 To 1959 Change	1950 to 1969 Change	1970 to 1979 Change	1980 to 1989 Change
Manila	-0.7	+0.083	+0.183	+0.142
Legaspi	+0.044	-0.071	+0.074	+0.165
Davao	-0.099	-0.024	+0.069	+0.165
Cebu	-0.09	-0.085	+0.027	+0.009
Jolo	-0.08	-0.078	-0.020	+0.069

Table 3.9 Areas Endangered by Sea Level Rise (for a projected SLR of 100 cm)

Location	No. of Municipalities/ Cities	Area, in ha.	Population
1. Ilocos Norte	6	2,169	9,170
2. Ilocos Sur	5	2,849	6,580
3. Cagayan	5	9,516	18,175
4. La Union	2	204	2,420
5. Pangasinan	5	24,018	246,000
6. Zambales	5	3,478	48,493
7. Aurora	2	1,060	5,036
8. Quezon	5	3,017	23,550
9. Cavite	3	5,512	230,506
10. Metro Manila	5	1,508	429,600
11. Bulacan	2	1,240	130,000
12. Leyte	4	1,683	27,596
13. Samar	4	20,596	80,710
14. Bohol	6	11,934	74,912
15. Negros Occidental	6	9,061	204,972
16. Mindoro Oriental	3	2,954	3,169
17. Davao del Sur	5	1,683	5,020
18. Davao Oriental	2	864	7,910
19. Surigao del Norte	3	6,412	23,585
20. Capiz	1	2,714	103,171
21. Iloilo	2	1,728	64,661
22. Cebu	2	1,497	146,194
23. Agusan del Norte	2	3,494	26,211
24. Misamis Oriental	5	1,939	19,350
25. Misamis Occidental	4	3,536	19,582
26. Camarines Sur	4	1,893	13,005
27. Negros Occidental	3	1,498	23,337
28. Maguindanao	1	1,057	2,500
	Total	129,114	1,995,415

Source: NAMRIA 1992

lolos, Bulacan, Marilao, Bocaue, Obando, Meycauayan, Guiguinto] and *Cavite* [*Kawit, Noveleta, Rosario, Bacoor, Cavite* City].

- Densely populated areas along the coast, especially the squatter areas of *Navotas* and *Malabon*, may survive ASLR but will be very vulnerable to severe storm surge(s)

- Saltwater intrusion will adversely affect agricultural productivity and water quality.

- Considering present costs (1995), coastal protection will be a very costly solution. For example, a concrete sea-wall 3 m high and 1 m thick with an underwater base that is 1.5 high and 3 m thick will cost US $0.6 million per kilometer.

Forestry

Changes in rainfall pattern may increase the rate of conversion of forest(s) to agricultural

lands due to human migration from areas degraded by drought and erosion to more productive forestlands. In drier areas, increase in CO_2 will likely increase productivity of vegetation by increasing water-use efficiency. A decrease in soil moisture in drier areas may accelerate forest loss while an increase in precipitation beyond evaporation demand could increase runoff resulting in soil erosion and flood occurrences. The local biodiversity will also decrease through extinction and inhibition of reimmigration from adjacent areas.

The rate of forestland conversion may increase due to drought and erosion.

In the tropics, marine organisms live closer to their maximum thermal tolerance than those in more temperate climates (*Vicente et. al*. 1992). Although the 1.5°C temperature rise scenario would raise the summertime mean temperature to 30.5°C over much of the tropical/subtropical region, most migratory species are expected to be able to tolerate such changes.

The occurrence of red tide or *pyrodinium* blooms which have become health and fishery problems in the Philippines since 1983 is also related to increased sea surface temperature. This relationship though is characterized by a time lag as observations by the Bureau of Fisheries and Aquatic Resources (BFAR) indicate. The bloom was found to appear at the onset of the rainy season, immediately after a prolonged, warm dry period with peaks towards the heavy rainfall months (BFAR, 1993). It appears then that the warm, dry episode triggers the spawning of red tide, while humid conditions at the start of the rainy season provide nourishment for its further growth.

Mangrove forests are a unique feature of protected coastal shorelines of the tropics and subtropics; their root systems stabilize sediment, dampen wave energy, provide habitat shelter for numerous organisms and provide the basis for the nearshore marine food web (*Vicente, et. al*., 1992). The best developed mangrove forests are associated with the areas of high rainfall and upstream runoff. Thus, in terms of global climate change, future changes in rainfall pattern and runoff will have severe impacts on mangroves. Mangroves grow best in moderately saline environments and could keep up with sea level rise of up to 12 cm/100 years.

The IPCC Assessment (1990) also expressed concern that the rise in sea level may aggravate leaching of contaminants from coastal sewerage and toxic waste disposal in nearby human population centers and agricultural regions. Bacterial and viral agents present in such sites and

in coastal septic sewerage systems could be increasingly released to coastal waters. While there are potential impacts on coastal resources including nutrient loading of confined waters (Valiela and Costa, 1991) the primary concern is for the human populations who consume the resources and the loss of commerce caused by the closure of fish and shellfish areas by health authorities.

Health

Consideration of climate change effects is relatively new to public health sector workers in the Philippines. However, such are currently being factored into the discussions in the health sector. Assessments indicate that the health situation is aggravated by poverty and inequity, the emergence of new challenges in the midst of unresolved problems, a very low government budget for health, and poor-allocation of limited resources. Compounded by the effects of climate change, this calls for a combination of immediate vertical and longer-term horizontal approaches.

The assessment of potential impacts of climate change on human health is a new area of inquiry. Researchers are still in the process of developing methodologies, techniques, and parameters for study (McMichael AJ *et.al.* 1996). According to McMichael *et.al.*, these studies have to take into account the evaluation of climatologists of when, where, and to what extent the ongoing greenhouse gas accumulation will translate into changes in climate. Secondly, they have to determine how those climate changes could affect the world's biogeophysical system.

In the Philippines, a study was undertaken under the Enabling Activity for the Preparation of the Initial National Communication. For this study, the following approach to correlate climate change and human health was utilized:

- **Developing some estimate of climate change based on mean monthly weather data (minimum and maximum temperatures; rainfall and humidity; and, mean sea-level pressure).**

These were drawn from reports of the PAGASA Synoptic Stations in areas representing each of the four climate types determined using a Modified Coronas classification -

- Ø Station 324 in Iba, Zambales as an area with Type I climate;
- Ø Station 440 in Daet, Camarines Norte as an area with Type II climate and Station 444 in Legaspi, Albay with a mix of Type II, III, and IV climates;
- Ø Station 618 in Puerto Princessa, Palawan as an area with Type III climate; and
- Ø Station 753 in Davao City and Station 748 in Cagayan de Oro, Misamis Oriental as areas with Type IV climate.

The following formula for measuring an "estimate of climate change" in any year was used:

The sum of the differences between the monthly observed value of a climate element minus the monthly mean of that element during a given base period, i.e., monthly weather data for a particular year (from 1961 to 1993) minus mean of the monthly weather data for the period from 1951 to 1960. For example, the "climate change" measure for 1999 would correspond to:

> The sum of [monthly weather values (1999 January to December) minus the mean of each corresponding monthly (January to December) weather data for the period from 1951 to 1960].

Using the above estimation, 5 "measures of climate change" for each year from 1961 to 1993 were generated: a "climate change measure" for minimum temperatures, a "climate change measure" for maximum temperature, a "climate change measure" for rainfall, a "climate change measure" for humidity, and a "climate change measure" for mean sea level pressure. This process was applied to the five provinces and one city studied.

· **Determining health impact using the incidence of selected diseases.**

For this study, existing central office data of the Department of Health (DOH) from its Health Intelligence Service was utilized. Data on file include the yearly incidence of notifiable diseases consolidated at the provincial and city levels from 1961 to 1993. The incidence and population weighted per 100,000 was chosen. Reports from the following areas were used –

- Ø The province of Zambales;
- Ø The province of Camarines Norte;
- Ø The province of Albay;
- Ø The province of Palawan;
- Ø The province of Misamis Oriental; and
- Ø The City of Davao.

Data on the following diseases were collected:

Viral infections that are spread by droplets from coughs/colds – 1 Influenzae (Flu), 2 Varicella (Chicken Pox), 3 Measles, 4 Mumps, 5 Viral Encephalitis

General respiratory diseases – 6 Bronchitis, 7 Pneumonia

Bacterial infections that are spread by droplets from coughs/colds – 8 Tuberculosis, 9 Diphtheria, 10 Whooping Cough, 11 Meningococcemia, 12 Leprosy Infections that are spread from feces to contaminated food or water – 13 Diarrhea, 14 Cholera, 15 Typhoid, 16 Hepatitis, 17 Polio

Diseases coming through the skin – 18 Tetanus, 19 Schistosomiasis

Sexually transmitted diseases – 20 Syphilis, 21 Gonorrhea

Mosquito-vector borne diseases – 22 Malaria, 23 Dengue or H-Fever, 24 Filariasis

Animal borne diseases – 25 Rabies, 26 Anthrax

Other diseases – 27 Cancers, 28 Nutritional Deficiencies

Disorders of the heart and AIDS were excluded because of the absence of data for most of the study and baseline period. TB meningitis, pulmonary Tuberculosis and other forms of TB were all grouped under Tuberculosis. In the same manner; Amebiasis, food poisoning, and Enteritis were all classified as Diarrhea.

