CRISIS OR OPPORTUNITY

Climate change impacts and the Philippines

GREENPEACE

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EXECUTIVE SUMMARY

Weather can change very rapidly from day to day and from year to year, even with an unchanging climate. Climate is the long-term average of such weather conditions. With climate change, such changes in the weather can go from one extreme to another. The Philippines runs the risk of being affected by more frequent and severe El Niño and La Niña events resulting in droughts and floods, respectively. More intense precipitation events due to increased southwest monsoon activities and severe storm occurrences have been taking place lately, causing massive landslides and flash floods. The resulting casualties and damage to property exacerbate the misery and predicament of an already over-burdened populace.

THIRD ASSESSMENT REPORT (IPCC-TAR, 2001) – FINDINGS AND PROJECTIONS.

The distinguishable signals of climate change are among its robust findings, i.e. that the earth is definitely warming; that globally, the 1990s was the warmest decade, and 1998 the warmest year in the instrumental record (1861-2000); that the global average surface temperature has increased over the 20th century by about 0.6°C; that global average sea level rose between 0.1 and 0.2 meters during the same period; and that rainfall may have increased by 0.2% to 0.3% per decade over the tropical (10°N to 10°S) land areas.

Such signals of a changing climate are already evident in the Philippines as our limited data (1960 to present) show that the increasing trends in temperature, sea level rise and extreme climate event occurrences are consistent with the above global trends.

The IPCC Report explicitly states with more confidence that *"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."* Human activities have increased substantially the atmospheric concentrations of the main anthropogenic greenhouse gases since the pre-industrial era. The highest recorded levels in the 1990s were primarily attributed to the combustion of fossil fuels, agriculture, and land-use changes. The current rate of increase of carbon dioxide (CO_2) alone of 31% since 1750 is unprecedented during at least the past 20,000 years.

Carbon dioxide concentrations, globally averaged surface temperature, and sea level are projected to increase under all IPCC emissions scenarios during the 21st century. Emissions of carbon dioxide (CO_2) due to fossil fuel burning are virtually certain to be dominant during the period. There will be an increase in globally averaged surface temperature of 1.4 to 5.8°C. This is about two to ten times larger than the observed warming over the 20th century. Global mean sea level is projected to rise by 0.09 to 0.88 meters between the years 1990 and 2100, but with significant regional variations.

REGIONAL CLIMATE CHANGE IMPACTS (ASIA)

Climate change will exacerbate water shortages in many water-scarce areas of the world. Runoff and water availability may decrease in arid and semi-arid Asia. Decreases in agricultural productivity and aquaculture will ensue due to thermal and water stress, sea-level rise, floods and droughts, and tropical cyclones would diminish food security in many countries of Asia. Human health would be threatened by possible increased exposure to vector-borne infectious diseases and heat stress in parts of Asia.

Accelerated sea level rise will expose many human settlements to increased risk of coastal flooding and erosion and saltwater intrusion into freshwater resources. Tens of millions of people living in deltas, in low-lying coastal areas of Asia will face risk of displacement. Coral reefs would be negatively affected by bleaching and by reduced calcification rates. Tourism, an important source of income and foreign exchange for many islands, would face severe disruption from climate change and sea-level rise. **Adaptive capacity of human systems is low and vulnerability is high in the developing countries of Asia.**

EXTREME CLIMATE EVENTS

IPCC-TAR reported with high confidence that extreme climate events/ variability, such as, floods, droughts, forest fires, and tropical cyclones have increased in temperate and tropical Asia. The warm episodes of the El Niño-Southern Oscillation (ENSO) phenomena have been more frequent, persistent and intense since the mid-1970s, compared with the previous 100 years.

This IPCC finding has manifested itself in the Philippines through the more frequent occurrence of severe El Niño and La Niña events, as well as, deadly and damaging typhoons and other se-

vere storms; floods, flash floods, landslides, drought, forest fires, etc.

There were 5 La Niña episodes and 7 El Niño episodes from 1970 to 2000 compared to only 3 La Niña episodes and 2 El Niño episodes from 1950 to 1970. The strong warm (El Niño) events were in 1972-73, 1982-83,1997-98, while the strong cold (La Niña) events were in 1973-74,1988-89 and 1998-99 (CAB T.P. No. 2001-7).

The most common extreme climate events with significant economic and social impacts in the Philippines are tropical cyclone occurrences of which typhoons are the strongest and most destructive. Several typhoon extremes were observed from 1990 to 2004. The highest and lowest frequency of tropical cyclone occurrence, the strongest typhoon, the 2 most destructive typhoons, deadliest storm and the typhoon that registered the highest 24-hour record rainfall occurred during this period (Amadore, L.A., 2005).

There were seven (7) extreme tropical cyclone/southwest monsoon-induced extreme events from 1991 to late 2004, namely, the Ormoc Catastrophe, 1991; Cherry Hill Tragedy, 1999; Payatas Garbage-slide, 2000; Baguio-La Trinidad landslides, 2001; Camiguin flashfloods, 2001; Southern Leyte-Surigao disaster, 2003; and the Aurora floods, 2004. **These extreme events have one thing in common – persistent torrential rains, causing landslides and flash floods, killing people and destroying properties and the environment along its path.**

Other extreme events were the great central Luzon floods of 1972, probably the worst damaging flood in Philippine history and a precursor to the recent spate of extreme events; the southern Mindanao drought of 1998, resulting in near starvation and the Indonesia forest fires, both associated with the1997-98 El Niño event; landslides and lahar flows caused by extreme precipitation (rainfall) events

CLIMATE CHANGE IMPACTS IN THE PHILIPPINES

The sector most affected by climate change, so far, is agriculture and food security. The sharpest fall in agricultural productions are experienced during strong El Niño events and after the occurrence of severe tropical cyclones. However, increases in rice and corn productions are attributed to favorable rainfall conditions during La Nina years. The highest typhoon damage was 1.17% of GDP and 4.21% of agriculture.

In the health sector, many of the biological organisms linked to the spread of infectious diseases are especially influenced by the fluctuations in climate variables. Among other factors, dengue fever and malaria are sensitive to such climate parameters as temperature, relative humidity and rainfall. Other climate-related diseases like cholera have been associated with extremes of precipitation, droughts and floods (Relox, N.A., 1998).

The climate change impacts on coastal zones and marine ecosystems observed in 1998 were massive coral bleaching in various reefs throughout the Philippines (Arceo, H.O. et al., 2001) caused by the elevated sea temperature during the severe 1997-98 ENSO episode. Fish kills and high mortality of cultured giant clams in ocean nurseries were also observed. Severe red tide outbreaks also occurred after the strong El Niño periods. The worst incidence of red tide in Manila Bay occurred in 1992, another El Niño period.

PROJECTIONS AND SCENARIOS ON EXTREME CLIMATE EVENTS DURING THE 21ST CENTURY:

More intense precipitation events over many areas in Asia; increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities; intensified droughts and floods associated with El Niño/ La Niña events; increased Asian summer monsoon precipitation; and more hot days are expected. Corresponding severe impacts on human and natural systems are to be expected (IPCC, 2001). Recent studies suggest that future warming may lead to an upward trend in tropical cyclone destructive potential (Emmanuel K., 2005)

A climate change timetable scenario shows the impacts of climate change multiplying rapidly from increased extreme events to extinction of species and collapse of ecosystems as average global temperature goes up, towards 1^0C above levels before the industrial revolution in the next 25 years, then to 2^0C in the middle of this century, and then 3^0C during the second half of the century (Hare, B., 2005; McCarthy, M., 2005).

Conclusions and Recommendations:

SIGNALS OF CLIMATE CHANGE

Several extreme weather/climate events are occurring worldwide lately: Hurricane Katrina, in the USA, massive flooding in India and China, extensive, severe drought in Thailand, heat waves in Europe, etc. In the Philippines and the Asian region, the ENSO phenomena and the associated flood, drought, forest fire, severe storms and heavy precipitations-causing landslides and flash floods, have become more frequent and severe during the last 20 to 30 years. Yet, attribution of such extreme events to climate change is virtually impossible due to lack of data. Current scientific evidence strongly suggests, however, that hurricanes/typhoons tend to become more destructive as ocean temperatures rise. The IPCC findings, backed by long-term worldwide observations, confirming the recent increases in extreme events should at least be treated as verifiable signals of climate variability/change.

On Vulnerability assessment and adaptation measures. A municipal-level, GIS-based vulnerability assessments on sea level rise, agriculture, water resources, health and coastal and marine resources should be conducted nationwide following closely the Common Methodology of the IPCC. From here, more focused and realistic adaptation measures can be formulated.

On (adaptation) and response strategies. Improve further the accuracy and effectiveness of the tropical cyclone warning and climate change monitoring systems and enhance further the preparedness, prevention and mitigation aspects of disaster management.

On mitigation strategies and measures. In order to strengthen the mitigation programs/activities of the country, it is strongly recommended that we participate actively in the Clean Development Mechanism (CDM) of the Kyoto protocol, particularly small-scale CDM project activities on renewal energy and energy efficiency. It is also essential that the country adopt a target in generating power from new, renewable resources such as solar energy, wind power and modern biomass. Securing a target of 10% from new, renewable energy coming from sources such as solar power, wind energy and modern biomass by 2010 is an essential start while putting strong brakes on coal-fired development is just as crucial.

On climate change awareness. There is an urgent need for an effective and sustained program to enhance the level of climate change awareness among policy/decision makers, the various stakeholders, the media, students and the academe, the entertainment media, and the general public or the' masa', etc. for their own empowerment.

INTRODUCTION

Concept of weather, climate, climate change

Weather refers to such elements we experience everyday as temperature, winds, humidity (rainfall), cloudiness, etc. In any one location, weather can change very rapidly from day to day and from year to year, even with an unchanging climate. Climate is the long term average of such weather conditions. The present average global temperature is about 15 degrees centigrade (15^{0} C). An increase in the average global temperature of say, 3^{0} C, could lead to changes in other weather and climate elements, such as winds, precipitation (rainfall), atmospheric pressure, cloudiness, etc. Basically, this is climate change in its simplest form. However, when the ensuing climate system (the totality of the atmosphere, hydrosphere, biosphere and geosphere and there interactions) processes are factored in, causing significant adverse effects in the lives of people, plants, animals or any living thing, for that matter, then climate change becomes a very complicated issue. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as, 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods' (UNFCCC, 2001).

Causes of climate change

The principal change to date is in the earth's atmosphere. (UNFCCC, 2001). Mankind has changed, and is continuing to change the balance of gases that form the atmosphere. This is especially true of such key "greenhouse gases" (GHGs) as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). (Water vapour is the most important greenhouse gas, but human activities do not affect it directly.) These naturally occurring gases make up less than one tenth of one per cent of the total atmosphere, yet these greenhouse gases are vital because they act like a blanket around the earth (Figure 1-1). Without this natural blanket the earth's surface would be some 30^{0} C colder than it is today (In the Philippines, snow is possible at such conditions, but in temperate countries it could go down to -40^{0}C or colder!).

The problem is that human activity is making the blanket "thicker". For example, when we burn coal, oil, and natural gas we spew huge amounts of carbon dioxide into the air. When we destroy forests the carbon stored in the trees escapes to the atmosphere. Other basic activities, such as raising cattle and planting rice, emit methane, nitrous oxide, and other greenhouse gases. If emissions continue to grow at current rates, it is almost certain that atmospheric levels of carbon dioxide will double from pre-industrial levels during the 21st century. If no steps are taken to slow greenhouse gas emissions, it is quite possible that levels will triple by the year 2100.

The most direct result, says the scientific consensus, is likely to be a "global warming" of 1.5^0 to 4.5^0 C over the next 100 years. That is in addition to an apparent temperature increase of half a degree centigrade since the pre-industrial period before 1850, at least some of which may be due to past greenhouse gas emissions.

Just how this would affect us is hard to predict because the global climate is a very complicated system. If one key aspect — such as the average global temperature — is altered, for example, wind and rainfall patterns and other climate elements that have prevailed for hundreds or thousands of years, and on which millions of people depend, may likewise change. Sea levels may rise and threaten islands and low-lying coastal areas. The ramifications ripple outward. Uncertain effects pile onto uncertain effects (UNFCCC, 2001), such as, the adverse cascading impacts of climate change on the environment and natural and human systems (agriculture and food security, hydrology and water resources, coastal and marine ecosystems, human settlements and health, etc.).

Purpose of report

This report aims to describe the climate change-related events obtaining in the country, which could form a part of a regional (Southeast Asia) perspective on climate change.

Figure 1-1: How human activities produce Greenhouse Gasses

GHGs act like a greenhouse, trapping heat in the earth's atmosphere

Increase in **carbon dioxide** emission
- fossil fuel combustion
- deforestation

Emission of **methane**
- fermentation process (wet rice paddy, live-stock, landfills, partial burning of vegetable material, natural gas leakage)

Emissions of **nitrous oxide**
- fossil fuel combustion
- fertilizer use

Emission of **cloroflouro-carbons** (CFC's)
- solvents, ref fluids, aerosol propellants

CLIMATE CHANGE: FINDINGS,SCENARIOS AND OPTIONS

The Climate Change 2001 Synthesis Report

The Climate Change 2001 Synthesis Report (IPCC-TAR, 2001) provides a policy-relevant, but not policy-prescriptive synthesis and integration of information in the Third Assessment Report; the Summaries for Policymakers and Technical Summaries of the three IPCC Working Groups.

A summary of relevant IPCC findings, projections/scenarios (TAR, 2001) are presented in Box 1.

The First Assessment Report (FAR - 1990) of the IPCC **confirmed the scientific evidence on climate change**, and the Second Assessment Report (SAR - 1995) **noted discernible human influence on the global climate.** On its Third Assessment Report (TAR - 2001) the IPCC explicitly stated and with more confidence that, **"There is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities."** Human activities have increased substantially the atmospheric concentrations of the main anthropogenic greenhouse gases (i.e., carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and tropospheric ozone (O_3)) and aerosols since the pre-industrial era. The highest recorded levels of such key greenhouse gases in the 1990s were primarily attributed to the combustion of fossil fuels, agriculture, and land-use.

Present-day climate scientists, armed with new data from the ocean depths and from space satellites, have found that Earth is absorbing much more heat than it is giving off, which they say validates computer projections of global warming. Some scientists described the findings on the planet's out-of-balance energy exchange as a "smoking gun" that should dispel doubts about forecasts of climate change (Hanley, C.J., 2005).

Regional climate change impacts (ASIA) – (IPCC-WGII, 2001)

Climate change will exacerbate water shortages in many water-scarce areas of the world. **Runoff and water availability may decrease in arid and semi-arid Asia** but increase in northern Asia. Fresh-water quality generally would be degraded by higher water temperatures;

BOX 1: FINDINGS, PROJECTIONS/SCENARIOS – THIRD ASSESSMENT REPORT (TAR)

The atmospheric concentration of carbon dioxide (CO_2) alone has increased by 31% since 1750, this current rate of increase is unprecedented during at least the past 20,000 years. Among the robust findings of IPCC-TAR as supported by world-wide scientific observations is that the earth is *definitely* warming; ***the 1990s was the warmest decade, and 1998 the warmest year in the instrumental record*** (1861-2000); ***the global average surface temperature has increased over the 20th century by about 0.6°C*** and the increase in surface temperature for the Northern Hemisphere is likely to have been greater than that for any other century in the last thousand years***; tide gauge data show that global average sea levels rose between 0.1 and 0.2 meters during the same period. The El Niño or the warm episodes of the ENSO (El Niño-Southern Oscillation) phenomena have been more frequent, persistent and intense since the mid-1970s***, compared with the previous 100 years. Rainfall has likely increased by 0.2% to 0.3% per decade over the tropical (10°N to 10°S) land areas. In some regions, such as parts of Asia and Africa, the frequency and intensity of droughts have been observed to increase in recent decades.

