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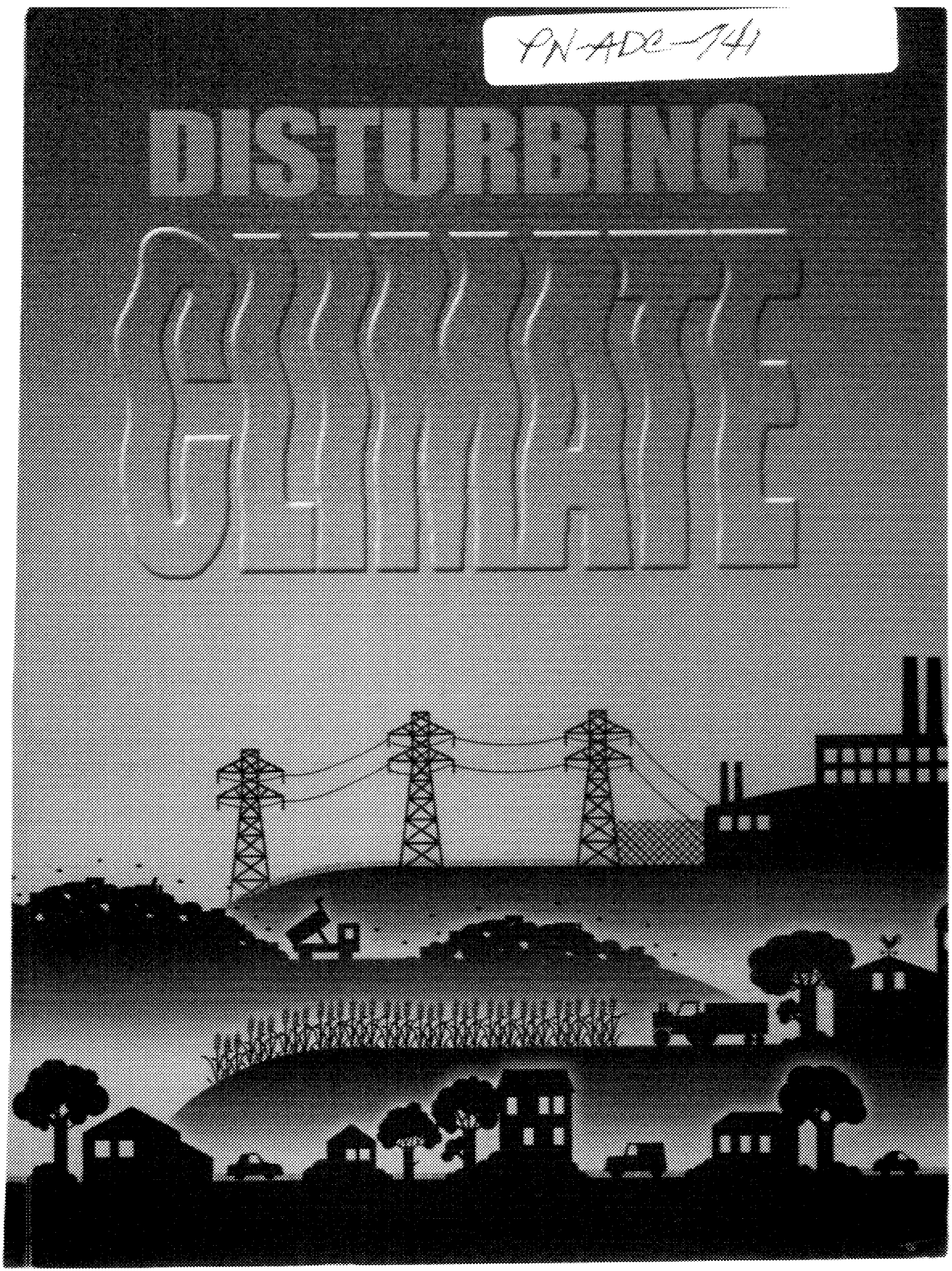