Correlating the yearly (1961 to 1963) "measures of climate change" with the incidence of notifiable diseases.

The disease incidence from each province or city was treated as a dependent variable, and all the "measures of climate change" as independent variables. Then the sample coefficient of multiple determination (R^2) was computed from regression analysis.

i.e. Y = incidence of one notifiable disease reported, and
X_1 as Climate Change measure of Minimum Temperature,
X_2 as Climate Change measure of Maximum Temperature,

X_3 as Climate Change measure of Rainfall,
X_4 as Climate Change measure of Humidity, and
X_5 as Climate Change measure of Mean Sea-Level Pressure

This was done for all six study areas, with 28 notifiable diseases. The sample coefficient(s) of multiple determination for each work area and their averages are provided in **Figure 3.9**.

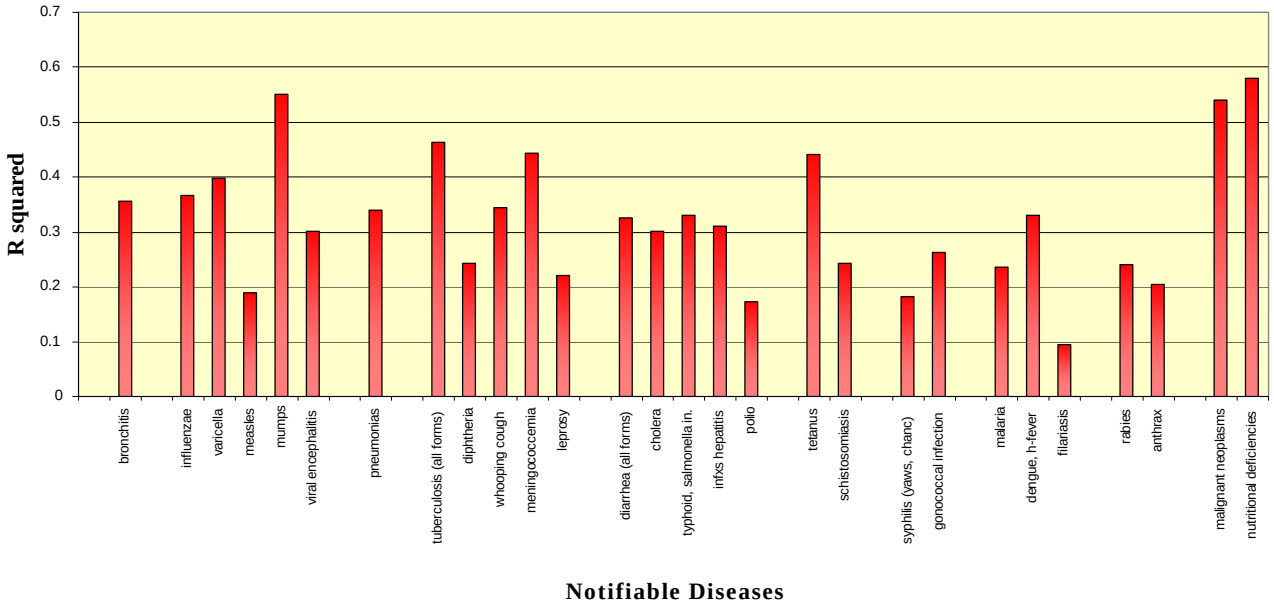
The closer R^2 is to 1.0 means that 100% of the variation between the values of the health index (incidence of the notifiable disease) is accounted for by a linear relationship with the "measurements of climate change."

The study started with a hypothesis that climate change is one factor that impacts on health but there are other alternative explanations contributing to the observed health status. As such, sample coefficients of multiple determination closer to 1.0 were not expected. Similar to the PAGASA NDRB protocol, R^2 values around 0.3 (30% linear relationship) were considered worth noting (Bucoy, 1998).

For this study, the highest R^2 are for cancers, nutritional deficiencies, and mumps. Values well above 0.3 were observed for most of the infections that are droplet-spread: Bronchitis and Pneumonia, Influenzae, Chicken Pox, Tuberculosis, Meningococcemia, and with the exception of Tetanus which is contracted through the skin. Apart from Polio, all the food or water-borne diseases have R^2 values of around 0.3 or above this. The vector-borne diseases (Schistosomiasis, Malaria, and Filariasis) show a generally lower R^2 value but that for Dengue or H-Fever is even higher.

Measles, Diphtheria, Leprosy, Syphilis, Gonorrhea, Rabies, and Anthrax all have lower R^2 values. It must be noted that an R value closer to zero implies a lack of linearity in the relationship and not a lack of association (Walpole 1997). Particularly for the mosquito-vector borne diseases, it is possible that the association is not linear but may be quadratic, where mosquito breeding pools are created by increasing climate change (for example, minimal rainfall) up to a point and decreases with higher levels of rainfall.

Figure 3.9 Average of Sample Coefficients of Multiple Determination Over Six Study Areas



These results exhibit association ranging from 10% to 58% between climate change (using the crude measurement proposed) and health (as indicated by disease incidence).

While there are indicative trends, these have to be validated and, therefore, more studies need to be undertaken.

Adaptation Strategies

Agriculture

The preliminary results of the various vulnerability studies indicate varied results. What is certain, however, is that global warming or temperature increases would cause the enhancement of activity of weeds and pests, and plant diseases; the reduced effectiveness of insecticides, pesticides and herbicides; and the acceleration of soil degradation. These are projected to weaken the positive effects of enhanced photosynthesis and a warmer climate on crop production.

Increased research on these areas and planning for adaptive measures should, therefore, be undertaken. There are three aspects that are highly vulnerable to climate change: the loss of arable lands due to sea level rise; decreased soil fertility due to increased soil erosion; and decreased crop productivity. Consequences of decreased crop yield would be a loss of food supply and a loss of jobs, especially for subsistence farmers. Therefore, it is essential that there are plans for mitigating the projected adverse impacts of climate change through a careful and exhaustive choice of adaptation strategies.

The mix of identified possible strategies for adaptation and mitigation were assessed following the decision matrix described in the IPCC methodologies. The result of the assessment made in a series of focused and consultative workshops held with major stakeholders is a mix of economic, technological, institutional and research strategies which are listed below:

Economic

1. Liberalization of agricultural trade barriers
2. Changes in existing subsidies
3. Extensive review/analysis of and appropriate action on economic incentives, subsidies, taxes, pricing and trade barriers

Technological

1. Changes in agricultural management practices
2. Natural rainfall management including water impounding dams and evaporation control
3. Cropping pattern adjustment according to the onset of the rainy season and observed frequency of tropical cyclones, including information dissemination to farmers and timely provision of farm weather services/ advisories, early warning systems (PAGASA - DA)
4. Access to available data on soil fertility from BSWM, particularly on

- Improved water management
- Developing heat-resistant varieties/genetic breeding
- Improved farm management
- Organic farming
- Diversified farming
- Safe and judicious use of fertilizers/ chemicals
- Optimum/efficient use of fertilizers/ chemicals
- Increasing effectivity/flexibility of irrigation
- Introduction of new least-cost technologies such as hydroponics
- Improvement of post - harvest and bulk

handling facilities (i.e. installation of grain-drying facilities in strategic areas).

Institutional

Institutionalizing agricultural drought management through:

1. Collaboration between managers of weather data, water resources, farmers, policy makers
2. Passage of legislative measures including those on land use conversion
3. Strengthening of extension services at the local government unit level

- Upgrade food storage distribution system
- Promote and implement judicious land use planning

Research

Study/review of and improvement of existing policies associated with production, processing, storage, transport and marketing to derive optimum effectiveness from research, technological developments and land use practices.

The adaptation strategies being recommended were chosen primarily because most of them will be least cost when implemented (i.e., natural rainfall management, cropping pattern adjustment, access to available information like soil fertility, soil taxonomy, etc.). A number of these measures are already being done by the Department of Agriculture. These are: safe and judicious and optimum/efficient use of fertilizers or the so-called Balanced Fertilization Strategy, implementation of strategies to address the ENSO episodes, and the introduction of new least-cost technologies such as hydroponics and evaporation control. These measures are viewed to entail little investment costs compared to the planned irrigation system development. Some of them will not even cost the government additional funding (i.e., collaboration between managers of weather data, water resources, farmers and policy makers and strengthening of extension services). All that is needed is improved coordination of basic services being provided by the various agencies in government. However, the recommended strategies entailing research and development of new systems (i.e., upgrading food storage system(s), improved water management, developing new heat-resistant varieties, genetic breeding and others) will need some funding . The rest of the recommended options will depend on strong advocacy and political will (i.e., legislative measures on land-use conversion and irrigation system development).