Carbon dioxide concentrations, globally averaged surface temperature, and sea level are projected to increase under all IPCC emissions scenarios during the 21st century. Human influences will continue to change the atmospheric composition. Emissions of carbon dioxide (CO_2) due to fossil fuel burning are virtually certain to be the dominant influence on the trends in greenhouses gases (GHG) concentration during the period. ***There will be an increase in globally averaged surface temperature of 1.4 to 5.8°C over the period 1990 to 2100.*** This is about two to ten times larger than the central value of observed warming over the 20th century. Global and regional climate model projections indicate scenarios that future changes in the global average surface temperature during the 21st century will rise at rates, very likely, without precedent during last 10,000 years; ***Global mean sea level is projected to rise by 0.09 to 0.88 meter between the years 1990 and 2100***, but with significant regional variations. ***An increase in climate variability and some extreme events is projected***, such as, changes in frequency, intensity, and duration of extreme events, such as more hot days, heat waves, fewer cold days, *heavy precipitation events, El Nino events, tropical cyclones and an increase of Asian summer monsoon precipitation variability.*

decreases in agricultural productivity and aquaculture due to thermal and water stress, sea-level rise, floods and droughts, and tropical cyclones would diminish food security in many countries of arid, tropical, and temperate Asia; human health would be threatened by possible increased exposure to vector-borne infectious diseases and heat stress in parts of Asia, and indirectly through changes in the ranges of disease vectors (e.g., mosquitoes), water-borne pathogens, water quality, air quality, and food availability and quality.

Adaptive capacity of human systems is low and vulnerability is high in the developing countries of Asia; extreme events, including floods, droughts, forest fires and tropical cyclones, have increased in temperate and tropical Asia. Decrease in agricultural productivity and aquaculture due to thermal and water stress, sea level rise and extreme events could diminish food security in many countries. Climate change could exacerbate threats to biological diversity due to land-use and land cover change and population pressure in Asia (WMO, 2001). The developed countries of the Region are more able to adapt and less vulnerable to climate change/variability.

Populations that inhabit small islands and/or low-lying coastal areas are at particular risk of severe social and economic effects from the projected sea-level rise of 5 mm per year for the next 100 years, tropical cyclones and storm surges, increased intensity of rainfall and flood risks. **Many human settlements will face increased risk of coastal flooding and erosion, saltwater intrusion into freshwater resources, and high resource costs to respond to and adapt to these changes and tens of millions of people living in deltas, in low-lying coastal areas of temperate and tropical Asia, and on small islands will face risk of displacement.** Resources critical to island and coastal populations such as beaches, freshwater, fisheries, coral reefs and atolls, and wildlife habitat would also be at risk.

Coral reefs would be negatively affected by bleaching and by reduced calcification rates due to higher $CO2$ levels; mangrove, sea grass bed, and other coastal ecosystems and the associated biodiversity would be adversely affected by rising temperatures and accelerated sea-level rise. Declines in coastal ecosystems would negatively impact reef fish and threaten reef fisheries, those who earn their livelihoods from reef fisheries, and those who rely on the fisheries as a significant food source.

Tourism, an important source of income and foreign exchange for many islands, would face severe disruption from climate change

and sea-level rise. Climate change would also increase energy demand, and influence transportation in some regions of Asia.

Mitigation and response strategies (IPCC-WGIII, 2001)

The projected rate and magnitude of warming and sea-level rise can be lessened by reducing greenhouse gas emissions and consequently lessen the pressures on natural and human systems from climate change. The greater the reductions in emissions and the earlier they are introduced, the smaller and slower the projected warming and the rise in sea levels.

There are complex issues on various aspects of the mitigation of climate change. Market-based approach, international cooperation, such as emissions trading and technology, joint implementation, among Annex I countries and the clean development mechanism (CDM) can lower mitigation costs. Mitigation measures may, likewise, result in ancillary benefits and no regrets opportunities.

Mitigation has costs that vary between regions and sectors. Substantial technological and other opportunities exist for lowering these costs.—**Development and transfer of environmentally sound technologies could play a critical role in reducing the cost of stabilizing greenhouse gas concentrations.** Transfer of technologies between countries and regions could widen the choice of options at the regional level. Economies of scale and learning will lower the costs of their adoption.

The capacity of countries to adapt and mitigate can be **more effective and enhanced when climate change policies are integrated with national development policies including economic, social, and other environmental dimensions.** Such portfolio of policy instruments may include energy mix requirements, land-use policies, emissions/carbon/energy taxes, provision and/or removal of subsidies, technology or performance standards, product bans, voluntary agreements, government spending and investment, and support for research and development.

Adaptation has the potential to reduce adverse effects of climate change and can often produce immediate ancillary benefits, but will not prevent all damages. It may be able to complement mitigation in a cost-effective strategy to reduce climate change risks; together they can contribute to sustainable development objectives.

POST-TAR ACTIVITIES AND ASSESSMENTS

Scientific basis of climate change

The global average surface temperature has increased over the 20th century by about 0.6°C. The increase in surface temperature for the Northern Hemisphere is likely to have been greater than that for any other century in the last thousand years. On the average, between 1950 and 1993, night-time daily minimum air temperatures over land increased by about 0.2°C per decade. Since 1950 it is very likely that there has been a reduction in the frequency of extreme low temperatures, with a smaller increase in the frequency of extreme high temperatures. Annual rainfall trends are either constant or slightly increasing during the past 20-30 years and it is likely that rainfall has increased by 0.2 to 0.3% per decade over the tropical (10°N to 10°S) land areas. Increases in the tropics are not evident over the past few decades. It is also likely that rainfall has decreased over much of the Northern Hemisphere sub-tropical (10°N to 30°N) land areas during the 20th century by about 0.3% per decade. Tide gauge data show that global average sea level rose between 0.1 and 0.2 meters during the same period (IPCC-TAR, 2001).

PHILIPPINE TRENDS

The annual mean temperature values range from 19.5 C in the mountain areas to 28.2 C in small islands. Higher temperatures are observed during El Niño episodes and higher minimum temperatures observed during the cold episode or La Nina. As a result, there is an increase in the mean annual temperatures during the last quarter of the 20^{th} century. Figure 3.1 shows that there is a warming trend during the last 25 years (1920 – 1998), comparable with the observed global temperature increase (CAB T.P. No. 2001-5).

There has been a significant increase in frequency of warm nights and hot days and a decrease of cool days and cold nights from 1960 to 2003 (Tibig, L.V., 2004). There is considerable spatial coherence of negative/positive temperature trends with other countries in the

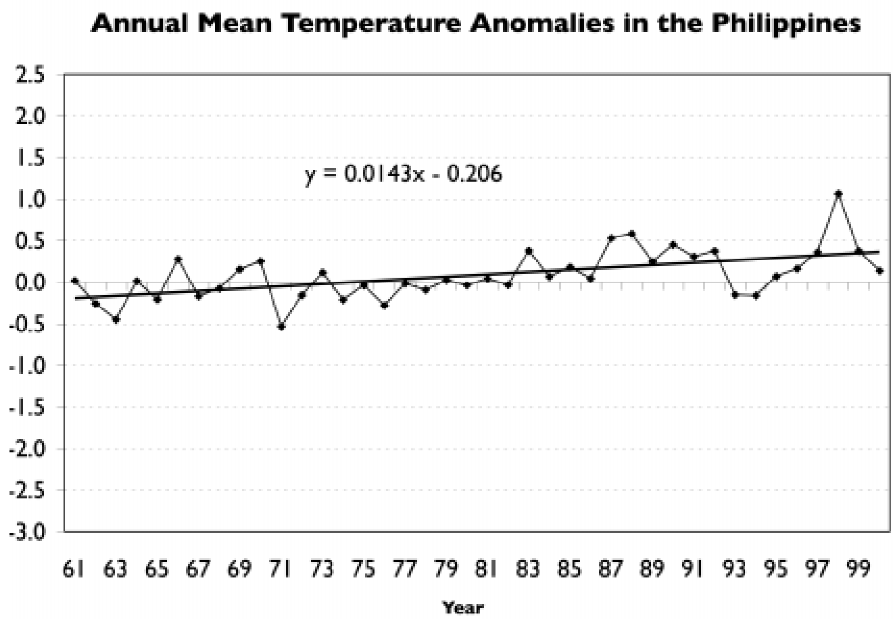


Figure 3-1. Temperature increase/ trend in the Philippines (1961-2000) and the Global temperature trend (1000-2000)

Local temperature increases/trends are consistent with global trends. Note the peak increase in 1998, which was also the warmest year, globally)

Southeast Asia-Pacific region. The number of warm nights and hot days across most of the Region usually increased substantially in the year after the onset of El Nino events. As for rainfall there is less spatial correlation in the Region. In the Philippines, no significant trends in rainfall indices were found except for generally increasing annual rainfall amounts and number of rainy days during the wettest and driest years per decade.

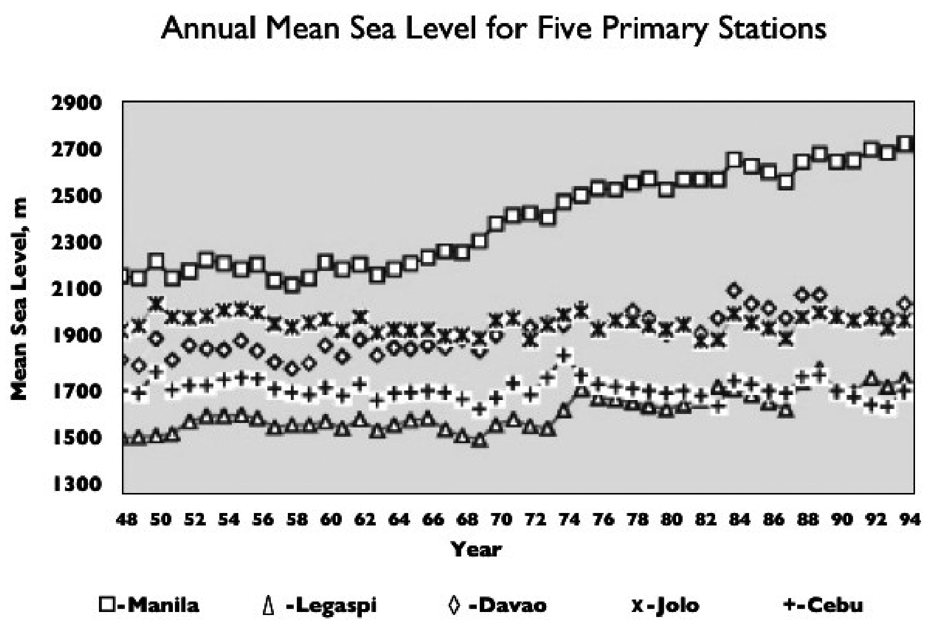


Figure 3-2. Sea Level Rise at 5 Philippine Primary Tide Stations

Local sea level rise trends/increase are also consistent with global ASLR. The high incremental increase in sea level at Manila bay may be attributed to other factors, other than climate change.

The increasing trend in sea level rise generally began in 1970 (IACCC, 1999). **Metro Manila, Legazpi (southern Luzon), and Davao (south-eastern Mindanao) showed an increase of nearly 15 cm,**

the lowest sea level rise expected by the IPCC. Jolo (southern Mindanao) and Cebu (central Visayas), had no perceptible sea level rise since 1948 (Figure 3.2). The relatively early start (1960) and high incremental increase in sea level at Manila bay may be attributed to other factors, other than climate change.

Extreme Climate Events (ECE)

Extreme climate events/variability, such as, floods, droughts, forest fires, and tropical cyclones have increased in temperate and tropical Asia. In some regions, such as parts of Asia and Africa, the frequency and intensity of droughts have been observed to increase in recent decades. The El Niño phenomenon has been more frequent, persistent and intense since the mid-1970s (IPCC-TAR, 2001).
A study based on the potential destructiveness index (PDI) of tropical cyclones from 1949 to 2003, suggest that the annual average storm peak wind speed summed over the North Atlantic and eastern and western North Pacific has also increased by about 50% (Emmanuel K., 2005).
These findings are manifested in the Philippines through the occurrence of severe El Niño and La Niña events, as well as, deadly and damaging typhoons and other severe storms; floods, flash floods, landslides, drought, forest fires, etc. since 1980.

THE EL NIÑO-SOUTHERN OSCILLATION (ENSO) PHENOMENA

The El Niño-Southern Oscillation (ENSO), although not yet rigorously defined is a large-scale ocean-weather phenomenon associated with a major warming (El Niño) / cooling (La Niña) of the surface layers of the central and eastern equatorial Pacific Ocean. The available observations indicate that the characteristics of ENSO variability over the second half of the century may have changed. There have been more ENSO events, particularly since the early 1970s, with an almost continuous sequence during the early 1990s and two major events in 1982-83 and 1997-98. Despite the continuing discussion on the changed characteristics of El Niño events, and attribution of cause, there is consensus that issues related to El Niño are inseparable from the broader issues of climate change. ENSO is part of the recurring patterns of extreme events and persisting climate anomalies that have enormous societal impacts, especially in developing countries (WMO, 1999).

The effects of El Niño/La Niña is not uniform throughout the Philippines, or throughout the world. Southeast Asia (for example, Indonesia and the Philippines) may experience droughts due to below normal rainfall conditions, while western South America is likely to experience floods due to heavier than normal rainfall. The reverse is true for La Niña. Major parts of the Philippines usually experience near normal to above normal rainfall conditions and flooding, normal or early onset of the rainy season or shorter dry season during La Niña.
Based on temperature variations and other factors/conditions in the tropical Pacific ocean during the past 51 years (1950 – 2000) the following ENSO phenomena were observed (CAB T.P. No. 2001-7):
There were three (3) La Niña episodes (1950-51, 1954-55, 1955-56) and two (2) El Niño episodes (1957-58, 1969) from 1950 to 1970. Likewise, five (5) La Niña episodes (1970-71, 1973-74, 1975-76, 1988-89, 1998-99, 1999-2000) and seven (7) El Niño episodes (1972-73, 1982-83, 1986-87, 1991-92, 1993, 1994-95, 1997-98) were identified from 1970 to 2005 (Table 1). Note that **there is indeed a significant increase in the frequency of ENSO events since 1970.**

The strong warm (El Niño) events were in 1972-73, 1982-83,1997-98, while the strong cold (La Niña) events were in 1973-74, 1988-89 and 1998-99. The longest warm (El Niño) episode alternating from weak to moderate and strong, then weak to moderate warm episodes was from the 2nd quarter of 1990 to the 1st quarter of 1995. Weak to moderate ENSO events were observed from 2000 to early 2005. The increase in ENSO intensities according to the IPCC findings (IPCC-TAR, 2001) are, likewise, evident during the period.

The most noticeable and quantifiable effect of this extreme climate event in the Philippines is the sharp decline in the gross value added (GVA) in agriculture at the height of the 1982-83 and the 1997-98 ENSO episodes, the two strongest El Niño events during the past century. This was reinforced in terms of the notable decline in the volume of production of the 4 principal crops (rice, corn, coconut and sugarcane), in 1983 and 1998 (Figure 3.3).