Coastal Resources

There are currently no existing policies or measures which directly address climate change and its impacts on the population, natural resources and infrastructures in the coastal zone. However, there are a number of laws and regulations regarding the use, protection, rehabilitation and exploitation of resources along the coast. These are as follows:

Policies

Development

- RA 1899 - Reclamation of foreshore lands by chartered cities and municipalities
- RA 2056 - Prohibits removal and/or demolition of dams and dikes or other works in public navigable waters and waterways and in communal fishing grounds.
- DENR AO 76 (1987) - Establishment of buffer zones in coastal, estuarine and mangrove areas.

Coastal Resources Exploitation and Protection

- PD 600/ PD 979 - Marine Pollution Law
- PD 604 - Revising and consolidating all laws affecting fishing and fisheries
- RA 5173 - Creating the Philippine Coast Guard
- PD 1998 - Restoration and rehabilitation of areas subject to development, exploration and exploitation, to their original conditions.
- Coastal Resources Management in the Local Government Code (RA 7160)

National Marine Policy

- Extent of national territory
- Protection of marine ecology
- Management of the marine economy and technology
- Maritime security

Habitation

- Act No. 3038 Authorizing the Secretary of Agriculture to sell or lease lands of private domain.
- Commonwealth Act No 141 - Public Land Act
- Lands Office Circular No. 29 - Precautions to be observed in the disposition of lands adjoining rivers, streams, creeks, lakes and other bodies of water.
- PD 1585 - Prescribing certain standards for government contracts, concessions, licenses, permits, leases or similar privileges involving the exploration, development or utilization of natural resources.
- Lands General Circular No. 51 - Additional conditions for lease contracts involving foreshore areas.
- Lands General Circular No. 58 - Directing district land officers to collect occupation fees on foreshore, marshy, reclaimed and other government lands occupied by any person or entity without authority or permit.

There are no clear-cut policies on the use and management of wetlands, mangroves, coral reefs and other precious coastal ecosystems. Among the recurrent coastal management issues that need to be addressed are the over-exploitation of fishing grounds; conversion of mangroves to other uses; the destruction of coral reefs and sea grass beds; and the red tide phenomenon. Some barriers to effective implementation that have been identified include institutional weakness(es) at different levels of government and the lack of resources to enforce existing rules and regulations.

Plans/Programs

There are currently plans and programs which are either being implemented or still to be undertaken to address the problems and issues of the country's coastal zones. Among these are the following:

Philippine Master Plan for Marine and Coastal Environment

On April 22, 1993, the Department of Environment and Natural Resources established the Coastal Environment Program (CEP) through Administrative Order No. 19, to implement programs and projects on the conservation and management of coastal and marine ecosystem. The CEP encompasses all concerns over the habitat and ecological support systems of coastal communities and fisheries specifically pertaining to their productivity, biodiversity, integrity, sustainability and equitability of access and use. The program includes activities related to the protection, conservation and rejuvenation of the population of endangered species, and research activities to mediate, ameliorate or mitigate threats to coastal resource systems.

The following summarizes the contents of the Coastal Environmental Program's Master Plan:

1. Fundamental principles for marine and coastal resources and environment management.

   a) Healthy environment;
   b) Equity and social justice;
   c) Sustainable development;
   d) Community-based Resource Management;
   e) Integrated coastal zone management.

2. Specific Policies on:

   a) Environment
   b) Public Participation
   c) Development projects/Activities
   d) Pollution
   e) Resource Use and tenure

3. Support Policies on:

   - Capability building
   - Research Monitoring and Evaluation
   - Coordination
   - Legislation

4. Management Options in Different Bio-geographic Sectors of the Philippines.

At present, the government is implementing the Fisheries Sector Program (FSP) that seeks to put into place the coastal resource management schemes in twelve priority bays. Mangrove reforestation is also part of this program and is being undertaken through contracts with private corporations. The Coastal Environmental Program seeks to develop coastal communities as resource and environmental managers. The task of mangrove reforestation was transferred to them.

The Lingayen Gulf Coastal Area Management Plan/Program(s)

The Coastal Resources Management Project (CRMP) was started in 1986, using the 160 km long coastline of the Lingayen Gulf as a pilot testing area of resource management initiatives that can be adopted by other coastal places in the country. Lingayen Gulf is the major fishing ground of Northwestern Luzon. The majority of the populace depend on coastal resources for food, income and employment. The capture fisheries, aquaculture and tourism sectors of the gulf are important to the region's economy.

The management plan is an attempt to lay the foundation for sustainable development of the Lingayen Gulf coastal area. It contains a brief review of the more important resource management issues, programs and projects to assess these issues, and institutional arrangements for plan implementation. These have been grouped into eight essential programs whose adoption is critical to the survival of the gulf. These programs are:

Fisheries Management

- Organizing municipal fishermen towards establishing common property management
- Creating a monitoring system for fisheries management.
- Upgrading expertise in fisheries management.

Environmental Quality management

- Development of institutional capabilities for monitoring water quality.
- Information, education and communication campaign against water pollution
- Establishment of pilot waste disposal systems for urban and urbanizing centers.

Coastal Zonation

- Coastal information system for coastal area management and planning.
- Codification of environmental laws and regulations for coastal area management.

- Rehabilitation of linked habitats
  *Rehabilitation of Upper Agno River system watershed
- Alternative livelihood for fishing families
  *Maguey production
  *Peanut production
  *Saltmaking
  *Environmentally sound aquarium fishing
- Rehabilitation and enhancement of critical habitats
  *Rehabilitation of mangroves
  *Establishment of the Santiago island community-based marine reserve
- Aquaculture development
  *Feasibility study for a saltwater canal system in Binmaley, Pangasinan
  *Seaweed culture
  *Seafarming in cages
  *Oyster culture
- Institutional Development

Department of Tourism (DOT) Master Planning Project (1991)

Under this initiative, a master plan for tourism was formulated, incorporating pertinent tourism development guidelines for the coastal zones. Specifically, these guidelines include measures for site planning such as siting, grading and clearing, beach improvements, buffer zones, setbacks, landscaping and protection of trees, solid wastes disposal, sewage treatment, water supply, drainage and marine habitat protection among others.

Presently, coastal management measures do not directly address the impacts of climate change.

Adaptation Measures for Coastal Resources

The following are the proposed policy measures for adaptation to climate change of the coastal resources sector.

- Assessment of current practices on crisis management (floods, droughts, storms).
- Information dissemination/education campaign on climate variability and change and its impacts for decision makers and the public.
- Formulation of guidelines and legislation for the implementation of Integrated Coastal Zone Management (ICZM) for all coastal zones of the Philippines, particularly on land-use planning.
- Mangrove resources development should be institutionalized highlighting the massive reforestation of degraded mangrove systems through a community-based approach.
- Public easements and buffer strips should be treated as separate lots during land surveys; i.e., exclusion from tilling or private ownership.
- LGUs should be required to reserve foreshore areas which are critical areas for recreation/tourism purposes and other public use and be excluded from disposition.
- Inclusion of wetlands, swamps, marshes in the NIPAS under a category of wildlife sanctuary or unique ecosystem.
- A multi-hazard mitigation and protection plan for natural coastal areas must be developed with priority on the maximum reduction in threat to life, structures and economic

production.

- Formulation and strict implementation of mining laws, reforestation of denuded watersheds to reduce river/coastal erosion.
- Requirement of geological, hydro-meteorological and structural engineering evaluation as part of the environmental impact assessment prior to coastal development.
- Limitation of government subsidies or tax incentives to develop land sensitive to sea-level rise, such as barrier islands, coastal wetlands, estuarine shorelines and critical wildlife habitats.

Under the Philippine Country Study, the identified adaptive measures for coastal resources to ASLR are as follows:

- Selective protection after thorough cost-benefit studies.
- Long-term planning in the perspective of coastal zone management to include proper resources exploitation and usage.
- Disaster mitigation and preparedness tie-up with climate change issues.
- Passage/implementation of policies and regulations on habitation and construction.
- Inclusion of measures to address climate change in the ICZM program.
- Information and education campaign to include government and the general public.

Water Resources

Thirty two (32) agencies under 12 Departments of the government are involved, in one way or another, in the management of the country's water resources. The lead agency designated as coordinating body of all the activities in the sector is the National Water Resources Board (NWRB).

To address the problems of the sector, the government has initiated several measures which include: the establishment of management committees in water crisis, droughts, and water supply; reforms in the water supply sector; and studies on the privatization of the MWSS and some water districts. Other studies have been done on the institutional aspects of water resources development and management over the past 20 years along with the proposed institutional reforms; the environmental sustainability of water resources development; and the financial sustainability of water development projects. A situational study on water resources, supply and development identified certain issues and concerns involving the present status of the country's water resources.

Other government policies include the Philippine Water Code of 1976 which provides the legislative basis for the management of the country's water resources; the National Economic and Development Authority (NEDA) Board Resolution No. 4 of March 1994 which strengthens

the NWRB staff; Executive Order No. 222 of 1995 which establishes the Committee on Water Conservation and Demand Management; the Water Crisis Act which empowers the President to implement measures to address a water emergency; Executive Order No. 374 of 1996 which created the Presidential Task Force on Water Resource Development and Management; and the recent privatization of the MWSS.

The Philippine Water Code of 1976 (PD2067) provides the legislative basis for the management of the country's water resources. The current water resources management framework consists of the following elements:

- A basic law (Water Code)
- A planning and coordination mechanism
- Assessment and basin framework plans
- A water use/waterworks regulatory system
- A water management agency - the NWRB that administers the Code

The Water Crisis Management Committee was formed in 1987 to basically address the problem of allocating water from the Angat reservoir for water supply, irrigation and hydropower during periods of drought. Members of the committee include the MWSS Regulatory Office (formerly Metropolitan Waterworks and Sewerage System), the National Power Corporation (NPC), the National Irrigation Administration (NIA), the Local Waterworks and Sewerage System (LWUA), the National Water Resources Board (NWRB), the Bureau of Soils and Water Management (BSWM), the Department of Public Works and Highways (DPWH) and the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).

The government's desire to resolve the water crisis at the soonest possible time gave rise to the National Water Summit of 1994. At the end of its deliberations, the Summit pointed to the "...urgent need to properly manage the nation's water in a sustainable manner, and ...the need for an integration and coordination of all water related efforts towards a more focused approach to water resources management."

As a result of the Summit, the President emphasized the nationwide concern for the water sector by involving his Cabinet. Cluster G (a Cabinet working group of department functionaries in charge of specific issues and concerns) was reconstituted into a Water Management Cluster. This Cluster now serves as the advisory committee to the President and the Cabinet on all matters relating to the water resources sector.

The National Economic Development Authority (NEDA) Board Resolution No. 4 in March 1994, strengthened the staff of the NWRB, the key regulatory and coordinating agency, in order to effectively cope with the planning, monitoring and implementation activities of the water resources sector.

Executive Order No. 222 of 1995 established the Committee on Water Conservation and Demand Management.

Pursuant to the National Water Summit of 1994, Congress enacted in 1995, Republic Act No. 8041 otherwise known as the "National Water Crisis Act of 1995". The law was meant to address the problems and ill effects spawned by the water crisis then prevailing.

The Water Crisis Act of 1995 provides, among others, the following:

a) Emergency powers for the President to restructure government agencies charged with the provision of water supply and sanitation services;
b) Powers for the President to enter into negotiated contracts for the financing, construction, repair and rehabilitation of water facilities;

c) Creation of the Joint Executive-Legislative Water Crisis Commission (JELWCC) chaired by the Executive Secretary, which is tasked to conduct a detailed study and review of the country's entire water supply and distribution structure.

Executive Order No. 374, issued in 1996 created the Presidential Task Force on Water Resources Development and Management. The task force is composed of the Secretary of the Department of Environment and Natural Resources as Chairman and the National Water Resources Board's Chairman as the Vice Chairman. The task force will serve as an oversight body to ensure the efficient sourcing and use of water resources, in particular, the provision of policy and program recommendations on water supply planning and coordination; prioritization of programs and projects critical for ensuring sustainable, adequate, safe and affordable water supply; coordination and monitoring of water policies and programs; and pricing policies on water resources.

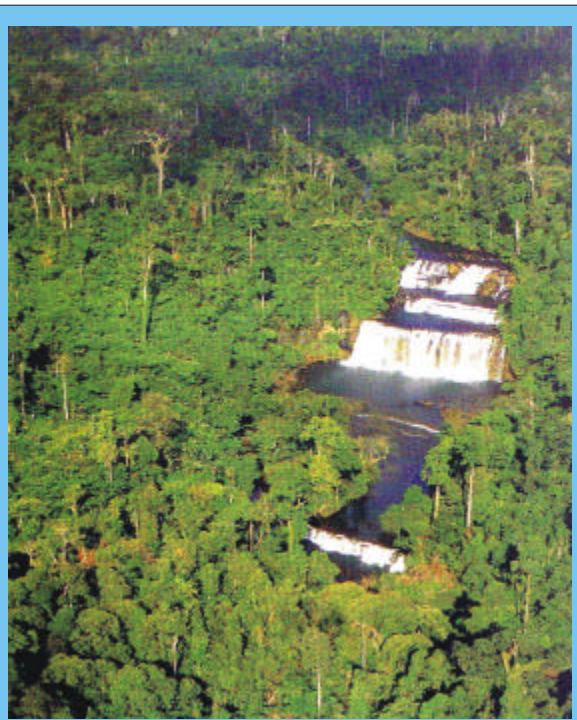
Watershed Management

The most important policy on watershed management in the Philippines is Presidential Decree 705, as amended, otherwise known as the "Revised Forestry Code of the Philippines". PD 705 embodies the general mandate of the Philippine Constitution to conserve and utilize properly the country's natural resources. The major policies enunciated in the said Decree, as applied to the watersheds are as follows:

a. all watersheds in the country shall be under the ownership and jurisdiction of the Philippine Government;
b. the watersheds shall be managed under the concept of multiple-use and sustained yield;
c. the watershed shall be managed to achieve and maintain a sound level of environmental quality; and
d. the natural resources of the Philippines, including watershed resources shall be managed with the participation of local populations and communities.

The Master Plan for Forestry Development (MPFD) provides for the integrated and holistic management of the country's watersheds and proposes a set of strategies essential to the management of the denuded watershed(s), law enforcement, resettlement, improved incentive(s), improvement of the monitoring of land uses and an integrated protection program. The MPFD was also instrumental in the DENR policy shifts of logging from the virgin forests to the residual forests, and the imposition of the logging ban in critical areas.

The National Integrated Protected Areas System (NIPAS) Act or Republic Act No. 7586



Watershed protection is a major measure to enable the country to respond to the impacts of climate change.

states that "it is the policy of the State to serve the Filipino people of the present and future generations." It also provides for the perpetual existence of all native plants and animals through the establishment of a comprehensive system of integrated protected areas.

By virtue of a Presidential instruction, the DENR is to facilitate the creation of a Watershed Management Council in a watershed prior to its proclamation as a watershed reservation. The Council comprises of representatives from different concerned government agencies (i.e., National Irrigation Administration, Local Government Units, Local Water Districts, Department of Agriculture, etc.) including non-government organizations and the private sector.

Under the Environmental Impact Statement System (PD 1586) and specifically Proclamation No. 2146 which defines the coverage of the system, watershed reservations are designated as Environmentally Critical Areas (ECAs). All activities/projects within these areas are subject to the requirements of the System, particularly obtaining the Environmental Compliance Certificate (ECC).

National and Regional Water Master Plans

Basin and regional framework plans for the twelve water resources regions have been prepared by the National Water Resources Board in the middle seventies containing an inventory of existing resources, facilities, management framework and indications of the country's needs up to 2000. The objective of this exercise is to provide agencies in the water resources sector an overview of the basin issues and problems outside their sector, as well as, identifying opportunities for joint projects. It was, however, realized that these framework plans are not adequate for the integrated sustainable development and management of water resources.

Adaptation Measures

Many water resource adaptation measures are potentially available to the country to enable it to respond to climate change impacts on water supply and demand. However, many factors will constrain it from adopting most of them. These include financial and socio-cultural factors. The latter involves social and cultural behavior or traditions that may inhibit adoption of some measures. In the preparation of the National Action Plan on Climate Change, a screening process involving a set of criteria was used to draw up an initial set of adaptation measures for the sector. The criteria are as follows:

- The adaptation measure should address high priority issues which involve irreversible or catastrophic consequences of climate change, long term decisions and unfavorable trends.
- The adaptation measure is likely to be effective.
- The measure should be inexpensive to implement.
- The measure should be feasible and must not have significant barriers to overcome such as institutional/legal, social and cultural, market and technological.

One of the major impacts of climate change is the change in the temporal and spatial distribution of precipitation and temperature. The resulting runoff or hydrological resource may be shifted in time and space. A change in the distribution with respect to time and space of runoff could greatly affect the effectiveness of existing system(s). Adaptation measures in the water resources sector, in this context, could be divided into two major classes:

· *Supply Adaptation*

- construction of new infrastructures;
- modification of existing physical infrastructure(s); and
- alternative management of the existing water supply systems.

· *Demand Adaptation*

- conservation and improved efficiency; and
- technological change.

The vulnerability analysis undertaken on two of the country's reservoirs, Angat and Lake Lanao showed that they would be highly susceptible to climate change. Due to sensitivity to rainfall changes, runoff for both areas could be dramatically altered with changes in rainfall, both in time and space. The climate change scenario from the CCCM shows an increase in temperature for all water resources regions of the country and large variations in rainfall. It would, therefore, be prudent to identify possible adaptation measures, to cope with the expected climate change in the short and long terms.

After a series of workshops, fora and round table discussions among concerned government agencies, private institutions, members of the academe, non-government organizations, members of the media and other stakeholders, a number of relevant issues and concerns relating to water resources were identified. Possible adaptation measures were also identified and evaluated based on criteria previously discussed. **Table 3.10** provides a summary of the adaptation measures for both demand and supply.