Year	JFM	AMJ	JAS	OND
1950	C	C	C	C
1951	C			W-
1952				
1953		W-	W-	
1954			C-	C
1955	C	C-	C-	C+
1956	C	C	C	C-
1957		W-	W-	W
1958	W+	W	W-	W-
1959	W-			
1960				
1961				
1962				
1963			W-	W
1964			C-	C
1965	C-		W	W+
1966	W	W-	W-	
1967				
1968				W-
1969	W	W-	W-	W-
1970	W-			C
1971	C	C-	C-	C-
1972		W-	W	W+
1973	W		C-	C+
1974	C+	C	C-	C-
1975	C-	C-	C	C+
1976	C			W-
1977				W-
1978	W-			
1979				
1980	W-			
1981				
1982		W-	W	W+
1983	W+	W		C-
1984	C-	C-		C-
1985	C-	C-		
1986			W-	W
1987	W	W	W+	W
1988	W-		C-	C+
1989	C+	C-		
1990			W-	W-
1991	W-	W-	W	W
1992	W+	W+	W-	W-
1993	W-	W	W	W-
1994			W	W
1995	W			C-
1996	C-			
1997		W	W+	W+
1998	W+	W	C-	C
1999	C+	C	C-	C+
2000	C	C	C-	C
2001	C			
2002		W-	W	W
2003	W-		W-	W-
2004			W	W
2005	W-			

Table 1. ENSO Occurrences (1950 – 2005). *La Nina* or Cold (C-, C, C+) and *El Nino* or Warm (W-, W, W+) Episodes by Season (Weak [-] Moderate, [   ], Strong [+]) Note the marked increase in moderate to strong El Nino (W,W+) and La Nina (C, C+) since 1970. A century, however, is too short a period to assess nulti-decadal ENSO variations)

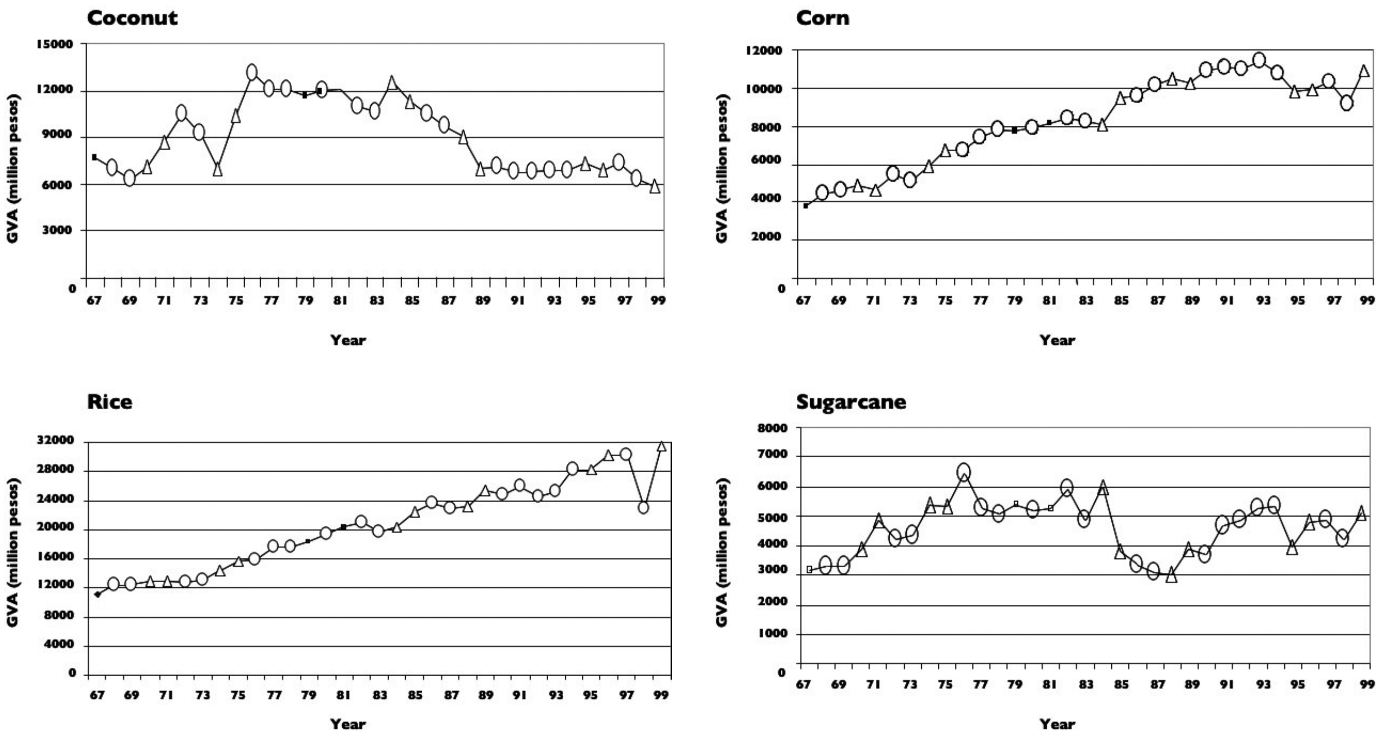


Figure 3-3. Effect of El Nino on palay, corn, coconut, sugarcane. Gross Value Added (GVA) in four principal cops at constant 1985 prices. (Gross value added refers to the difference between gross output and intermediate outputs. Gross output is equal to the gross value of the goods and services produced during the period, while intermediate inputs refer to the value of goods and services used in the production process during the accounting period – NSCB, 2003)

The GVA in palay showed slight decreases in 1983, 1987, 1990 and 1992, and a very sharp fall in 1998. All of these are El Niño years, whereas increases in the GVA were observed during normal and La Nina years (Amadore, L.A., Jose, A. M., and Tibig, L.V., 2002)

Although other crops such as corn, sugar cane and coconut showed some sensitivities to climate variability, i.e. some increases during La Niña years and decreases during El Niño years, yet an examination of other factors is necessary in order to identify impacts of ENSO-driven events more accurately.

The longest warm ENSO episode of 1990 –93 had caused destruction of several metric tons of corn. The corn-producing provinces most severely affected were the Cotabato provinces, Maguindanao and Bukidnon in Mindanao and Isabela in northern Luzon.

The 1997-98 El Niño and the 1998-99 La Niña. The effects of El Niño began on the third quarter of 1997 and eventually followed by that of La Niña that caused both minor and major damages. The drought condition (El Niño) during the first half of 1998 severely affected palay and corn crop production, while strong typhoons and floods (La Niña) during the second half of the same year had taken their toll on the same crops. El Niño weather conditions were most pronounced in Southern and Central Philippines, while La Niña-induced typhoons affected the Luzon provinces and parts of Eastern Visayas. The Philippine government declared the provinces of South Cotabato, North Cotabato, Davao del Sur, Sultan Kudarat, Maguindanao, Sarangani, Davao del Norte, Davao Oriental, Davao City, Cotabato City, and General Santos City as among those badly affected by El Niño. On the other hand, 26 provinces were reported to be seriously affected by La Niña: Pangasinan, Nueva Ecija, Bulacan, Pampanga, Tarlac, Nueva Vizcaya, Isabela, Cagayan, Camarines Sur, Albay, Sultan Kudarat, Maguindanao, North Cotabato, Iloilo, Bukidnon, Davao del Norte, Ilocos Sur, Negros Occidental, Zamboanga Sur, Occidental Mindoro, Oriental Mindoro, Ilocos Norte, Laguna, Palawan, Leyte, and Quezon (PCARRD, 2001).

Hardest affected was the agriculture sector, especially on the production of its major crops, i.e., palay, corn, coconut and sugarcane. At the barangay-level, for example, the average production losses per hectare for palay was 25% and 92% below normal during the wet and dry season, respectively, or an estimated average net income loss of P8,148 during the dry season. There was practically no palay planting/production during the 3rd cropping season due to the prevailing drought condition (PCARRD, 2001).

In aquaculture production losses were experienced due to drying out of fishponds, shorter production cycles, stunted fish growth, and fish mortalities caused by stress, poor water quality, and disease. A total of 41,005 ha (20.6%) of the 198,864 ha of brackishwater fishponds in the country had been affected by the dry spell. Milkfish and shrimp production in some areas dropped by 10-80%. Yields of seaweeds also declined because of high water temperatures during the recent El Niño (Seaweed Industry Association of the Philippines).

Likewise, landslides were experienced in the southern part of the country. Moreover, increased incidence of diseases. such as cholera, typhoid fever, dengue, cough, colds, diarrhea and asthma was experienced during this period. About 20,512 people were reported to be downed by dengue and 359 of them died (PCARRD, 2001).

TROPICAL CYCLONES AS EXTREME CLIMATE EVENTS

Global changes in tropical and extra-tropical storm intensity and frequency, are dominated by inter-decadal to multi-decadal variations, with no significant trends evident over the 20th century,

especially as far as the frequency of occurrence is concerned. High-resolution modelling studies, though suggest that peak wind and precipitation intensity of tropical cyclones are likely to increase over some areas (IPCC-TAR, 2001).

Tropical cyclone variability/extremes. Tropical cyclone data at PAGASA from 1948 to 2004 indeed show that there is such an inter-decadal to multi-decadal variations in the intensity and frequency of tropical cyclones in the Philippine Area of Responsibility. However, several typhoon extremes were observed from 1990 to 2004. Extremes in the frequency of occurrence of tropical cyclones happened recently, with the highest frequency of 32 tropical cyclones in 1993 and the lowest occurrence of only 11 tropical cyclones in 1998. It was also in 1998 that the most severe (strongest) typhoon hit land (Typhoon Loleng, land-falling at Virac, Catanduanes with maximum observed winds of 290 kilometers per hour, kph). The most destructive typhoons occurred in 1990 (Typhoon Ruping, with maximum winds of 205 kph, damage of 10 billion pesos) and in 1995 (Typhoon Rosing, with maximum winds of 255 kph, damage of over 9 billion pesos). Tropical storm Uring with the highest casualty of 5080 dead occurred in 1991 and Typhoon Feria registered the highest 24-hour recorded rainfall of 1085.8 millimeters at Baguio City in July 2001. There were seven (7) extreme tropical cyclone-induced events from 1991 to late 2004 (Ormoc Catastrophy, 1991; Cherry Hill Tragedy, 1999; Payatas Garbage-slide, 2000; Baguio-La Trinidad landslides, 2001; Camiguin flashfloods, 2001; Southern Leyte-Surigao disaster, 2003; and the Aurora-Infanta floods, 2004).

Tropical cyclone statistics. On the average, 19 tropical cyclones enter the Philippine Area of Responsibility (PAR) annually, with about 8 or 9 of them crossing the Philippines. At least 1 tropical cyclone per year may not make its landfall but still inflict damage and casualties in the country. A tropical cyclone may occur any time of the year, but the months from June to December may be considered as the typhoon season, with its peak during the months of July and August. However, most of the destructive and deadly typhoons usually occur during the latter part of the season, notably, September, October and November, when tropical cyclones generally move to the eastern coastal seaboard of the country with their strengths still undiminished. From June to August, tropical cyclones usually form at higher latitudes (>10^0N) then, move generally to northern Luzon or towards the Taiwan or Japan area. From 1975 to 2002, the annual average of casualties was 593 dead, damage to property of 4.578 billion pesos, including damage to agriculture of 3.047 billion pesos.

Year, Month	T.C. Name (Landfall Region)	Max Wind (kph)	Dead	Injured	Missing	Affected Families	Houses Destroyed Total	Damage Bn PhP
1984 Sept	Nitang (8)	220	900	1,856	443	273,794	108,219	3.913
1984 Nov.	Undang (8)	230	895	2,526	272	373,491	201,014	1.541
1987 Nov.	Sisang (5)	240	808	927	171	318,968	153,339	1.119
1988 Oct.	Unsang (8)	215	157	316	60	537,152	38,932	5.636
1988 Nov	Yoning (8)	175	217	149	133	575,782	91,673	2.767
1990 Nov.	Ruping (8)	205	508	1,278	246	1,010,004	222,026	10.846
1991 Nov.	TS Uring (8)	95	5101	292	1,256	43,397	5,232	1.045
1993 Oct.	Kadiang (2)	110	576	337	81	815,813	35,206	8.752
1993 Dec	Monang (5)	185	273	607	90	264,912	60,357	2.464
1993 Dec	Puring (8)	150	187	280	52	349,850	34,221	2.742
1995 Sept	Mameng (5)	115	116	49	126	241,430	13,234	3.173
1995 Nov	Rosing (5)	255	936	4,152	316	960,777	225,872	10.829
1998 Sept	Gading (1)	110	108	22	10	335,699	10,900	3.794
1998 Oct.	Loleng (5)	290	303	751	29	910,912	96,581	6.787
2000 Oct	Reming (5)	100	114	319	47	486,400	16,910	3.944
2001 July	Feria (2)	155	188	241	44	415,436	12,774	3.586
2001 Nov.	Nanang (8)	90	236	169	88	262,612	1,973	3.246
	Averages		**1367**	**1,679**	**204**	**480,966**	**78,145**	**4.481**

Table 2. Most Destructive, "Killer" Typhoons (1984 – 2001) i.e. with damage of at least 1 billion pesos and deaths of more than 100 persons) Some 18 typhoons caused either more than 100 deaths each or more than 1 billion pesos each in damage, from 1960 to 1983)

Typhoon damage and casualty. Nineteen (19) severe tropical storms and typhoons had caused damage of more than 1 billion pesos (~$20 million, USD) and deaths of at least 100 persons each, for the period, 1980 to 2002. Another 10 can be identified as significant tropical cyclones for causing either more than 100 deaths or at least 1 billion pesos (PhP) in damages (Amadore, L.A., 2005)

Damage to structures and vegetation by a typhoon depends upon its strength (maximum winds), its size and amount of rainfall, as well as, the vulnerability of the place being affected. Deaths and injuries attributed to typhoons may be due to the collapse of structures, fallen trees or posts, flying debris or indirectly, over the seas, to sinking of passenger ships, fishing boats, ferries and other watercraft. But the leading causes of deaths and destruction are the typhoon's accompanying storm surges at coastal areas and extensive inland flooding, flash floods and landslides. A storm surge is characterized by a sudden rise of water (sea) level along the coast at or near the place of landfall of a typhoon. The rise in water level could be as high as 5 meters or more.

EFFECT ON THE ECONOMY

There are three (3) discernible slow-down in GDP growth in the 1980 to 2003 period (Figure 3.4). Negative growth rates were experienced in 1984 and 1998 and zero growth in 1991 and 1992. Significant typhoon damage were incurred and the weather phenomenon, "El Niño" was present during these periods, alongside with the poor economic performance in 1984, the intensity 7 earthquake and Mt. Pinatubo

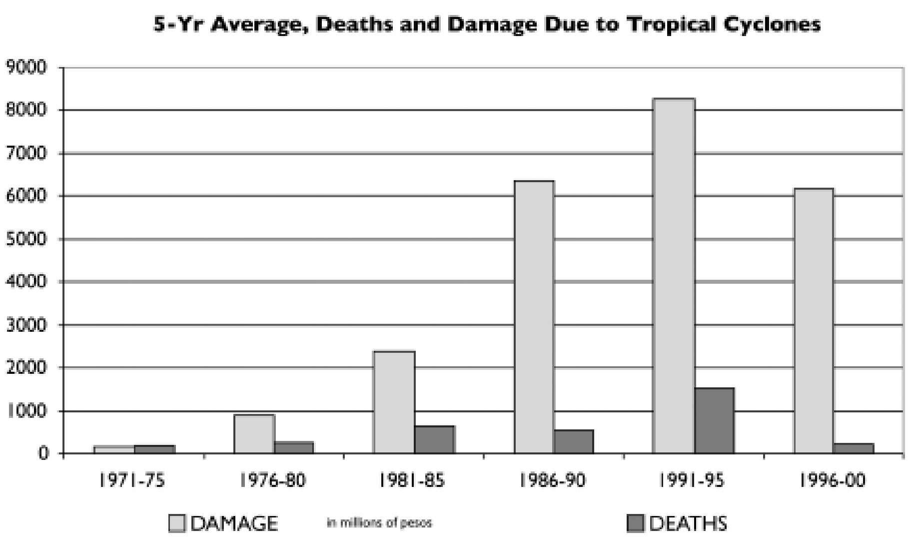


Figure 3-4. Typhoon Damage (in million pesos) and Casualties. Note that globally, the 1990s was the warmest decade when most of destructive typhoons in the Philippines occurred: 13 in 1991-95, 8 each in the 1986-90 and 1996-2000 period, compared to only 5 in 1971-76 and 4 in 1976-80

volcano eruption in 1990-1991 period, and the Asian financial crisis in 1998 (WB-NDCC, 2003).

The production of specific agricultural crops, such as, palay (un-husked rice), copra (processed coconut meat), cereals (palay and corn), were seriously affected by typhoons.

The effect of tropical cyclones on agriculture and the economy is shown in Figure 3.5. Typhoon damage rose to more than 1% of GDP in 1984, 1988, and 1.17%, the highest, in 1990. The highest ratio of tropical cyclone damage to agricultural output was 4.21% in 1990, followed in 1996 by 4.05%. Other significant percentages of typhoon damage to productivity in agriculture of more than 2% were in 1984, 1993,1995 and 1998.

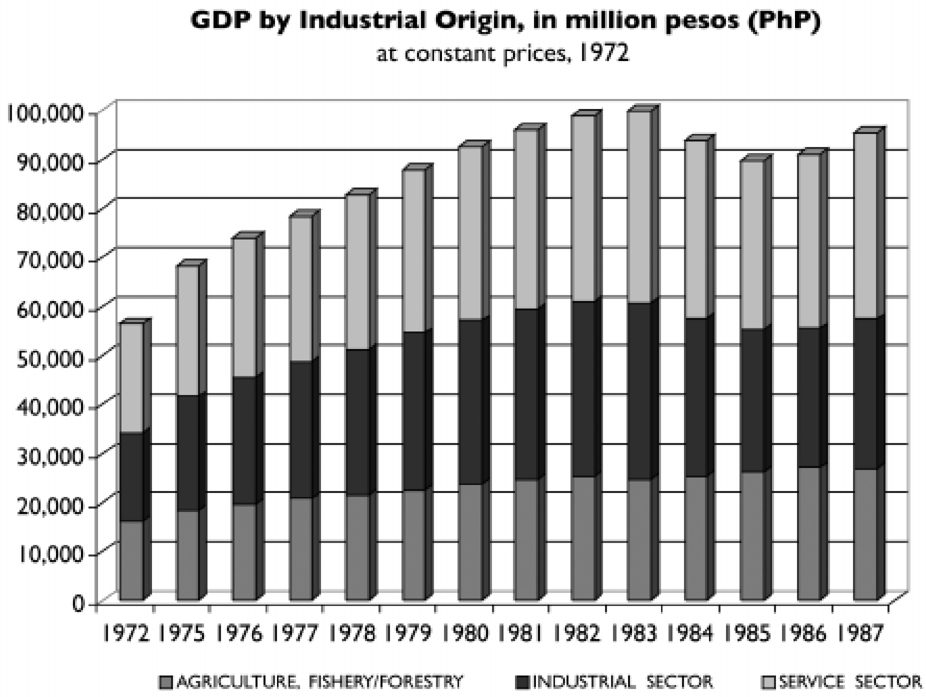
Effect on society (regional level). Region 5 (Bicol) and Region 8 (Eastern Visayas) are the areas where most (85%) of the destructive typhoons make their landfall, with their full fury still intact from the Pacific ocean. It may not be a mere coincidence that Regions 5 and 8 have the highest incidence and severity of poverty! (Figure 3.6) More realistically, of course, it may be difficult to prove that typhoons and other natural disasters are the ultimate cause of poverty, but it is quite obvious that the poorer sector of society suffers the most from typhoons and other natural disasters (Amadore, L.A., 2005).

OTHER EXTREME CLIMATE EVENTS

The Great Luzon Floods of 1972. This extreme event may not be directly linked to climate change, as even more recent, vintage events are not even directly attributable to climate change, but extremes in climate like this and that of the Bangladesh cyclone that killed about 300,000 people, and other similar events worldwide prompted meteorologists from countries all over the world to recognize in the First World Climate Conference in 1979 that the earth's climate is changing.

However, this is a typical example of extensive flooding caused by heavy, persistent precipitation. The presence of three (3) tropical cyclones northeast of the Philippines (Trop. Storm Edeng, July 6-7; Typhoon Gloring, July 10-18; and Trop. Depression Isang, July 29-August 1, did not pass directly over Central Luzon) triggered the intensification of the southwest monsoon causing continuous, heavy rainfall over Central Luzon and environs for almost 40 days starting at the end of the first week of July 1972. This period may be considered as a transition from a La Nina to an El Nino episode. This July 1972 event, probably the worst flood recorded in the country's history, overflowed the major river basins, swamps and other drainage systems in Central Luzon, inundating the low-lying areas of the provinces of Bulacan, Pampanga, Tarlac and Nueva Ecija and even Metro Manila (CAB T.P. No. 2001-7).

The Central Plains of Luzon is considered as the rice granary of the Philippines, but rice production in the region plummeted, with the third quarter of 1972 posting the lowest production ever. Flooding occurred between the planting of irrigated paddy rice for the first cropping season in May and its harvesting in August.



The Southern Mindanao Drought of 1998. The El Nino of 1997-98 was one of the most severe ENSO event to hit the country. Beginning July 1997, some parts of the country were already having below normal rainfall. By October of the same year, practically the whole country experienced a drastic drop in rainfall, leaving rice and corn production at risk. The peak of the dry spell had ravaged the country until June of the next year (CAB T.P. No.2001-7).

Figure 3-5. GDP-Philippines, 1972 – 2000. Effect on the economy of the 1983-84 and 1997-98 El Niños, high typhoon damage in 1984 and 1998; the poor economic performance in 1984 and Asian economic crises of 1998.

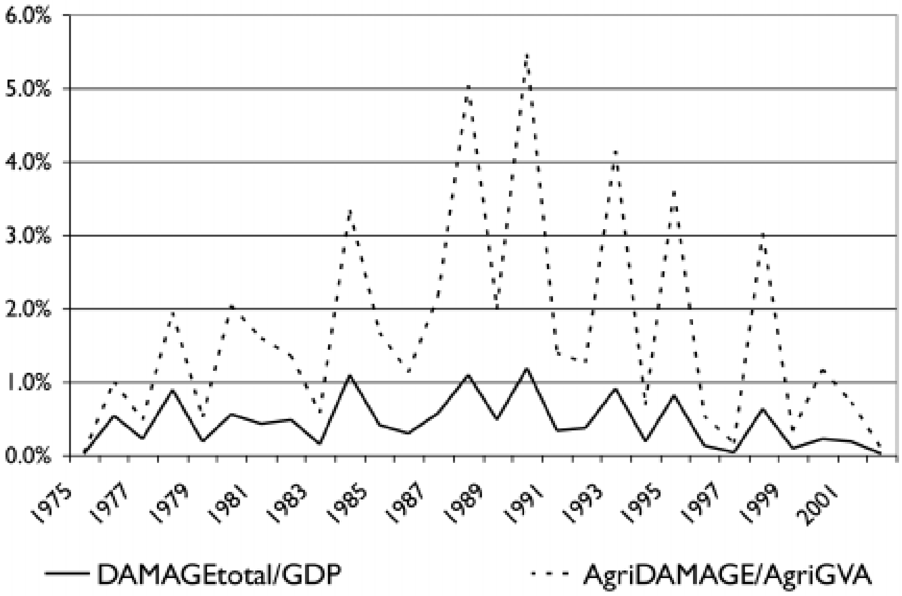


Figure 3-6. Effect of typhoons on the economy/agriculture. Agriculture is the Sector most affected by tropical cyclones.

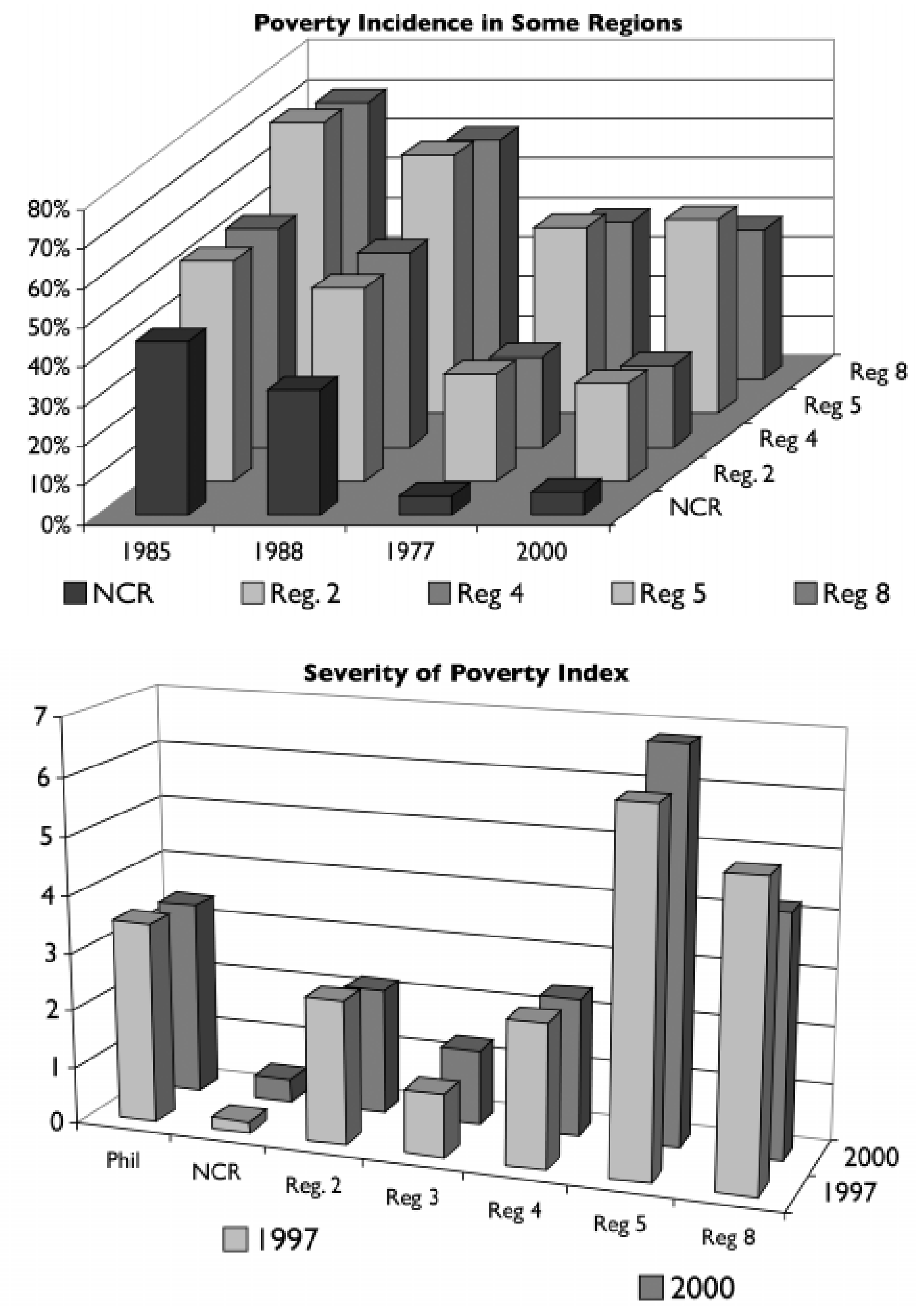
Irrigated and non-irrigated paddy rice are planted twice a year. In 1997, however, the *drastic* drop in rainfall coincided with the start of the second cropping for these crops. It was then that some fields were left idle or some farmers, despite the deficit in water, risked their crop production. As a consequence, production losses for both palay and corn crops were incurred during the period, posting the highest damage due to drought, exacerbated by pests and diseases. Agriculture incurred the highest production loss amounting to 307 million pesos for rice and 521 million pesos for corn.

This severe drought condition left some 800,000 families in near starvation in Central, Southern and a portion of Northern Mindanao. Some upland farmers who were the most affected by the drought resorted to eating yam harvested from the highlands that proved to be poisonous in some instance.

Landslides. Mass movements or landslides may be triggered by natural causes such as earthquake or heavy rainfall aggravated by man-made causes such as denudation of forests, man's modification of the slope of the terrain, etc.
Rainfall saturates the slope material leading to a decrease in the cohesion between particles and allowing them to slide past one another with relative ease (DENR, 2001).
Majority of the landslides or mass movements in the country are triggered by continuous and persistent heavy rains. The Philippine archipelago lies along the path of typhoons and subject to monsoon rains that have annually triggered rain-induced landslides in many mountainous or hilly areas which constitute approximately 70% of the country's land area. The intensified southwest or northeast monsoon usually brings in persistent heavy rains causing flash floods and landslides in some parts of the country.

For the period covering 1989-1999, mass movements or landslides occurred almost every year over the Cordillera Administrative Region (CAR). The highest number of incidents happened during the La Nina years of 1996 and 1999, with an annual total of 17 and 29 events, respectively (Figure 3-7). The mass movements almost always follow after a heavy rainfall event with the most significant ones coinciding with La Nina episodes.

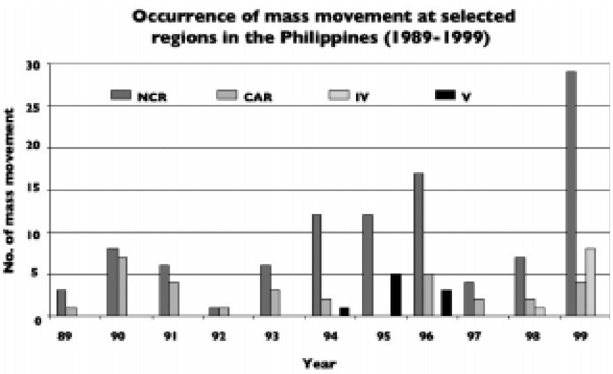
Another form of mass movement experienced by the Philippines is lahar flow (Lahar is a rapidly flowing mixture of rock debris and water from a volcano). After the Mt. Pinatubo volcano eruption, lahar flow was triggered during the 1991 and 1992 monsoon seasons. Important rivers and other drainage systems in Central Luzon were rapidly filled with fast-moving lahar causing deaths and destructions in inhabited areas and inflicting heavy damage to agricultural fields.



Forest fires. During the 1997-98 El Nino episode, uncontrolled forest fires threatened the whole of Southeast Asia region. Man-made and natural blazes in Indonesia and Borneo left hundreds of thousands of hectares of forest covers burnt to the ground. Thick smoke caused cancellation or suspension of flights because of poor airport visibility; posed danger to human health; and had adverse effect on wildlife/endangered species. Nearby countries, such as Malaysia and even southern Philippines and Palawan were affected by those forest fires. Travel warnings were issued to citizens by concerned countries.

It is notable that the highest recorded damage by forest fire in the Philippines occurred in1982, 1992 and 1998 which happened to be El Nino years (Figure 3.7). Central Luzon (Region III) and the Cordillera Autonomous Region (CAR) had the most frequent and the highest for-

Figure 3-7. Incidence and Severity of Poverty at Selected Regions. Region 5 [Bicol] and Region 8 [Eastern Visayas] are the areas where most powerful typhoons make their landfall and have the highest and severity incidence of poverty.