Supply Adaptation

a. Comprehensive Watershed Management

One major concern with respect to the water resources sector is the considerable decline

Table 3.10 Summary of Identified Adaptation Measures for Angat Dam and Lake Lanao

Adaptation Measures	High Priority	Effectiveness	Low Costs	Low Barriers
Supply Adaptation:				
Alternative management of existing water supply system(s)	**P**	**P**	X	X
Plan and coordinate use of water basin/ groundwater source	**P**	**P**	**P**	**P**
Improve monitoring and forcasting systems for flood and drought and water quality	**P**	**P**	**P**	**P**
Demand Adaptation:				
Treated and untreated water supply/pricing	**P**	**P**	X	**P**
Water treatment and recycling for major water users	**P**	**P**	X	**P**
Introduce low water use crops and farming practices	**P**	**P**	**P**	**P**

of watersheds. Excessive logging and shifting cultivation in the watersheds triggered widespread degradation and consequent erosion and siltation of rivers, lakes and reservoirs (Santos, 1997). The Angat and Lake Lanao watershed areas face this kind of problem in the future.

The watershed management programs of the government aimed at rehabilitating watershed areas are key steps in preventing degradation of the country's existing watershed areas. Strict implementation of existing forestry rules and regulations should also be undertaken by both concerned government and private entities.

b. Water Allocation System and Procedures

Water allocation is a powerful tool for managing the demand for water. In the Angat reservoir, irrigation and hydropower are prioritized over domestic water supply. However, in times of drought or emergency, domestic water supply gets priority over all the others within the limits of the users' water rights as determined by the NWRB. Conflicts arise when the MWSS withdraws water from the reservoir over and above its existing water rights, in the process, expropriating a portion of NIA's (in charge of irrigation) water rights. Several studies are now being conducted that would provide recommendations on water reallocation and compensation schemes to meet the demand of the sectors drawing from the Angat reservoir, particularly in the event of drought/floods in the future.

Demand Adaptation

a. Enhancement of irrigation efficiency

As the greatest consumer of water, the agricultural sector needs to increase its efficiency in water use such that water saved could be used for other purposes. The problem in the irrigation subsector is low water use efficiency due to technical and institutional deficiencies, i.e., flooding in the wet season and inadequate water availability during the dry season. The dilapidated state of canal structures in the irrigation systems and the low water use efficiencies result in water loss. Some of the possible responses to enhance irrigation efficiency in the NIA systems are: changing the cropping schedule to reduce the demand for irrigation at the end of the dry season; use of canal lining to reduce water losses; maximizing the use of available water through the construction of reservoir-type projects and redesign of irrigation facilities to reuse return flows.

b. Introduction of low water use crops and efficient farming practices

Majority of the farm areas that rely on the reservoirs like Angat for irrigation are planted to rice. And, since the crop needs substantial amounts of water from land preparation to its reproductive stage, most of the water from reservoirs, particularly of Angat, is used by the agricultural sector. During times of drought, the supply of water from the Angat reservoir has not been sufficient to irrigate a substantial portion of the concerned farmlands. The need to look for alternative crops that use less water would then be imperative. With the necessary support and assistance from the Department of Agriculture, introduction of such crops can be started.

Use of drip irrigation, mulching, improved irrigation practices and the use of windbreaks to reduce windspeed and evapotranspiration are some farming practices that could be adopted (Baradas, 1996).

c. Recycling (Reuse) of water

Due to the recurrent shortages of water, the policy of the government is to encourage reuse

of effluent in agriculture and industry. Industries are encouraged to save water and adopt measures to reuse their effluents for other secondary purposes. In the case of irrigation systems, drainage water reuse is another possibility for extending the supply of water. Installation of drainage reuse systems are now being undertaken by the NIA and the farmers to supply water to areas which cannot be reached through the normal irrigation channels.

Water used for power generation, as in multipurpose dams like the Angat Reservoir and Lanao Lake, is rechanneled for domestic use and irrigation. Households, during serious water shortages, are likewise encouraged to reuse laundry water for flushing and cleaning toilets and driveways.

Lanao Lake, used for power generation, is rechanneled for domestic use and irrigation.

d. Improvement of monitoring and forecasting systems for floods and droughts

One adaptation measure that would entail lesser cost and encounter less constraints relative to other adaptation measures is the improvement of the drought/flood monitoring and forecasting capability of the concerned entities. It has been shown that droughts and floods have tremendous effects on water resources, and climate change is likely to affect the frequency of droughts and floods. Improvement of the present system of knowing in advance future occurrences of such events could be translated to improved water management. Monitoring systems will help in coping with these changes and would still be beneficial even without climate change.

e. Use of water pricing policies and structures

Water has traditionally been treated as a public good and the government is expected to bear the cost of making this commodity accessible to the population. With the growing scarcity of water, especially in Metro Manila, and the constraints on financial resources, there is now an increasing tendency to shift to a commodity focus wherein users bear the full cost of being supplied with water.

f. Promoting awareness of climate variability and change

The public and some decision makers frequently do not understand climatic variability and the potential risks of climate change. Because climatic adaptation will affect the individual, organizational, and policy levels, awareness on the impact of climate variability on every member of the community is important. Increasing sensitivity to climate issues will facilitate adoption of measures to prepare for climate variability and change.

Mitigation Strategies

Under the UNFCCC, the developed country Parties have the primary responsibility to adopt policies and measures to limit their anthropogenic emissions of greenhouse gases and to report these to the Conference of the Parties for its review. Developing country Parties have no such obligation to reduce greenhouse gas emissions.

However, the adoption of GHG abatement measures, particularly renewable energy production systems which likewise avoid generation of other pollutant emissions like sulfur dioxide (SO_2) and nitrous oxides (NOx), contribute to the country's pursuit of sustainable development objectives. Hence, it is to the interest of the Philippines and its people, that these measures are undertaken. These measures are reflected in the various sectoral plans, particularly those of the Energy, Transport and Agriculture sectors.

They have likewise fed into the assessment processes in initiatives like the Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS) and the National Action Plan (NAP) on Climate Change. The ALGAS drew up the least cost mitigation options for the Philippines while the NAP identified the gaps and recommended strategic thrusts.

As Contained in the Philippine Energy Plan

Some of the Philippines' policies and strategies on the abatement of its greenhouse gas emissions, in the context of the above, are contained in the most recent update of the Philippine Energy Plan (PEP), 1999 – 2008. The plan's objectives are laid down as:

a.) Security of energy supply, which aims to avoid energy supply disruptions;

b.) Affordable and reasonable prices which means ensuring energy supply at lowest cost; and

c.) Socially and environmentally compatible energy infrastructures and projects, which is the provision of cleaner energy, taking into consideration benefits for the host communities.

New and Renewable Energy

Under the Plan, new and renewable energy sources are envisioned to contribute significantly to the country's electricity requirements. Total installed capacity from NRE over the next ten (10) years is projected to be around 410 MW.

Biomass fuel supply potential which is currently estimated to be 247.9 MMBFOE, is expected to grow annually by 2.2%, reaching 301.5 MMBFOE by 2008.

Of this total, municipal wastes will contribute 133.1 MMBFOE, wood/wood wastes, 97.7 MMBFOE, coconut residues, 26.2 MMBFOE, bagasse, 21.6 MMBFOE, animal wastes, 13.4 MMBFOE and rice residues, 9.6 MMBFOE.

For the period 1999-2008, solar PV systems, totaling about 19 MW, are likewise projected to be installed. Wind, meanwhile, is expected to contribute a maximum of about 145 MW to the grid by 2008. Off-grid wind turbine generators are projected to contribute 36.9 MW while micro-hydro installations, 8.52 MW at the end of the period. Ocean energy is hoped to contribute around 30 MW to the grid also at this time.

The incremental contribution of the NRE sector is expected to be brought about by the

PAGASA's windmill in Tagaytay City.

passage of policies and legislation like the Non-Conventional Energy Bill, which will try to address some of the barriers in the promotion and implementation of NRE measures and projects.

The Department of Energy will continue to promote the commercialization of renewable energy technologies through such initiatives as the Decentralized Energy System (DES) which has established lending mechanisms to support the establishment of NRE networks like the Philippine Solar Energy Society (PSES), Biomass Energy Association of the Philippines (BEAP) and the Wind Energy Association of the Philippines (WEAP). Also, it will continue to provide technical support to the rural NRE clientele through the Affiliated Non-Conventional Energy Centers (ANECs). There are currently 20 ANECs in all the regions. In some regions, they are present at the provincial level.

Overall, the capital investments for the promotion, development and commercialization of new and renewable energy is estimated to cost PHP49.3 billion. Of this, 88.6% is expected to be put up by the private sector while the government will provide the remaining 11.4%.

Energy Efficiency and Demand-Side Management

Twelve (12) energy efficiency programs will be pursued for the period 1999-2008. These programs are projected to achieve around 70,600 MBFOE of energy savings by 2008, translating to around US$1,129.2 M in foreign exchange savings and an average reduction in electricity demand of 491 MW.

These programs focus on energy management trainings, energy efficiency information campaigns, development of linkages among energy research and development entities, energy efficiency measures for industrial equipment and facilities and household appliances. Some of these programs likewise focus on demand-side management of power generation and distribution utilities.