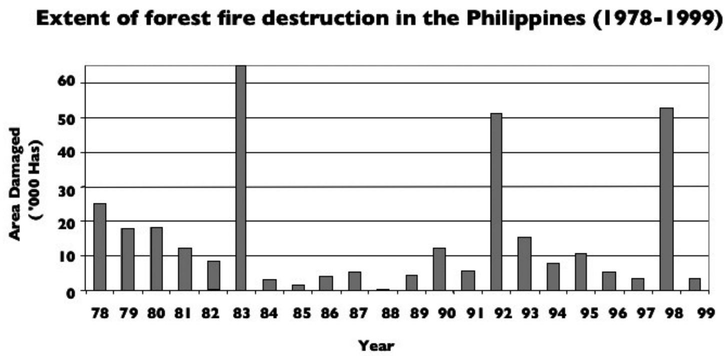


Figure 3-8. Landslides and forest fires in the Philippines. Landslides are associated with heavy rainfall; forest fire with droughts.

est areas damaged by forest fires. These events usually occur during the months of March and April every year and could be a result of a combination of high temperature, low humidity and lack of rainfall that persist during these dry months. Such conditions favourable to forest fire are enhanced during El Nino events (CAB T.P. No?, April 2001).

Tragedies after tragedies

The Ormoc catastrophic flash flood (November 5, 1991). More than 5000 people perished in this single tragedy. Unusually heavy, continuous rains (580.5 millimeters in 24 hours at Tongonan geothermal site) brought by Tropical Storm Uring caused landslides at the steep slope of a dendritic river system (Anilao river) leading to the city of Ormoc. The floodwaters, along with the landslide debris (loose soil, boulders, volcanic rocks, driftwood, uprooted trees, etc) dammed-up the at the 90° river bend upstream of the Anilao bridge, submerging the adjacent island community at the river bed and when the bridge collapsed, the full force of the water surged, as in a dam-break, over the downstream areas and into the city proper, killing people and destroying properties along its path (DOST, 1991).

Cherry Hill tragedy (August 1999). Cherry Hill is a typical middle-class subdivision at the foothills of the mountain city of Antipolo, a few kilometres south of Metro Manila. Rainwater seeped into and loosened the ground soil, after three consecutive days of persistent moderate to heavy rains (24-hr rainfall of 357.3 mm. August 1, at Boso-boso) brought about by a nearby typhoon. This caused the mud to cascade into the subdivision and slammed over 175 houses of the 440 houses there. This tragedy left a total of 378 houses damaged, 58 people killed and 31 others injured.

Payatas garbage-slide (July 10, 2000). Continuous moderate to heavy monsoon rains over Metro Manila for several days brought about by a distant typhoon caused the collapse of the Payatas garbage pile, at the outskirt of Quezon City, where a community of garbage scavengers, lived resulting in the loss of 224 lives and 100 houses destroyed (Figure 3.8).

Figure 3-9. Garbage-slide at Payatas, Q.C. Heavy rains and total disregard of safe and clean living may lead to disaster.

Baguio-La Trinidad landslides (July 2001). A record-breaking 24-hour rainfall of 1085.8 millimeters was registered at Baguio City (Nilo, P. 2001), causing widespread landslides in the mountainous areas of the Cordillera Administrative Region (CAR), killing 85 persons in Baguio and La Trinidad area alone.

Camiguin flashfloods (November 7, 2001). Continuous light to moderate rains started on November 5 and 6 at this island province of Camiguin in Northern Mindanao caused by an incipient severe storm (Tropical Storm Nanang) moving towards the area. Heavy continuous rains poured in for about 10 hours in the early evening of November 6. (Figure 3.9) Flash floods carrying landslide debris of boulders, uprooted trees, loose soil and others came rushing from the mountainside in the morning of November 7, burying residents alive (134 people dead) and bringing havoc to vegetation and man-made structures along its path of destruction (Relox, N.A. and Quintos, R., 2001)

Figure 3-10. Boulders and other debris, Landslide/flashflood at Camiguin. Once in a while, nature has to cleanse its forests of its debris.

Southern Leyte-Surigao disaster (December 2003). Surigao del Norte recorded 1,119.0 millimeters of rain in 3 days, with 566.4 mm in just one day (18 December) and 699.0 mm of rain in southern Leyte for 3 days (18-20 December).
Numerous faults and major fractures cut through the major rock units in the Leyte-Surigao area. When continuous rainfall occurs, water seeps into the fractures of the broken rocks and promotes the deterioration of the rock mass. This situation led to several landslides and flash-floods at different places in Mindanao from December 18 to 21. Southern Leyte suffered most because of the 3 successive landslides in the municipalities of Liloan, San Ricardo and San Francisco with 154 dead, compared to Agusan and Surigao provinces with 44 dead due to the ensuing flood/flashflood (DENR, 2003).

Aurora-Infanta floods (November-December 2004). About 20 days of persistent moderate to heavy rains caused by four (4) successive tropical cyclones towards the end of 2004 brought forth destruction and misery to the populace of eastern Luzon. The heavy rains (hardly any strong winds) triggered major landslides in several areas and cleansed the forests of its debris resulting in heavy damage and casualty downstream along rivers and coastal areas (Figure 3.10).

BOX 2:
KATRINA AND URING – ATTRIBUTION TO CLIMATE CHANGE?

Both tropical storms caused enormous death and destruction primarily due to flooding; Katrina (2005) occurred in the Atlantic tropical cyclone basin (New Orleans, USA) causing 219 dead and $ billions in relief and rehabilitation and Uring in the Pacific basin (Ormoc, Philippines) almost one and a half decade earlier causing 5101 deaths and a billion pesos in damage to property. The vulnerability of both places to flooding as well as the late disaster response were quite similar. New Orleans, a sand castle set on a sponge three meters below sea level (Gibbs, N. 2005), nestled into what essentially was a lake bed is built in a bowl between the Mississippi River and Lake Pontchartrain (Ripley, A., 2005). When three of the 563 km of levees failed, the city filled like a bathtub. In the case of Ormoc city there were communities/settlements within the riverbed, downstream of the gently sloping Anilao river. The collapse of the Anilao bridge, holding the landslide and flood debris, served as a dam-break, sweeping away people and houses into the city and into the sea (DOST, 1991). The triggering mechanism in both instances was heavy rains.

Can these extreme events and others be attributed to climate change? There is no way to prove that Katrina [and/or Uring] either was, or was not, affected by global warming (Rahmstorf, S., et al, 2005). For a single event, regardless of how extreme, such attribution is fundamentally impossible. It is impossible to know whether or not this event would have taken place if we had not increased the concentration of greenhouse gases in the atmosphere as much as we have. Current scientific evidence strongly suggests, however, that hurricanes/typhoons tend to become more destructive as ocean temperatures rise. An unchecked rise in greenhouse gas concentrations will also very likely increase ocean temperatures further, ultimately overwhelming any natural oscillations. Dr. Kerry Emanuel (2005), a hurricane expert at the Massachusetts Institute of Technology, was unequivocal when he wrote recently based on his research that "The large [storm] upswing in the last decade is unprecedented, and probably reflects the effect of global warming."

IPCC-TAR (2001) further states: An increasing body of observations gives a collective picture of a warming world and other changes in the climate system: El Nino events became more frequent, persistent, and intense during the last 20 to 30 years compared to the previous 100 years; extreme climate events, such as, floods, droughts, forest fires, and tropical cyclones have increased in temperate and tropical Asia; extreme events are currently a major source of climate-related impacts.

Consider further the recent major extreme events happening world-wide. The economic losses from such catastrophic weather events have risen globally 10-fold (inflation-adjusted) from the 1950s to the 1990s, much faster than can be accounted for with simple inflation. The insured portion of these losses rose from a negligible level to about 23% in the 1990s.

Are these events mere coincidences or is dangerous climate change not that far behind?

Typhoon Unding (November 14-21, 2004) caused 45 sea mishaps (40 fishing/pump boats reported missing and 5 others capsized/sunk), series of landslides, and flooding, storm surge and power interruptions; Trop. Storm Violeta (November 22-26, 2004): landslides in Dingalan, Baler and San Luis, Aurora Province and flooding in San Leonardo, Gabaldon, Bongabon and Laur, Nueva Ecija; Trop. Depression Winnie: November 28- 30, 2004): major landslides in General Nakar, Real and Infanta, Quezon; Typhoon "Yoyong" (November 30 – December 3, 2004): massive flooding in central and southern Luzon and landslides in the Cordillera Autonomous Region.
The reported casualties caused by the four (4) cyclones are: 1,068 dead, 1,163 injured and 553 still missing. Houses totally destroyed were 42,119 while 146,142 were partially damaged while the estimated cost of damage to properties was placed at P7,615.98M. The cost of assistance as of this report is P 176,897,515, aside from foreign and local donations *(NDCC Website, 2005)*.

Figure 3-11. Aftermaths of the Aurora-Infanta landslides/floods. Uprooted trees, logs, boulders and other debris from the forests.

These extreme events have one thing in common – persistent torrential rains, causing landslides and flash floods, killing people and destroying properties along its path. These recent events happened at very short intervals which is a reminder of the more extensive and disastrous floods often plaguing China, India, Thailand, and other parts of Asia and even in other parts of the world, such as the USA and Europe. This could be a virtual validation of the IPCC- TAR finding that "Extreme climate events/variability, such as, floods, droughts, forest fires, and tropical cyclones have increased in temperate and tropical Asia" and its prediction that "An increase in climate variability and some extreme events is projected, such as, **changes in frequency, intensity, and duration of extreme events, such as more ... heavy precipitation events, El Nino events, and tropical cyclones...** and an increase of Asian summer monsoon precipitation variability is likewise, expected. The projected changes in climate extremes could have major consequences"

Potential Climate Change Impacts:
Vulnerability and cascading effects

The risks arising from projected human induced climate change increase significantly with increasing temperature (B. Hare, 2005). Below a 1°C increase the levels of risk are low but in some cases not insignificant particularly for highly vulnerable ecosystems. In the 1-2°C-increase range risks across the board increase significantly and at a regional level are often substantial. Above 2°C the risks increase very substantially involving potentially large extinctions or even ecosystem collapses, major increases in hunger and water shortage risks as well as socio-economic damages, particularly in developing countries. Africa seems to be consistently amongst the regions with high to very high projected damages.

Sea level rise is of great concern to residents of Pacific islands and coastal nations in Asia, because of the large number of people living on small islands, archipelagos and in river deltas. Many major Asian and Pacific island cities, such as Manila, Jakarta, Shanghai and Hongkong are almost at sea level. Coastal reefs and mangroves are also threatened by rising seas and higher temperatures. Water resources in the Region, particularly in South and Southeast Asia and the islands are very sensitive not only to changes in temperature and precipitation but also to changes in tropical cyclones and monsoons. Changes in average climate conditions and climate variability will have significant effect on crop yields in many parts of the Region. Low-income populations dependent on isolated agricultural systems are particularly vulnerable. Changes in climate variability will affect the reliability of agriculture and livestock production (Amadore, L.A. et al, 1996).

AGRICULTURE AND FOOD SECURITY

IPCC – TAR findings. "Even though increased CO_2 concentration can stimulate crop growth and yield, that benefit may not always overcome the adverse effects of excessive heat and drought. When autonomous agronomic adaptation is included, crop modeling assessments indicate, with medium to low confidence, that yields of some crops in tropical locations would decrease generally with even minimal increases in temperature, because such crops are near their maximum temperature tolerance and dryland/rainfed agriculture predominates. Where there is also a large decrease in rainfall, tropical crop yields would be even more adversely affected. With autonomous agronomic adaptation, crop yields in the tropics tend to be less adversely affected by climate change than without adaptation, but they still tend to remain below levels estimated with current climate."

Warming of around 1°C will produce relatively small damages when measured from the point of increased risk of hunger and/or under nourishment over the next century (B. Hare, 2005). In this temperature range nearly all developed countries are projected to benefit, whilst many developing countries in the tropics are estimated to experience small but significant crop yield growth declines relative to an unchanged climate. Above this level of change the number of people at risk of hunger increases significantly. Between 2 and 3°C warming the risk of damage begins to increase significantly. One study shows rapidly rising hunger risk in this temperature range with 45-55 million extra people at risk of hunger by the 2080s for 2.5°C warming which rises to 65-75 million for a 3°C warming. Another study shows that a very large number of people, 3.3-5.5 billion, may be living in countries or regions expected to experience large losses in crop production potential at 3°C warming. For a 3-4°C warming, in one study the additional number at risk of hunger is estimated to be in the range 80-125 million depending on the climate model. In Australia a warming of the order of 4°C is likely to put entire regions out of production. B. Hare (2005) further warned that at all levels of warming, a large group of the poor, highly vulnerable developing countries is expected to suffer increasing food deficits. It is anticipated that this will lead to higher levels of food insecurity and hunger in these countries. Developed countries will not be immune to large effects of climate change on their agricultural sectors.

Regional overview - ASIA. The variability of rainfall in developing countries of tropical Asia is rather high so that these countries have also been rendered quite vulnerable to extreme events such as droughts and floods (Zhao, Y. et al, 2002). Moisture stress due to prolonged dry spells/droughts in some areas, coupled with heat stress have already been seen to affect crops, especially when these environmental conditions occur during the critical stages of the crops. On the other hand, excessive moisture could also cause substantial crop losses due to flooding and loss of nutrients and soil erosion.

Results also show that increasing minimum temperatures could impact on rice yields. In the rice producing countries of China, Japan, Vietnam, the Philippines and other countries in south and southeast Asia, doubled CO^2 scenarios give results showing positive effects of enhanced photosynthesis, although these are more than offset by the negative effects of increases in temperatures greater than 2^0 C,

National level- Philippine setting. Results of data analysis/study (CAB T.P. No. 2001-7) indicate that the sharpest fall in gross value added (GVA) and in volume of production in agricultural sector were in 1982-1983 and 1997-1998, the occurrence of the two strongest El Niños in the country. There was a decline in GVA and in volume of production of 4 principal crops (rice, corn, sugarcane and coconut). Increases in GVA in rice and corn production are attributed to favorable rainfall conditions during La Nina years.

Fishery, livestock and poultry are not as sensitive to extreme climate events, although at the farm level there could be impacts on climate variability. Some third order impacts have also been seen such as shortfalls in the annual economic growth, increased burden on urban resources as a result of migration of displaced agricultural workers to the cities for jobs, increased dependence of agricultural workers on government subsidy, worsening poverty situation, etc.

Vulnerability assessments done on rice and corn production using global circulation models (GCMs) to give simulations of climate change scenarios and process-based crop models gave varied results (for example, national rice production would change from +6.6% increase to –14.0% decrease), a reflection of the wide range of temperature projections of the various models. Simulations showed generally, increases in rice yield except for those scenarios generated by one model. The results showed that at current temperatures, with no temperature increment, a doubling of CO_2 level resulted in a yield increase of about 30%, but with current levels of CO_2, increasing the temperature always decreased yields and more so in the dry season. However, in both wet and dry seasons, temperature increment of $+4^0$ C always produce a decrease in yields in all increments of CO_2.

What is certain though, is that when the agricultural sector in any local area has already been rendered vulnerable by increasing climate variability, including occurrences of extreme events and other non-climatic factors like increasing population, diminished/ degraded agricultural areas and ineffective/insufficient agricultural support services, such as lack of irrigational facilities, the projected adverse impacts will certainly contribute to decreases in crop yield (CAB T.P. No. 2001-7)

HYDROLOGY AND WATER RESOURCES

IPCC-TAR findings: Demand for water is generally increasing due to population growth and economic development, but is falling in some countries because of increased efficiency of use. Climate change may substantially affect irrigation withdrawals, which depend on how increases in evaporation are offset or exaggerated by changes in precipitation. Higher temperatures, hence higher crop evaporative demand, mean that the general tendency would be towards an increase in irrigation demands

Flood magnitude and frequency could increase in many regions as a consequence of increased frequency of heavy precipitation

events, which can increase runoff in most areas as well as groundwater recharge in some floodplains. Land-use change could exacerbate such events.

The number of people living in water stressed countries, defined as those using more than 20% of their available resources, and is expected to increase substantially over the next decades irrespective of climate change (B. Hare, 2005). Particularly, in the next few decades population and other pressures are likely to outweigh the effects of climate change, although some regions may be badly affected during this period. In the longer term, however, climate change becomes much more important. Exacerbating factors such as the link between land degradation, climate change and water availability are in general not yet accounted for in the global assessments.

Around 1°C of warming may entail high levels of additional risk in some regions, particularly in the period to the 2020s and 2050s, with this risk decreasing due to the increased economic wealth and higher adaptive capacity projected for the coming century. For the 2020s the additional number of people in water shortage regions is estimate to be in the range 400-800 million. Between 1-2°C warming the level of risk appears to depend on the time frame and assumed levels of economic development in the future. One study for the middle of this temperature range has a peak risk in the 2050s at over 1,500 million people, which declines to around 500 million in the 2080s. Over 2°C warming appears to involve a major threshold increase in risk. One study shows risk increasing for close to 600 million people at 1.5oC to 2.4-3.1 billion at around 2.5oC. This is driven by the water demand of mega-cities in India and China (including Metro Manila?). In this study the level of risk begins to saturate in the range of 3.1-3.5 billion additional persons at risk at 2.5-3°C warming. One of the major future risks identified by two studies is that of increased water demand from mega-cities in India and China. It is not clear whether or to what extent additional water resource options would be available for these cities and hence, to what extent this finding is robust. This may have broad implications for environmental flows of water in major rivers of China, India and Tibet should the mega-cities of India and China seek large-scale diversion and impoundments (B. Hare, 2005).

Regional overview – ASIA: Runoff and water availability may decrease in arid and semi-arid Asia but increase in northern Asia. The Asia-Pacific region, home to almost a billion of the world's poorest people, has among the world's lowest freshwater supply. Freshwater withdrawal from rivers, lakes, reservoirs, underground aquifers and other sources increased more in Asia during the past century than in other parts of the world. About 80% of freshwater withdrawal from rivers is for irrigation usage. In many parts of the region, misuse and overexploitation of water resources has caused major disruptions to the hydrological cycle. Water quality has been steadily degraded. In Southeast Asia the industrial sector is the main source of pollution but untreated domestic wastewater as well as chemical residues and animal wastes increasingly threaten water quality in most major rivers. While agriculture will continue to use most water, freshwater demand is growing fastest in the urban and industrial sectors (Jose, A.M., Cruz, N.A. and Bildan, L., 2003).

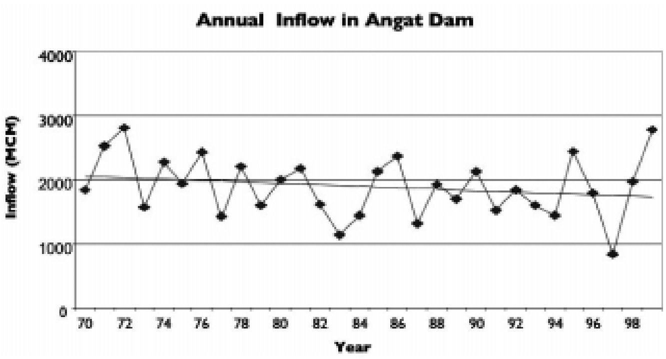
National Overview: The Philippines is naturally endowed with abundant water resources. The largest contribution to the rainfall in the Philippines comes from tropical cyclones. The PAGASA study shows that about 38% of the annual average rainfall in the country from 1951 to 1997 is derived from tropical cyclone occurrences (CAB T.P. No. 2001-5). Of the country's average annual rainfall of around 2400 mm. about 1000 to 2000 mm flows as surface runoff to some 421 principal river basins, 18 of them considered as major river basins, 59 inland lakes, several swamplands and other water bodies. The country's freshwater resource provides water to 3 major users: agriculture, domestic and industry, with major demand from agriculture.

A study was conducted on five (5) major reservoirs in Luzon (Angat, Pantabangan, Magat, Binga and Ambuklao) and Mindanao (Lake Lanao). The stored water in dams and lake are primarily for domestic water supply, irrigation, and power generation.

The frequency of occurrence of extreme events affects the rainfall and inflow patterns of the reservoirs. During the 70s, more cold, La Nina-type episodes dominated resulting to a relatively moist decade while the 80s and the 90s were characterized by the occurrence of 4 strong, warm periods (1982-83, 1986-87, 1991-92 and the 1997-98 El Nino events) causing a consistent negative anomalies of rainfall and inflow.

During the 1997-98 El Nino, there was a 10% reduction in water production at Angat dam (Figure 3-11), resulting in water rationing over Metro Manila as the daily service delivery time was shortened by about 4 hours. On irrigation – elevated areas could not be serviced by water impounding reservoirs. Program areas of the Angat-Maasin river irrigation system in Bulacan was decreased for 2 successive cropping periods.

In Luzon the impact on power generation during drought is minimal since deficiencies are remedied by augmentation from other energy



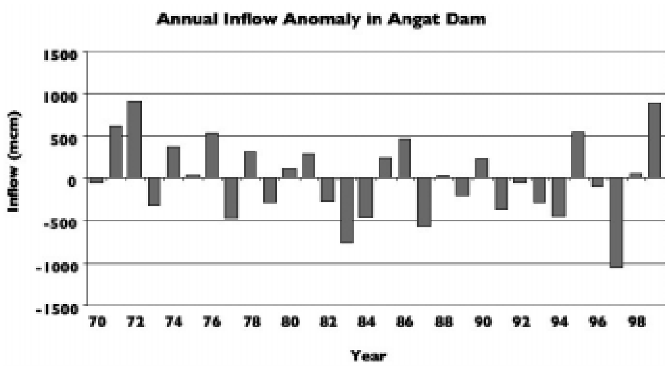


Figure 3-12. Effect of ENSO on water resources (Angat Dam, Bulacan) Lower than normal inflows are observed during El Niño years, but note the peak inflows during La Niña years.

sources. However, in Mindanao, when the1992 drought water level of Lake Lanao reached its lowest, power curtailment was imposed in the entire island, 10 to 15 hours daily, resulting in economic losses of several billion pesos.

Flood occurrences are manifested both during extreme and normal events. The great flood in 1972 was due to prolonged, heavy rainfall over Central Luzon during the transition from La Nina to El Nino. During the 1998 La Nina, 3 typhoons recorded the highest water level at Binga dam and for the first time had all its gates fully opened.

HUMAN HEALTH

IPCC – TAR findings. Many vector-, food-, and water-borne infectious diseases are known to be sensitive to changes in climatic conditions. From the results of most predictive model studies, there is medium to high confidence that, under climate change scenarios, there would be a net increase in the geographic range of potential transmission of malaria and dengue-two vector-borne infections each of which currently impinge on 40-50% of the world population

Projected climate change will be accompanied by an increase in heat waves, often exacerbated by increased humidity and urban air pollution, which would cause an increase in heat-related deaths and illness episodes. The evidence indicates that the impact would be greatest in urban populations, affecting particularly the elderly, sick, and those without access to air-conditioning.

Regional Impacts – the Tropics. Extensive experience makes clear that any increase in flooding will increase the risk of drowning, diarrheal and respiratory diseases, and, in developing countries, hunger and malnutrition. Likewise, if tropical cyclones were to increase re-

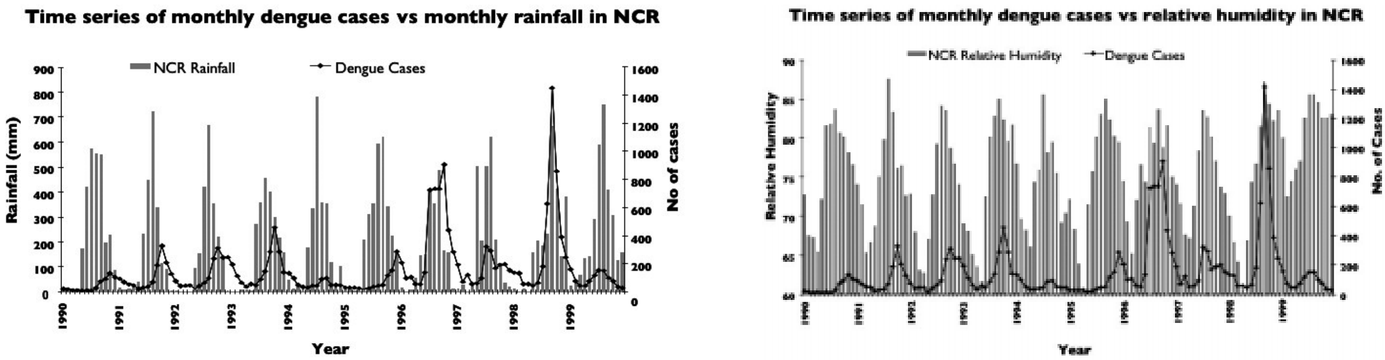


Figure 3-13. Health in relation to weather/climate parameters. Rainfall and humidity data could be useful indicators of rise in dengue cases.

gionally, devastating impacts would often occur, particularly in densely settled populations with inadequate resources. A reduction in crop yields and food production because of climate change in some regions, particularly in the tropics, will predispose food-insecure populations to malnutrition, leading to impaired child development and decreased adult activity

Philippine setting. Many of the biological organisms linked to the spread of infectious diseases are especially influenced by the fluctuations in climate variables notably temperature, precipitation and humidity. Additionally, the disruption of environmental health services and infrastructure (like water supply and public sanitation) by climatic events can contribute to a significant rise in water and food borne diseases. For example, the climatic conditions that could have caused the dengue outbreak in 1998 may be associated with the 1997-98 El Niño event (CAB T.P. No. 2001-3, 2001).

The extreme heat and water shortage brought by El Niño events had been considered as the most likely causes of a number of health-related problems. This was the case during the 1997-98 El Niño. Reports from the Department of Health (DoH) reveal that several outbreaks of cholera, dengue, malaria and typhoid fever were reported in 1998 (also a La Niña year) in various parts of the country, especially in the national capital region. One such case is the high transmission of malaria in the endemic barangays of Montalban, Rizal, a locality near the suburban area of Metro Manila. The DoH affirmed that the above-average incidence of these diseases had been due to hot climate brought about by the El Niño phenomenon and the fairly high humidity associated with the onset of the rainy season.

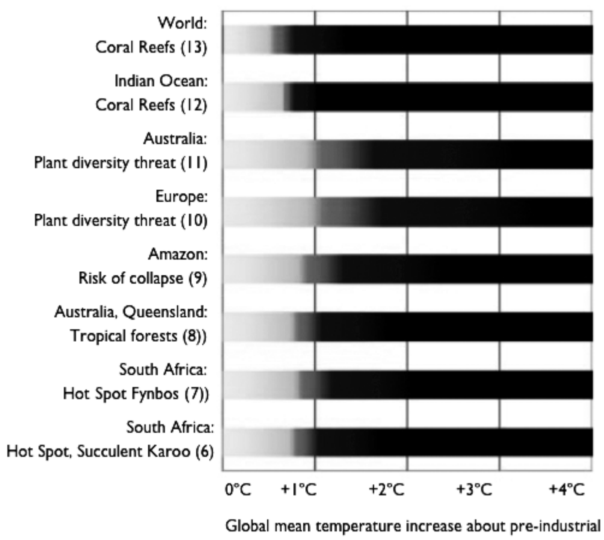
There is a great potential for the use of climate forecast and information to mitigate the associated health impacts of extreme climate events/variability. Correlation analysis done on dengue and malaria show that these two diseases are most sensitive to climate as shown by the effects of temperature, relative humidity and rainfall on the incidence of these diseases (Figure 3-12). On the other hand, other climate-related diseases like cholera have been associated with extremes of precipitation, droughts and floods (Relox, N.A., 1998), although other factors, such as, the poor sanitary conditions of the large part of the population in the NCR coupled with potable water shortage contributed to the high incidence of cholera and other water-borne diseases.

COASTAL ZONES AND MARINE ECOSYSTEMS

IPCC-TAR findings. Large-scale impacts of climate change on oceans are expected to include increases in sea surface temperature and mean global sea level, decreases in sea-ice cover, and changes in salinity, wave conditions, and ocean circulation. Impacts on highly diverse and productive coastal ecosystems such as coral reefs, atolls and reef islands, salt marshes and mangrove forests will depend upon the rate of sea-level rise relative to growth rates and sediment supply, space for and obstacles to horizontal migration, changes in the climate-ocean environment such as sea surface temperatures and storminess, and pressures from human activities in coastal zones. Episodes of coral bleaching over the past 20 years have been associated with several causes, including increased ocean temperatures. Future sea surface warming would increase stress on coral reefs and result in increased frequency of marine diseases (high confidence).

According to the climate change timetable drawn up by B. Hare (2005), for a temperature increase of below 1ºC, the risk of damage is low for most systems. Between 1 and 2oC warming moderate to large losses appear likely for a few vulnerable systems. Of most concern are threats to the Kakadu wetlands of northern Australia and the Sundarbans of Bangladesh, both of which may suffer 50% losses at less than 2ºC and are both on the UNESCO World Heritage List (*See Box 3: Saint Paul's Subterranean Cave)* . Between 2ºC and 3ºC warming, it is likely that the Mediterranean, Baltic and several migratory bird habitats in the US would experience a 50% or more loss. Results of the analysis of the risks to ecosystems for coastal wetlands are presented graphically in Figure 3.13. Between 2 and 3ºC warming coral reefs are projected to bleach annually in many regions. Above 3ºC, large impacts begin to emerge for waterfowl populations in the Prairie Pothole region in the USA. In the Arctic the collared

Impacts on Ecosystems



lemming range is reduced by 80%, very large reductions are projected for Arctic sea ice cover particularly in summer that is likely to further endanger polar bears.

National and regional findings on coral bleaching: In 1998, massive bleaching was observed in various reefs throughout the Philippines from early June to late November (Arceo, H.O. et al, 2001). The observations coincided with the occurrence of hotspots or thermal anomalies in the region as derived from satellite-based sea surface temperature data. Coral studies during this period in five areas (Bolinao, Pangasinan; Kalayaan Island group in the South China Sea; North Palawan Shelf; and Tubbataha Reefs, Sulu Sea) detected significant decreases in live coral cover of up to 46% and dead coral cover of up to 49% in some areas. The results, according to the study, support the hypothesis that elevated sea temperatures was the major cause of the bleaching event. The level of susceptibility to elevated sea temperatures was highest in the northwestern part of the Philippines. For example, in Bolinao, extensive bleaching was observed. This could also be attributed to other factors, such as, the extensive dynamite fishing going on in the area and the waste problem of the host and neighboring municipalities with elevated sea temperatures as an exacerbating factor. Fish kills and high mortality of cultured giant clams in ocean nurseries were also observed and attributed to abnormally high temperature of up to 35C (Cross ref: Gomez and Mingoa-Licuanan, 1988). This extensive warming of sea surface temperature was due to the severe El Nino-Southern Oscillation (ENSO) event of 1997-98. Some patterns of susceptibility within and across reefs, such as wave energy, tidal fluctuations and reef morphology were also observed.

The high temperature during El Niño may induce coral bleaching, especially, in shallow reef areas. Coral bleaching was also reported in the Masinloc Fish Sanctuary and some parts of Luan , Megalawa Island and Oyon Bay. Bleaching occurred in about 70% of the corals in the Masinloc Sanctuary (Cross ref: Marquez, 1999). Coral bleaching is induced by high water temperature and occurs as coral tissue expels zooxanthellae, a type of algae that resides in the structure of the coral. Similar occurrences were reported in other parts of the world. Corals are expected to recover from bleaching unless high ocean temperatures persist for long periods (PCARRD, 2001).