The program(s) targeted at the industrial sector are expected to generate about 28,400 MBFOE energy savings by 2008 (equivalent to 40.2% of the total savings). Transport sector programs will result in 16,300 MBFOE savings or 23% of the total, while those for the residential and commercial sectors will account for 15.5 and 3.6%, respectively.

Specifically, some of these programs are as follows:

1. Energy Efficiency Information Campaign

The Department of Energy, in cooperation with the concerned sectors, has launched the Power Patrol and Road Transport Patrol Programs. These programs promote efficiency in electricity and gasoline fuel use in the industrial, commercial, residential and transport sectors. The Transport Patrol Program , particularly, involves a tri-media campaign for drivers, operators, vehicle and fleet owners, among others, on fuel conservation. Energy savings is estimated to be 23,800 MBFOE at the end of the plan period.

2. Energy Audit

To determine energy use patterns and energy efficiency opportunities, the Department of Energy provides advisory services, particularly on energy audits, for industries and other establishments. Through the energy service companies, an average of 50 establishments are targetted for audit annually. Potential savings from this exercise is estimated at 24,000 MBFOE by 2008.

3. Energy Labeling and Efficiency Standards

Through the Bureau of Product Standards (BPS) and the Association of Home Appliance Manufacturers (AHAM), energy efficiency standards for room airconditioners, refrigerators, freezers and lamp ballasts will be imposed. Around 7,800 MBFOE is expected to be saved by the end of the planning period. To improve performance of industrial fans and blowers, a National Fans and Blower Certification Program will be developed. The Program is expected to result in approximately 270 MBFOE energy savings.

4. Vehicle Efficiency Standards and Testing Program

The program aims to establish fuel economy standards and passenger car labelling which are envisioned to achieve 830 MBFOE energy savings by 2008. Activities of the program include testing and certification.

5. Systems Loss Reduction Program for Utilities (SLRP)

The SLRP, which is an on-going program, is expected to continue through 2008, resulting in 870 MBFOE savings. Systems loss reduction of private utilities and rural electric cooperatives will be effected through various measures.

6. Heat Rate Improvement of Power Plants (HRIP)

The HRIP is an on-going undertaking aimed at enhancing the operational efficiency of around 380 power plants over the planning period. This is projected to result in accumulated energy savings of 4,100 MBFOE.

7. Demand-Side Management (DSM) Program

The DSM Program aims to influence end use electricity consumption through the various activities of the electric utilities. Cumulative energy savings by 2008 is projected to be 5,900 MBFOE from this program.

8. Financing Energy Conservation Projects

For this initiative, the government, through the DOE and with USAID

assistance, established the Technology Transfer for Energy Management Demonstration Loan Fund (TTEM-DLF). For the planning period, the fund is projected to provide funding for around 134 projects representing about 1,070 MBFOE of energy savings.

Development and Use of Other Climate Friendly/Cleaner Fuels

The Philippines is intent on developing cleaner indigenous energy sources like natural gas, hydro and geothermal. By 2008, the Philippine domestic gas production is expected to reach 146 BCF. This is projected to be utilized for power plants like the *Iligan* and *Sta. Rita*, which will have a total installed capacity of 2,220 MW. From an almost nil percentage share in the total energy mix, natural gas is projected to comprise 6.9% of the total which is 416.5 MMBFOE.

Total installed hydro capacity is expected to double from 2,304 MW in 1998 to 4,025 MW in 2008. Hydro's share in the total energy mix will increase slightly from 3.7% in 1999 to 4% in 2008. Hydro projects in the pipeline and those being contemplated are a mix of 8 large, 2 small and 14 minihydro projects over the ten-year planning period.

Approximately 558 MW is projected to be contributed by geothermal power to the capacity mix for the period under consideration. Total cumulative installed generating capacity by 2008 is estimated at 2,450 MW. The country's total resource potential was estimated at 5,000 MW in 1995.

The Transport Agenda

The Transport Agenda under the 1999-2004 Medium Term Philippine Development Plan was developed through the Philippine Transport Strategy Study, funded by the Asian Development Bank.

At the core of this agenda is the revitalization of the transport sector so that it could operate transport services. The Agenda primarily focuses on the road system because it serves a majority of passengers and freight transport in the country. Under the scheme, the national road network is to be maintained and developed. The Philippine Road Classification Study (PRCS) under the ADB 6th Road Improvement Project has made recommendations, which, if implemented, would improve the national network.

The elements of the Road Transport Strategy/Agenda are as follows:

a.) Maintenance;
b.) Rehabilitation, which would involve reconstruction of the road structure;
c.) Improvement, which would include upgrading pavement design and bridges for heavier traffic, road widening or realignment and junction improvements;
d.) Development of penetrator roads, which are new roads meant to stimulate development; and
e.) Missing Links which are essentially new roads, especially port and airport access roads.

Rail is also considered essential to the country's transport system. In fact, it is envisioned to be its backbone. Within 100 kilometers of Metro Manila, particularly, rail has a strategic long term role because of the congested road networks. However, it must overcome a lot of hurdles, mainly institutional. Among the other issues to be examined are:

a.) future availability of rail route(s) through Metro Manila;
b.) possibility of running a cross city express service; and

c.) adoption of common technical standards to ensure contained operation of the railway as a system.

Multi-modal transport is considered appropriate to the country's topography. The Agenda, therefore, targets the development of "multi-modal corridors and establishment of multi-modal chains."

The Medium Term Agricultural Development Plan (MTADP), 1993-1998

The MTADP utilized the Key Production Area (KPA) approach for this plan period. Under this scheme, government support was focused on areas where land and water resources could be put to best use.

Under the Plan, the main mitigation measures include:

a. The Balanced Fertilization Program, which provides location specific recommend-ation for organic and inorganic fertilizers aimed at sustaining high crop yields over long cropping seasons without depleting the natural resource base. It also provides guidelines for strategic distribution of appropriate fertilizers.
b. Reduction of programmed area for irrigated rice fields;
c. Judicious use of pesticides through Integrated Pest Management; and
d.) Utilization of low-water use crops.

The Master Plan for Forestry Development (MPFD), 1990

The MPFD serves as the government's blueprint for managing the country's forest lands and resources. Programs to be implemented under the Plan are:

a. Program on Man and the Environment;
b. Program on Forests and Forest Products Development; and
c. Program on Institutional Development.

GHG mitigation measures are contained in the following sub-programs:

1. Soil and Watershed Conservation
2. People-Oriented Forestry
3. Forest Protection
4. Forest Plantation Establishment

The ALGAS Proposed Mitigation Initiatives

The Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS) is the analysis of the mitigation options of 12 Asian countries, including the Philippines, under the guidance of the Asian Development Bank, with funding from the Global Environment Facility (GEF), through the United Nations Development Programme (UNDP).

Based on the greenhouse gas emissions inventory of 1990 and projections of GHGs to 2020, mitigation measures were drawn up for three sectors: energy, forestry and agriculture. The projected emissions for these sectors were generated utilizing a number of tools. For the Energy Sector, the baseline scenario was developed using the Market Allocation (MARKAL) model. For the Forestry and Agriculture sectors, the Business-as-usual Scenarios utilized inputs from the sectoral master development plans but not based on any specific GHG abatement objectives.

Baseline and mitigation scenarios were projected to the year 2020. Mitigation scenarios for the Energy Sector were generated for both the

Table 3.11 Summary of National Least-Cost Abatement Strategy Initiatives

Implementation Time Frame	GHG Abatement Initiative	Potential GHG Emissions Reduction (MT of CO2 Equiv.)	Cost of Initiative (US$/ ton of CO2)
Energy Supply Side			
Short to Medium Term	System Loss Reduction	69.7	(-) 17.20
Short to Medium Term	Heat Rate Improvement	157.7	(-) 5.10
Short to Long Term	New & Renewable Energy		
	Wind	7.3	(-) 1.64
	Solar	3.7	1.36
	Biomass	3.7	0.27
	Natural Gas	55.0	2.40
Energy Demand Side			
Short Term	Use of CFL	33.0	(-) 26.30
Short to Medium Term	Hi-eff Air Con System	44.0	(-) 6.10
Short to Medium Term	Hi-eff Refrigerators	11.0	(-) 5.40
Short to Medium Term	Hi-eff Industrial Motors	7.3	(-) 13.70
Short to Medium Term	Hi-Eff Boilers	11.0	(-) 26.00
Transport			
Medium to Long Term	Hi-Eff Transport System	40.3	(-) 2.90

Table 3.12 Methane Mitigation Options in Rice Production

Mitigation Options	Feature of Alternate Practice	Methane Emissions Reduction Potential (kg GHG/ha/season)	% Change In Yield	Feasible Target Area
A. Fertilizer Management				
Use of ammonium sulfate instead of urea	Easy to apply Commercially available	105.5	6.5	Farmers using urea
Use of phosphogypsum in combination with urea instead of urea alone	Easy to apply Low cost	217	8.6	Areas where gypsum is abundant and available
Use of composted rice straw instead of fresh rice straw (both in combination with urea)	Indigenous material Farm mechanization made easy	421	1.3	Areas where burning of rice straw is not possible
B. Water Management				
Field drying at mid tillering and at two weeks before harvest as against continuous flooding	Allows soil aeration which is beneficial to plants Controls pests like "golden snail" Ease of harvesting	180	4.8	Areas with good irrigation and drainage system that will allow field drying
C. Cultivar				
Use of improved varieties instead of IR72	Low methane emitting variety	58.2	0	All irrigated areas

Supply and Demand sides. Using the MARKAL model, twelve least cost options were generated. These are contained in **Table 3.11**. Factors utilized include availability of resources, market penetration and readiness of technology.