The worldwide coral reef bleaching events in the last two decades had been increasing in frequency and scale (Cross ref: Glynn, 1933). Recent global episodes were observed following extensive warming of sea temperatures brought about by the El Nino phenomena. During the severe El Nino episode of 1982-83, for example, massive bleaching was observed in the western Pacific and in other parts of the world.

The predominant factors that have been known to cause extensive bleaching are elevated sea temperature, solar radiation and the combined effects of both (Cross ref: Brown, 1997). Solar radiation is abundant during El Nino events because of relatively clear and partly cloudy skies. To top it all, 1998 was the warmest year in the instrumental record (1861-2000).

Severe red tide outbreaks occurred after the strong El Niño periods. The first serious outbreak of red tide in the Philippines occurred in 1983, which is considered an El Niño period. The worst incidence of

BOX 3:
ST. PAUL'S SUBTERRANEAN RIVER AND SEA LEVEL RISE

St. Paul Subterranean River National Park (SPSRNP), is located north-west of Puerto Princesa, Palawan, 490km south-west of Manila. SPSRNP consists of various landforms, the most impressive of which is the karst mountain landscape of the Saint Paul Mountain Range. The focus of the area is a spectacular karst landscape containing an 8.2km long subterranean river, one of the most unique of its type in the world. The underground river includes many speleotherms, and several large chambers exist, up to 120 meters in width and 60 meters in height. A distinguishing feature of the river is the fact that it emerges directly into the sea, and that the lower portion of the river is brackish and subject to tidal influences. The underground river (the Cabayugan River) arises approximately 2km southwest of Mount Saint Paul at an altitude of 100m, and flows underground for almost its entire length to an outflow into St. Paul's Bay (Sheppard, D and H. Friederich, 1999).

Three forest formations consist of lowland, karst and limestone. About two-thirds of the forested area is dominated by hardwood species. In the coastal area, mangroves, mossy forest, sea grass beds and coral reefs are also found. The faunal diversity in the SPSRNP consists of endemic mammals including the Palawan tree shrew, Palawan porcupine and Palawan stink badger. Dugong have been recorded in the marine component of the park. Monitor lizard and marine turtles are also present. The Palawan Peacock Pheasant has also been recorded in the SPSRNP (recognised as an internationally threatened species).

While SPSRNP could provide evidence of changing sea levels like the Ha Long Bay caves in Vietnam, yet its unique, diverse yet fragile flora and fauna could likewise be threatened by accelerated sea level rise and warmer sea surface temperatures due to climate change. The coral reefs in the coastal area of SPSRNP, like that of the nearby Tubbataha reef, another UNESCO Heritage, will be adversely affected by El Nño and other climate change-induced increases in sea temperature. Speleotherms (stalagmites and stalactites) could provide useful paleo-climate data of yore, but are likewise endangered by extreme rainfall and temperature changes.

red tide in Manila Bay occurred in 1992, another El Niño period. Shellfish bans were enforced in at least three coastal bays at the onset of the rainy season or just after the recent El Niño episode - Manila Bay, Lianga Bay, and Barobo Bay. Extremely high values of the paralytic shellfish poison were reported in Lianga and Barobo Bays in December 1998 (PCARRD, 2001).

HUMAN SETTLEMENTS

IPCC – TAR findings. The most widespread direct risk to human settlements from climate change is flooding and landslides, driven by projected increases in rainfall intensity and, in coastal areas, sea-level rise. Riverine and coastal settlements are particularly at risk (high confidence), but urban flooding could be a problem anywhere that storm drains, water supply, and waste management systems have inadequate capacity. In such areas, squatter and other informal urban settlements with high population density, poor shelter, little or no access to resources such as safe water and public health services, and low adaptive capacity are highly vulnerable.

Regional Impact. Rapid urbanization in low-lying coastal areas of both the developing and developed world is greatly increasing population densities and the value of human-made assets exposed to coastal climatic extremes such as tropical cyclones. Model-based projections of the mean annual number of people who would be flooded by coastal storm surges increase several fold (by 75 to 200 million people depending on adaptive responses) for mid-range scenarios of a 40-cm sea-level rise by the 2080s relative to scenarios with no sea-level rise. 60% of this increase will occur in southern Asia (along coasts from Pakistan, through India, Sri Lanka and Bangladesh to Burma), and 20% will occur in South East Asia, from Thailand to Vietnam including Indonesia and the Philippines (Nicholls, R., 2005). Potential damages to infrastructure in coastal areas from sea-level rise have been projected to be tens of billions US$ for individual countries — for example, Egypt, Poland, and Vietnam.

Philippine Setting. Being an archipelago, the Philippines has one of the vast irregular coastline (17,000 kilometers) in Asia with many bays, gulfs, inlets and peninsulas of different sizes, shapes and bathymetry. Negative environmental factors, such as, the destruction of mangroves, coral reefs, and other forms of natural barriers, siltation of river deltas, bays and gulfs, and shore-line reclamations, may add to the vulnerability of coastal areas to storm surges. In fact some

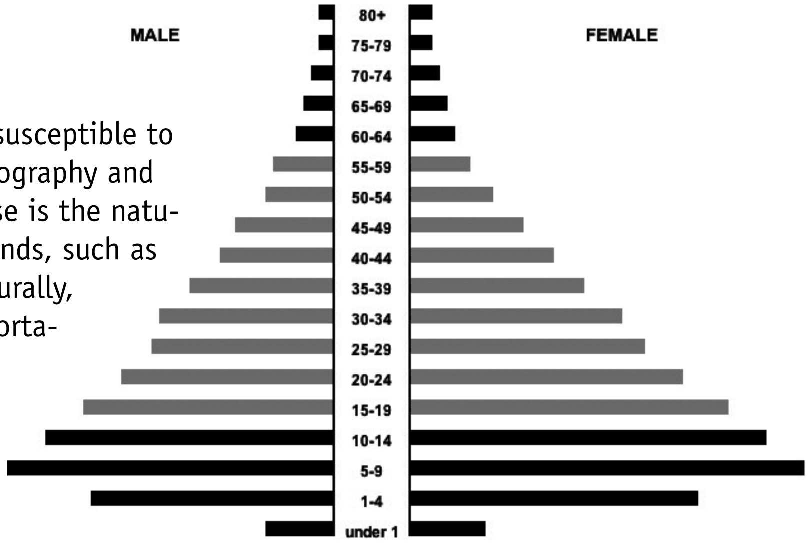


Figure 3-15. Population at risk (red) to extreme climate events (NSCB data, 2003) The age group that are considered to be highly vulnerable to extreme events are the youngest [under 1 year old up to 10] and the oldest [65 years old and older], although everyone is at risk.

35 basins were identified to be especially susceptible to storm surges by virtue of their bottom topography and coastal configuration alone. On top of these is the natural tendency of people in mountainous islands, such as the Visayas, to reside in coastal areas. Naturally, fishing is a popular occupation and transportation by sea and rivers or streams is convenient. This makes these areas highly vulnerable to typhoons and the accompanying storm surges.

The effects of tropical cyclones alone on the population and housing/ human settlements are quite revealing. An average of 2.45 million persons per severe typhoon were affected, with an average casualty of 1,367 dead, 1,679 injured and 204 missing. An average of 480,966 families and a staggering number of houses were destroyed per typhoon (with an average of 78,145 houses completely destroyed and 182,296 partially destroyed). An average of 4.48 billion pesos per typhoon as damage to infrastructure, agriculture, etc. was recorded (Amadore, L.A., 2005).

A visit into the aftermath of one of these severe storms would reveal more than the above statistics. The pain, the agony and sorrow of those who lost their loved ones, the despair, gloom and helplessness of those whose main source of livelihood were gone, those whose only dwellings became a part of the wide swath of destruction are there waiting to be quantified!

Out of 14.9 million houses, all over the Philippines, about 27% have roofs or walls of indigenous, sub-standard building materials (nipa, cogon or anahaw) and makeshift non-engineered structures (NSCB, 2003), which are, by and large, vulnerable to the strong winds of tropical cyclones. This accounts for the vast number of houses being totally or partially destroyed by a relatively strong typhoon. Most of these structures are located in the rural areas, in highly congested and old sections of the community and in slum communities at highly urbanized cities.

Except for 17.5% of the total population (Southern, Central and Western Mindanao and ARMM), some 84 million Filipinos will be at risk to tropical cyclones in 2005. At greater risk will be those under 1 to 14 years old (37%) and those 60 years old and above (6%), more than one-half of which are female (Figure 3-13).

CALL TO ACTION

IPCC-TAR Projected Changes in Extreme Climate Phenomena:

More intense precipitation events are very likely, over many areas. There will be increased flood, landslide, avalanche, and mudslide damage; increased soil erosion; increased flood runoff could increase recharge of some floodplain aquifers; and increased pressure on government and private flood insurance systems and disaster relief.

Increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities are likely, over some areas. The effects will be increased risks to human life, risk of infectious disease epidemics and many other risks; increased coastal erosion and damage to coastal buildings and infrastructure; and increased damage to coastal ecosystems such as coral reefs and mangroves.

Recent studies suggest that future warming may lead to an upward trend in tropical cyclone destructive potential and - taking into account an increasing coastal population - a substantial increase in hurricane/typhoon-related losses in the 21st century," (Emmanuel, K., 2005)

Intensified droughts and floods associated with El Niño events in many different regions are likely to occur. The projected impacts are decreased agricultural and rangeland productivity in drought- and flood-prone regions; and decreased hydro-power potential in drought-prone regions.

Increased Asian summer monsoon precipitation variability. Increase in flood and drought magnitude and damages in temperate and tropical Asia.

Higher maximum temperatures, more hot days and heat waves over nearly all land areas very likely. This will result in: Increased incidence of death and serious illness in older age groups and urban poor; increased heat stress in livestock and wildlife; shift in tourist destinations; increased risk of damage to a number of crops; and increased electric cooling demand and reduced energy supply reliability.

A grim climate change impact scenario

In a recent paper setting a timetable on global warming (Hare, B., 2005), an association between different levels of surface temperature increase and/or sea level rise versus specific impacts and risks on natural and human systems was presented. It showed that the risks arising from projected human induced climate change, increase significantly and systematically with increasing temperature. Below a 1^{0}C increase the level of risks are generally low but in some cases not insignificant, particularly for highly vulnerable ecosystems and/or species. For a 1oC warming a significant number of developing countries appear likely to experience net losses, which range as high as a few % of GDP. Above a 1^{0}C increase, risks increase significantly, often rapidly for highly vulnerable ecosystems and species. In the 1-2^{0}C increase range, risks across the board increase significantly and at a regional level are often substantial. . For a 2^{o}C warming the net adverse effects projected for developing countries appear to be more consistent and of the order of a few to several percentage points of GDP depending upon the model. Regional damages for some developing countries and regions, particularly in Africa, may exceed several percentage points of GDP. Above 2^{0}C the risks increase very substantially involving potentially large numbers of extinctions or even ecosystem collapse, major increases in hunger and water shortage risks as well as socio-economic damages, particularly in developing countries. The socio-economic effects on several developing regions appear to be in the range of 3-5% of GDP for a 2.5-3^{o}C warming, if there are no adverse climate surprises. Global damage estimates are in the range of 1-2% for 2.5-3^{o}C warming, with some estimates increasing substantially with increasing temperature (Hare, B., 2005).

This timetable shows the impacts of climate change multiplying rapidly as average global temperature goes up, towards 1^{0}C above levels before the industrial revolution, then to 2^{0}C, and then 3^{0}C (McCarthy, M., 2005).

This far, that world temperatures are already 0.7^{0}C above the pre-industrial level, the process is clearly well under way. **The frequency of extreme climate events is already increasing causing socio-economic disruptions.** In the near future - the next 25 years - as the temperature climbs to the 1^{0}C mark, some specialized ecosystems will start to feel stress, such as some tropical highland forests. In some developing countries, food production will start to decline, water shortage problems will worsen and there will be net losses in GDP.

It is when the temperature moves up to 2^{0}C above the pre-industrial level, expected in the middle of this century - within the lifetime of many people alive today - that serious effects start to come thick and fast, studies suggest. In tropical regions "bleaching" of coral reefs will become more frequent, perhaps, annually - when the animals that live in the corals are forced out by high temperatures and the reef may die. Some regions will be hit by more forest fires and insect pests, while in others, rivers may become too warm for certain fish species.

When the temperature moves up to the 3°C level, expected in the early part of the second half of the century, these effects will become critical. There is likely to be irreversible damage to the Amazon rainforest, leading to its collapse, and the complete destruction of coral reefs is likely to be widespread. There will be a rapid increase in populations exposed to hunger, with up to 5.5 billion people living in regions with large losses in crop production, while another 3 billion people will have increased risk of water shortages.

Above the 3°C raised level, which may be after 2070, the effects will be catastrophic: the Arctic sea ice will disappear, and species such as polar bears and walruses may disappear with it. In human terms there is likely to be catastrophe too, with water stress becoming even worse, and whole regions becoming unsuitable for producing food, while there will be substantial impacts on global GDP (McCarthy, M., 2005).

International response to climate change

The issue on climate change was first brought to the attention of the international scientific community by meteorologists of various countries during the First World Climate Conference of the World Meteorological Organization (WMO) in 1979. Several intergovernmental conferences on climate change followed leading to the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988. The IPCC is mandated to assess the state of knowledge on the various aspects of climate change and the climate system.

The UN General Assembly approved the start of the climate treaty negotiations under the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC/FCCC), with the ultimate objective of: **"Stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow eco-**

systems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."

Negotiators noted the apparent lack of commitment and quantified targets to achieve the objective of the Convention, so a protocol to the Convention was developed to meet the ultimate objective of the UNFCCC through quantified emission reduction targets within a specified time frame – the so-called Kyoto Protocol (1997). The Protocol is **a legally binding instrument for developed countries to reduce gas emissions to an average of 5% below 1990 levels between the period 2008 to 2012.**

On the sidelines of an Association of Southeast Asian Nations (ASEAN) meeting in Laos (July 2005), the United States and Australia unveiled the so-called Asia Pacific Partnership on Clean Development and Climate, a six-nation initiative including China, India, Japan, and South Korea that emphasizes consensus, cooperation and advanced technologies as the means to reduce GHG emission. This was, however, widely criticized by environmentalists who fear that this rival plan may deliver a fatal blow to the Kyoto Protocol; that the non-binding agreement is merely a vision statement that spells out no concrete goals and sets no emission targets for countries (Bird, M. et al, 2005).

A ray of hope has glimmered in the recently concluded Group of Eight (G8) Summit Meeting at Gleneagles, Scotland in July 2005 by including in their agenda the issue on climate change. This was supposed to be a big step forward to foster the realization of the ultimate objective of the UNFCCC and the Kyoto Protocol, however, while it was a clear initiative that broke new ground the outcome appears to be severely diluted due political maneuverings, according to some quarters .

The *"Joint science academies' statement: Global response to climate change"* (NAS, 2005), signed by scientists from 11 National Academy of Science (NAS) centers of the world is a clear recognition of the scientific community of climate issues. It urged all nations, calling particular attention to world leaders, including the G8 Summit participants, to take prompt actions to reduce the causes of climate change, adapt to its impacts and ensure that the issue is included in all relevant national and international strategies.

Among other things, world leaders were also called upon: to acknowledge that the threat of climate change is clear and increasing; to recognize that delayed action will increase the risk of adverse environmental effects and will likely incur a greater cost; to work with developing nations to build a scientific and technological capacity best suited to their circumstances, while explicitly recognizing their legitimate development rights; to show leadership in developing and deploying clean energy technologies and approaches to energy efficiency, and share this knowledge with all other nations; and to enhance research and development efforts, which can better inform climate change decisions.

Such call by a prestigious scientific community if heeded, will certainly have wide and far-reaching effects. Similar calls from influential groups of our community are in order. Our own scientific community may also take the lead role, in rallying the various stakeholders, such as, the business community, the agriculture sector and others to convince the national leadership about the seriousness of the threat posed by climate change to our future existence. But of course, these agencies and stakeholders should first be made to believe that climate change is real and is already showing signals of its impending threat.

The preamble to the NAS statement, states that "There will always be uncertainty in understanding a system as complex as the world's climate. However, there is now strong evidence that significant global warming is occurring." How true! The precautionary principle of the UNFCCC further categorically states that "Parties should take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects. **Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing such measures..."**

National/Regional Response

The Inter-Agency Committee on Climate (IACCC) was established under Administrative Order No. 220 dated, May 8, 1991, to coordinate various climate change-related activities, prepare the Philippine position to the UNFCCC negotiations and propose climate change policies (Figure 4-1). The IACCC prepared and submitted to the UNFCCC the Philippines' Initial National Communication on Climate Change.

The INCCC, a developing country commitment to the UNFCCC, contains essentially a national GHG inventory, steps to be taken to implement its commitments and other information relevant to the

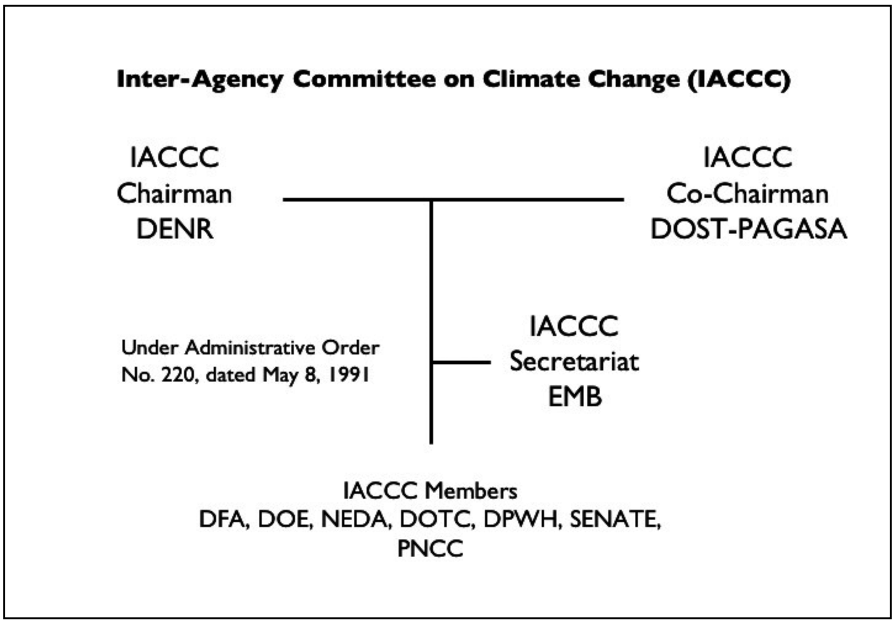


Figure 4-1. The Inter-Agency Committee on Climate Change (IACCC). The PAGASA and EMB are bureau-level IACCC members, representing the DOST and the DENR, respectively. The Initial National Communication on Climate Change (INCCC) of the Philippines and the National Action Plan (NAP)

achievement of the objective of the Convention. The NAP, on the other hand, is a framework plan which aims to identify the general thrusts to be focused on by the stakeholders, particularly as input into national development plans and programs of the government, to address the issue of climate change. Aside from the GHG inventory and GHG mitigation strategies, the INCCC and NAP also contain recommendations on education, training and public awareness, systematic observations and research, vulnerability assessments and adaptation strategies on agriculture, water resources, coastal resources, energy, forestry and human health.

Information dissemination on climate change issues were already being undertaken, even prior to the adoption of the Earth Summit in Rio (1992). Such activities were mainly undertaken by NGOs. Hopefully the NGOs will continue its financial resource mobilization efforts to further enhance this activity with the aid of government entities. Little has been done on systematic vulnerability assessment and adaptation strategies. The use of a detailed GIS-based vulnerability assessment should be pursued before meaningful and effective adaptation strategies could be formulated. Systematic observations are in place but would need upgrading and modernization to meet international standards. Several climate-related research activities are ongoing, others completed. Some of the climate change-related projects undertaken by various GOs' and NGOs' are the *Philippine Climate Change Report* (ADB-funded), which highlighted the initial "GHG" inventory and identified general measures to mitigate climate change impacts, 1995; *Philippine Country Program to Address Climate Change Issues* under the US Country Studies Program (US-CSP) - highlighted the 1990 GHG inventory and climate change impact studies on selected vulnerable areas such as coastal, agriculture and water resources; *Asia Least Cost Greenhouse Gas Abatement Strategy* (ALGAS) – Regional, GEF/UNDP/ADB-funded, which looked into GHG mitigation options in the energy, agriculture and forestry sectors, etc.

Based on some guiding principles of the Convention on "common but differentiated responsibilities" of states and on "polluters' pay principle", the burden of meeting the quantified emission limitation and reduction commitments lies with the developed countries, which in the first place, emitted large quantities of greenhouse gases, particularly, carbon dioxide into the atmosphere since the start of the industrial revolution.

Developing countries, however, have existing commitments under the Convention and in the Kyoto Protocol: They "shall formulate, where relevant and to the extent possible, cost-effective national and, where appropriate regional programmes to improve the quality of local emission factors, activity data ...", and... "...programmes containing measures to mitigate climate change and measures to facilitate adequate adaptation to climate change."

ENERGY, GHG INVENTORY AND MITIGATION STRATEGIES

The 1994 GHG Emissions Inventory (Figure 4-2) shows the contribution of 4 important non-LUCF sectors to anthropogenic gas emissions, i.e., energy (49%), agriculture (33%), industry (11%) and waste (7%). GHG emissions from the energy sector are primarily from transport, power generation, and manufacturing industries. The main fuel types used in these sub-sectors are conventional fossil fuels such as oil and coal which contribute substantially to GHG emissions.

The Philippines, as a developing country, does not have any quantified emission limitation reduction targets and its present GHG emission is still low compared to other countries (Figure 4.2). However, certain mitigation measures need to be put in place given the country's climate change vulnerabilities and the vast renewable resources that the country possesses. Unfortunately, the latest energy plan of the DOE shows that, excluding large hydro, geothermal (renewable but mature technology) and conventional biomass, new and renewable energy comprises less than 0.2 percent in the country's power mix. Under the same plan, the share of coal would increase greatly.

Time-bound targets, i.e., such as the call to source 10% of our power requirement from the sun, the wind and modern biomass by the year 2010 is a good start, along with more demand-side management and more aggressive energy efficiency measures.

CLEAN DEVELOPMENT MECHANISM (CDM)

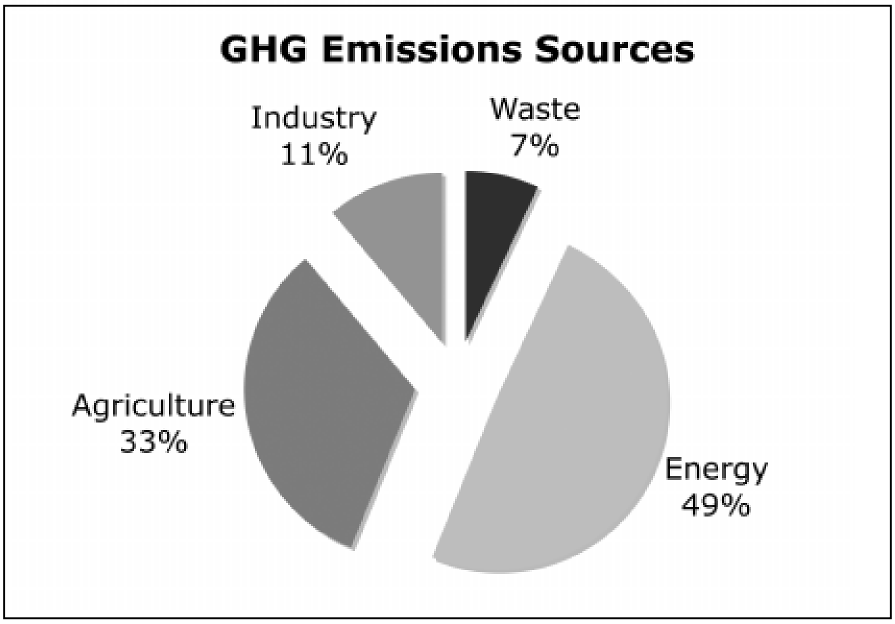


Figure 4 -2. **GHG Emissions Sources (Philippines, 1994)**

An important provision in the Kyoto Protocol relevant to the cooperation between developed and developing countries is the Clean Development Mechanism (CDM), whose purpose, **"shall be to assist Parties not included in Annex I (developing countries) in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I (developed countries) in achieving compliance with their quantified emission limitation and reduction commitments."**

The Conference of the Party (COP) has already come up with simplified modalities and procedures for small-scale CDM project activities. The Philippines should take advantage of this opportunity by proposing project activities that shall meet the eligibility criteria for small CDM project activities set out in paragraph 6 © of decision 17/CP.7. The CDM project activities eligible under these criteria are: Type (i): Renewable energy project activities with a maximum output capacity equivalent of up to 15 megawatts (or an appropriate equivalent); Type (ii): Energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 15 gigawatt-hours per year; and Type (iii): Other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilotonnes of carbon dioxide equivalent annually.

These are the type of project activities that the country needs that would help meet its energy mix targets and where private (NGOs) and public (GOs) entities can cooperate, subject to the guidance of the Executive Board of the CDM. It should, however, be emphasized that the purpose of any CDM project activity shall be to assist the developing countries, like the Philippines, in achieving sustainable development and in contributing to the ultimate objective of the Convention and not for personal or corporate gains; that part of the share of the proceeds from certified project activities shall be used to meet the costs of adaptation (KP Art. 12.9); ensure that the project activi-

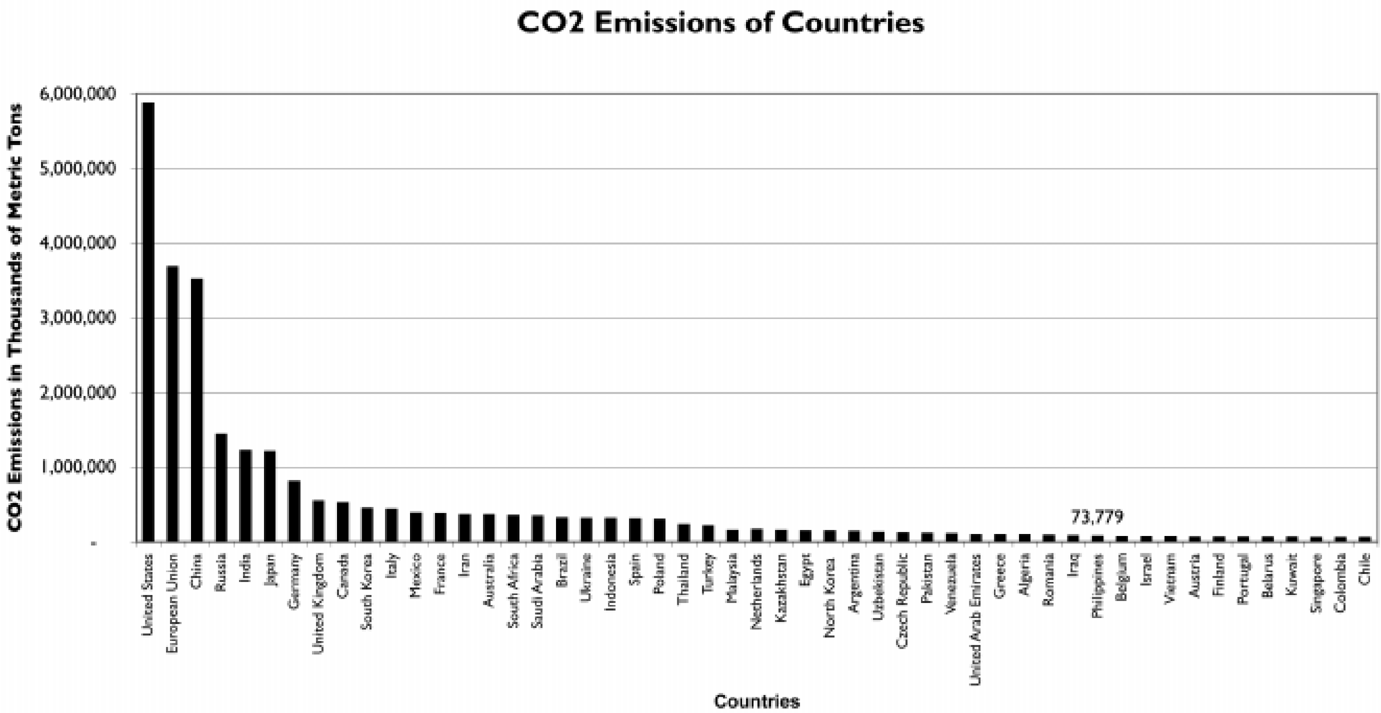


Figure 4 -3. Carbon dioxide (CO_2) emissions of countries

ties are not merely for using the carbon space of the country, but the provisions on supplementarity, fungibility, etc. should be followed; that no project activity involving current unresolved debates (nuclear, clean coal, sink-based, etc., projects) should be proposed; and that all criteria set by the Executive Board of the CDM should be strictly adhered to.

Time to take action

High hopes are pinned on the UNFCCC and its Protocol that a runaway climate change scenario and its dire consequences will not happen. The quantified emission limitation targets and the corresponding timelines of developed countries (although the USA, the biggest polluter of all, has not yet ratified the Kyoto Protocol), as well as, the implementation and monitoring mechanisms are in place. It is up now for world leaders to act.

Yes, we have not yet heard of islands being submerged by sea level rise, or daily heat waves, floods or drought, but climate change does not happen in a day, a month or a year. Our timetable is for the long-term. The relatively frequent occurrence of extreme climate events in recent years is just a wake-up call for all of us - a reminder that the worst is still to come if we don't take action today.

Yes, our predictions and scenarios are based on theoretical global climate models only. However, the IPCC clearly reports that although complex physically-based climate models cannot yet simulate all aspects of the planet's climate, nevertheless, confidence in the ability of these models to provide useful projections of future climate has improved due to their demonstrated performance on a range of space and time-scales (IPCC, 2001).

Unfounded doubts and scientific uncertainties should not be taken as an excuse for not responding to the challenge of climate change. The risks are far too great to ignore.

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Leoncio A. Amadore, Ph.D.November 2005

GREENPEACE

Greenpeace is a global organization that uses non-violent direct action to tackle the most crucial threats to our planet's biodiversity and environment.

Greenpeace's regional presence in Southeast Asia was formally established in 2000. Through its campaigns, Greenpeace aims to protect the region from further ecological ruin and serve as a beacon of awareness and action in the interest of environmental protection and sustainable development. To date, its work in the region has included stopping hazardous waste imports, opposing radioactive shipments, campaigning against destructive logging, stopping dirty and polluting technologies like waste incinerators and coal power plants, halting the spread of GMOs, promoting renewable energy and sustainable solutions to key environmental problems. Often working with local groups, Greenpeace has been leading successful campaigns in the Philippines, Thailand, and Indonesia.

Greenpeace Southeast Asia
in the Philippines
24 K-J St corner K-7 St., East Kamias,
1102 Quezon City, the Philippines
tel: +63 2 434 7034
fax: +63 2 434 7035
email: greenpeace.philippines@dialb.greenpeace.org