In the agriculture sector, use of low methane (CH_4) emitting rice cultivators had the highest abatement potential, while use of sulfate fertilizers had the lowest. Mitigation options considered for rice cultivation are given in **Table 3.12**.

The Forestry and Land Use Sector Mitigation Assessment under ALGAS generated a number of options such as forests plantation, urban forestry and sustainable forest management, among others.

GHG Mitigation in the Context of the National Action Plan (NAP) on Climate Change

It must be stressed that the NAP is a framework plan which aims to identify the general thrusts to be focused on by the stakeholders, particularly the government, to address the issue of climate change. The prescribed mitigation measures are, therefore, largely directional, meant to provide guidance to sectoral agencies like the Departments of Energy, Agriculture and Trade and Industry, among others.

For the energy, transport and industry sectors, the following actions are proposed under the NAP:

1. Energy and Transformation

   A. Shift the energy mix towards renewable energy
      - Building of commercial proto-types to accumulate operating data
      - Least cost planning and full cost accounting
      - Research and technology cost trends of renewables (solar, wind, biomass, hydro)

   B. Revise efficiency targets
      - Supply-side efficiency improvements; power plants efficiency improvement; transmission loss reduction; replacement of coal plants with natural gas combined cycle plants
      - Demand side efficiency improvements; energy conservation, use of energy efficient technologies
      - Energy-efficient designs for new buildings

2. Transportation

   A. Traffic improvement scheme
      - Development and use of efficient mass transport systems
      - Use/promotion of non-motorized transport modes
      - Emission control schemes focusing on improved fuel and vehicle efficiency
      - Parking facilities development by public and private sector
      - Improvement of road markings and signages, as well as, intersection control

   B. Travel demand management
      - Traffic volume reduction measure such as the Unified Vehicular Volume Reduction Program (UVVRP)
      - Road pricing or area licensing scheme for urban railway corridors (i.e. MRT and LRT)
      - Staggered commuting scheme
      - Fuel and vehicle tax policy
      - Land use control and growth management

3. Industry

    - Implementation of energy efficiency measures
    - Promotion of energy conservation
    - Use of alternative non-CO_2 emitting industrial processes

For the agriculture sector, the NAP proposes the following:

- Use of tubular polyethylene bio-digesters and urea-molasses mineral block as nutrient supplement in animal production
- Use of sulfate fertilizers to reduce methane emissions
- Use of rice straw, water management and low-emitting cultivars
- Upgrading of food storage and distribution systems
- Promotion and implementation of judicious land-use planning

Over-all, it can be seen that although the Philippines does not have any legally binding commitment to reduce greenhouse gas emissions, it is undertaking a considerable number of measures to abate the generation of such.

Total and sectoral mitigation potential(s) have been estimated and specific projects identified to realize these potential(s). At the moment, however, further analysis of these proposed options are being undertaken to ensure that those to be undertaken, in addition to measures already being implemented as contemplated under the various sectoral plans and the MTPDP, are in consonance with the country's sustainable development objectives.

The avowed policies, to promote the widespread use of renewables, maximization of energy efficiency opportunities, promotion of climate-friendly technologies and practices and protection/enhancement of the country's forest resources are expected to shape and guide the development of these mitigation activities and undertakings. These policies are enshrined in Executive Order (E.O.) No. 462 (on renewables, in particular, ocean, solar and wind) Republic Act (RA) 8749 or the Clean Air Act and the various laws on forest protection, among others.

Chapter IV

FINANCIAL, TECHNOLOGICAL NEEDS AND CONSTRAINTS

The Philippines, like other developing countries, is faced with a number of constraints in its efforts to continue communicating information under the Climate Change Convention. These constraints include financial, as well as, technological ones. It is likewise severely ill-prepared for the onslaught of the impacts of climate change.

Below is a documentation of these contraints, primarily the problem on sustainability of the inventory process, capacity to undertake vulnerability, adaptation and mitigation assessments, as well as, capacity to draw up and implement strategies as a result of these assessments.

Issues And Concerns

1. National Greenhouse Gas Inventory

Despite the fact that the Philippines has undertaken two greenhouse gas inventories and in the process, presumably built considerable capacity in preparing its national greenhouse gas inventory on a regular basis, it is plagued by a number of problems threatening sustainability of the exercise. These problems and issues are as follows:

- Availability, Reliability and Variability of Activity Data and Emission Factors

For activity data, problems include data gaps, prohibiting more accurate compilation of greenhouse gas emissions. Some are highly variable because of continuous updates, compromising their reliability. In some cases, these data are outright unreliable. More and more, there is a growing consensus that the default factors utilized for the inventory are not representative of the country's actual situation.

There is, therefore, a need to generate local statistics through researches and field studies to be participated in by concerned agencies and entities.

· Institutionalization and Linkages

In some agencies, while data are available, there is a dearth of manpower to regularly produce the inventory. This is because the inventory is not included in their regular functions and mandates. There is, therefore, a need to institutionalize the inventory process within the various participating agencies. Specifically, a statistical framework and database information system for the inventory should be established. A linkage mechanism to enable academe to continuously feed into this database information system should likewise be established. **Table 4.1** lists in detail the issues attending the inventory process by sector.

Overall, to lower uncertainties in the inventory process, sensitivity analysis should be undertaken, while addressing the above issues of country specific data and emission factors needs.

2. Mitigation

Among the main issues confronting the Philippines involving mitigation of greenhouse gases is the affordability of the technologies it would like to use, e.g. utilization of renewables in power production. In view of this, interventions in terms of overcoming market barriers for the widespread use of renewables need to be undertaken. Also, more applications need to be implemented to gain field experience and additional operating data.

While an initial assessment of the country's mitigation potential has been undertaken with projects like the ALGAS, additional assessment initiatives and subsequent identification of greenhouse gas abatement projects should be carried out. For example, the wastes sector represents considerable abatement opportunities but its full potential has not yet been determined.

Moreover, a single mitigation strategy needs to be agreed upon. To this end, an integration should be made of the various GHG abatement efforts being proposed and contemplated under the various sectoral plans and the MTPDP, as well as those proposed by such project as ALGAS and the NAP. This should be done in the context of the developments in the climate change negotiations.

The capacity of implementing institutions and entities is another issue which must be addressed. Mechanisms, structures and entities needed to implement the integrated abatement strategy should either be established or strengthened. A policy and institutional framework should be drawn up. Training of critical sectors and groups should be undertaken, particularly in the fields of renewable energy and energy efficiency, among others. Specifically, training in the use of planning models like the MARKAL is needed.

Information and data management should be strengthened and enhanced. To this end, networks of information centers should be established to facilitate the flow of information from the information source(s)/provider(s) to the users.

3. Vulnerability and Adaptation

The following issues and concerns have been identified in the conduct of vulnerability and adaptation assessment under the various studies made for the three (3) major sectors (agriculture, water resources and coastal resources) in the country:

Table 4.1 GHG Inventory Sectoral Issues and Concerns

I. ENERGY	
Problems/Issues/Concerns	**Recommendation(s)**
* No country specific data; specifically on local emission factors	* Study local fuel types, particularly composition and develop local emission factors
* Institutionalization of the Overall Energy Balance (OEB)	* OEB adapted in such a way that it will contain all the necessary information necessary for the computations of GHG emissions in the energy sector.
* Data needed readily available from the DOE but are highly variable due to continuous updates in fuel consumption and allocation	* Link data in the OEB with the GHG emissions calculations to reflect instantaneously any changes resulting from the new set of values.
* Incomplete database on household consumption of biomass fuels such as wood/woodwaste, charcoal, agriwaste and other biomass/waste. * Data available is only for the year 1989 and projections made for the years 1995 and 2000 from the study made by the UNDP-ESMAP. The DOE commenced its Household Energy Consumption Study (HECS) only in 1995. Data gathered are not yet complete to date.	* Institutionalize/regularize surveys and studies on household fuel consumption not only biomass fuels, but all other conventional and nonconventional fuel types.
* Major data gaps in the transportation subsector constrains a more accurate GHG emission computation: * Type and technology of registered vehicles; VTEC, fuel injection, etc. * No. of kilometers travelled per year (annual mileage) * Year and make of car.	* Institutionalize a complete and comprehensive registration process containing all the necessary and important information for each registered vehicle in every LTO registration branch
* Institutionalization	* Develop close linkage with the DOE specifically with the Demand Analysis and Planning Division (DAPD), main data center of the department, and the Environment Division with computes and projects national CO_2 emissions from the energy sector.

II. INDUSTRY	
Problems/Issues/Concerns	**Recommendation(s)**
* Availability of data, this being highly dependent on what industrial firms, estates, or associations choose to provide for regulatory purposes (especially to the DENR or EMB or any such regulatory body as well as any indirectly related purpose)	* Draw in other data sources like DTI and PEZA which also issue annual permits
* Reliability of data	* Involve NGOs like the Philippine Business for the Environment (PBE) which are pro-active in the environment awareness circles * Involve industrial associations, e.g. PISI, SPIK, PHILCEMCOR, PHINMA, etc. to increase cooperation within sectors. * Institutionalize inventory methodologies within DTI, NSCB, and EMB all of which already have most of the requisite data available. Possibly develop local emission factors for highly emissive sectors like cement and iron and steel.

III. AGRICULTURE	
Problems/Issues/Concerns	**Recommendation(s)**
* Deficiency on country-specific factors and data. Default factors not representative of country's actual situation	* Generate local statistics by conducting researches and surveys to be participated in by concerned agencies such as BAS, BAI, IRRI, PhilRice, etc.
* Institutionalization	* Establish a statistical framework and a database information system for the inventory
Domestic Livestock * Present data on distribution of animal manure among animal wastes management systems are estimations only.	* Ascertain actual distribution of animal manure among the animal wastes management systems
Prescribed Burning of Savanna * Lack of country-specific statistics (biomass density of savanna, fraction of exposed biomass that is burned, etc.) necessary for the estimation of emission	* Undertake research studies, with the DA/FMB as lead agencies
Burning of Agricultural Residues	* Conduct research/survey on cultural practices of local farmers to generate data on crop residue
Agricultural Soils Management * No country-specific factors	

IV. WASTES	
Problems/Issues/Concerns	**Recommendation(s)**
Solid Wastes * Need for more comprehensive source(s) of data	* Data for other regions (besides the NCR) should be obtained. Data may be acquired from the LGUs * Provisions for categorizing wastes disposal by economic class, region, etc. to determine the impact of these specific categories.
Domestic/Commercial Wastewater Treatment * Need to acquire sludge data. * Need to acquire new/accurate data regarding wastewater treatment plants specially on volume of wastewater they could process, efficiency, number served, etc.-for all regions * Data on wastewater; no local BOD levels * Untreated wastewter	* More comprehensive data on sludge. May be quantified by the local sewerage entities like Maynilad Water Services Inc. *Scientific and experimental determination of local BOD levels. * Study effects of untreated waste water- on methane generated
Industrial Wastewater * No readily available data on industrial waste-water. * Data do not cover the entire nation * Data in BOD and not COD	* Conduct regular survey/study on national wastewater treatment systems. (DENR/ DTI) * Scientific study for COD levels in wastewater treatment systems

V. LAND USE CHANGE AND FORESTRY	
Problems/Issues/Concerns	**Recommendation(s)**
* Significant variability among existing data	* Conduct more field studies * Validate default data
* Deficiency in country specific data (data gaps)	* Conduct actual field studies * Validate default data
* Unrealiable data on forest area	* Determine actual forest area by reliable party using precise methods - key government institution, FMB
* Need to enhance capability of some government agencies involved in collecting relevant forest data.	
* Need to establish systematic schemes for collecting data	
* Limited resources available on carbon sequestration studies	* Institutionalize collection of data on carbon sequestration * Formulate strategies to generate more resources for carbon sequestration studies
* Data on Soil Carbon	

On the use of simulation models (GCMs) in predicting various climate change scenarios, a number of uncertainties associated with their use have been cited which must be dealt with, such as:

- The models have weaknesses in coupling the land surface and atmospheric hydrological cycles simulations of regional climate and extremes, particularly with regard to precipitation;

- The spatial resolution of current GCMs is too coarse to capture local changes in precipitation and temperature;

- There are uncertainties in the projected climate scenarios in terms of changes in temperatures, rainfall amounts, solar radiation, etc. The GCMs used are run at fairly coarse resolution (grid points are at 5° longitude by 5° latitude or roughly 555 kms by 555 kms.), so that discrepancies exist between simulations and observed climate because even variability in the climate are also, as yet, not well simulated. There is much more natural variation in local climate than in climate averaged over larger scales.

- For the vulnerability and adaptation assessments done under the Philippine Country Study, only the GCM equilibrium (2 x CO_2) temperature, rainfall and radiation are used as inputs. Effects of extreme climatic events including that of strong winds due to tropical cyclones were not considered in the scenarios.

Agriculture

Currently, a number of policies and measures are critically needed in order to develop the country's capability to address climate change issues. Foremost are a national land use policy, to generate more support for farmers and those that would increase the adoption of modern technologies.

Considering that the national studies (e.g. The Philippine Country Study) have been mainly focused on vulnerability and adaptation (V & A) assessment of rice and corn production to projected impacts of climate change, a number of gaps need to be addressed. These are:

- V & A of production of other important crops (i.e. sugar cane, coconut, cash crops, etc.) and of livestock;

- assessment of the changes in geographical and seasonal distribution of thermal and water resources important to crop and livestock production;

- assessment of reduction in GHG emissions with the implementation of the Balanced Fertilization Program;

- assessment of reduction in GHG emission from different mixes of adaptation strategies;

- development of management methods from adaptation of agriculture systems to the predicted increased CO_2 concentrations and associated climate change;

- assessment of impacts of intensive farming systems, especially because rice production needs to meet demands of increasing population; and,

- assessment of long-term effects of climate change on soil fertility and effectiveness of fertilizers and chemicals.

Water Resources

The assessment of the effects of climate change on the country's water resources has been

limited to surface water. One of the constraints is the lack of direct studies on the effect of global warming on groundwater recharge.

Another limitation is that only changes in rainfall and temperature were considered in studies on future water supply and demand. There are other climatic variables that could influence water supply and demand such as relative humidity, evapotranspiration and wind speed which need to be factored in future studies. These climatic variables will likewise have significant changes with respect to time and space as a result of changes in the global climate system. Other external or non-climatic factors such as land use changes, increase in population, pollution and watershed degradation will affect the supply-demand condition in the future.

On information gaps, there are several areas in the sector that need to be studied. These are:

- vulnerability assessment of other existing major reservoirs and river basins in the country. A more comprehensive vulnerability analysis of the country's reservoirs and river basins would provide a wider perspective in the identification of appropriate adaptation measures.

- comprehensive data base for the various water resources regions of the country. This would in turn be of valuable importance in the conduct of vulnerability analysis as well as adaptation assessment.

- impacts of climate change (temperature/ rainfall increase) on major water users such as the domestic, industrial and agricultural sectors. As mentioned previously, information on the impacts of climate change on domestic consumption, particularly of developing countries, is still vague.

- impacts of variations in temperature on the quality of surface and ground water.

- impacts of climate change on underground water resources.

- development of proper methodologies for long-term data projection.

A sustainable water resources management plan that is consistent with socio-economic development goals is necessary to address the problems of water use efficiency, especially in water utilities. It is also needed to facilitate the coordination and effective linkages among concerned government agencies; to address the inadequate balance of water supply and demand; and, to mobilize public funds and private investments to support relevant projects.

Coastal Resources

The need for baseline data and monitoring cannot be over emphasized. There is an exigency for improving and extending the existing knowledge and information on long-term hydrologic and meteorological conditions and changes (sea level, storm surge and tsunami wave heights), morphological processes, salinity intrusion, response of ecological systems (such as coral reefs to warm temperature), and availability of high resolution topographic information. This will involve increasing the quality and quantity of observing platforms. Aside from these physical data, other information needed for all coastal zones are provided in **Table 4.2** .

The availability of the above information in the context of a Geographical Information System (GIS) will be beneficial in the early monitoring of the impending impacts of climate change on the vulnerability and sustainability of coastal resources.

The Philippine coastal zones are already experiencing multiple problems. Among these are declining ecosystems (coral reefs, sea grasses,

Table 4.2 Coastal Zone Information Needs for Adaptation

Coastal Resource Base	Social Organization in the Coastal Zone	Existing Environment and Resource- Related Programs	Institutional, Legal & Financial Capacity
Inventory of: * Existing coastal resources * Present use of coastal resources * Present status of coastal resources * Potential for present and future use	* Existence & character of human settlements (villages, towns) * Economic basis for human settlements * Existence of indigenous peoples & their traditional coastal activities	* Environmental regulatory programs * Fisheries management programs * Protected areas programs * Beach/erosion mgt. programs * Pollution control programs * Other environmental management programs	* Relevant national level institutions * Relevant regional/ provincial-level institutions * Relevant local institutions * Survey of legal authorities relative to coastal and ocean activities * Existing capacity building efforts, including those funded by external forces

mangroves), low yield fish stocks, fast growing populations, human settlements (squatting) and conflict in use of the coastal zones/resources, among others. An integrated coastal zone management is proposed to address the short and long term problems. The short term-problems are usually demand driven while climate change and its impacts fall in the long term time realm.

The issues and concerns involving both the short and long term needs should be brought to the attention of the concerned communities who are the direct targets of the impacts, and of the policy makers who will direct the changes towards adapting to these impacts. Hence, information, education and communication is essential along with the technical and scientific efforts to achieve a well balanced adaptation plan.

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