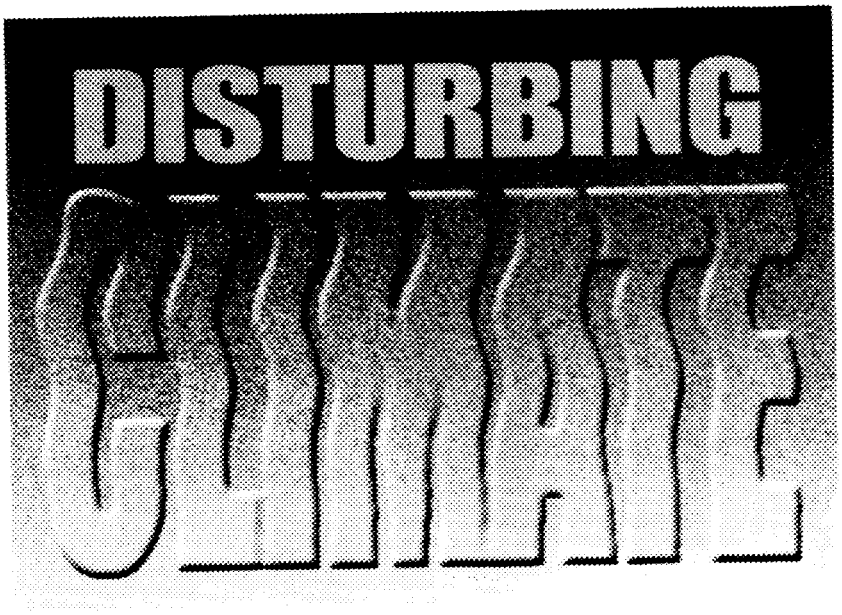

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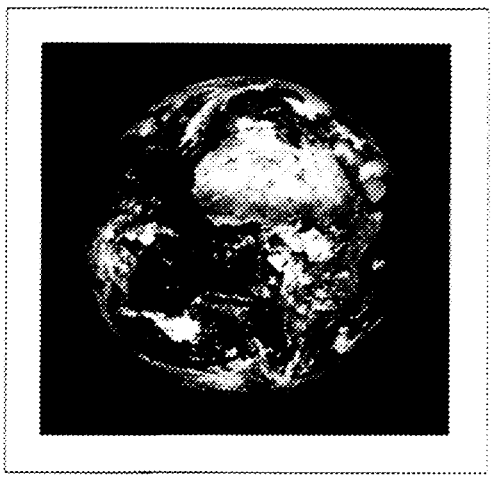
Introduction



It is the month of July. From somewhere in the Central Pacific, a typhoon takes off with enough power of a megaton bomb, careening towards the Philippine archipelago. A few days are all we have to prepare for the assault. Typhoon trajectories are immediately drawn. People are warned, communities are advised to brace themselves for the onslaught. We know all too well the devastation wrought by a storm's brutal lashing. When it batters our fragile landscape, we do best not to face and do battle with the wind. We can only wait it out. For most of our poor, we dig in, we huddle in helpless huts, with only a shiver of a prayer. After a few days of this relentless barrage of wind and water, the extent of the damage becomes clear. A few tens or hundreds of lives are lost. A few tens or hundreds of million pesos worth of property are irretrievably destroyed.

The month of December could very well be the next visit. This time, at the opposite bank of the Pacific, a warm ocean current mysteriously invades the coasts of Peru. It would have been harmless if not for the marked decrease in Peru's fish catch. The crisis would have been manageable if it were just a local, transient aberration, confined to the coasts of a far-flung nation. But now we know the global and temporal reach of such a deceptively local phenomenon. Now we know that it occurs with a peculiar frequency (every two to five years) which affects the extensive circuit of wind and rain in the Pacific.

In our corner of the Western Pacific basin, the onset of El Niño ushers in a drought spell that is severe enough to stall our economy and wreak havoc on our water resources. We find ourselves ill-prepared for this subtle, less dramatic, yet prolonged visitation. For most of us, the only option left is to wait it out. Only, it takes longer, a few months to a year when water-laden clouds migrate elsewhere, leaving our portion of earth bereft of life-sustaining moisture while those in other parts of the globe are drenched in unrelenting rain.

A typhoon in July, a drought from December to November; there lies the difference between weather and climate. Weather represents transient turbulence, lasting only a few hours to several days, while climate is more than episodic or torrential. It is a sustained, general pattern of wind and rain and temperature, lasting for weeks to months to years.

Many of us take this for granted but it is the steady, almost faithful rhythms and seasons of our climate that have shaped our native environment, sustained our natural resources, and provided for our continued existence. The concern, therefore, that surrounds climate change is premised on the assumption that a shifting climate may have profound, pervasive, irreversible impacts on those ecosystems deemed critical for our development and survival. The severity of those impacts will depend on the rapidity and magnitude of such a change.

Moreover, at the heart of the issue is a radical, contentious idea, which holds that we, human beings, have the capacity to alter the balance of climate that has long sustained and protected our planetary existence. We wield this power by virtue of the unprecedented gaseous emissions released into the atmosphere by our industrial, agricultural and urban activities. The idea itself subverts our view of climatic events, which, together with typhoons and other 'heavenly' events, have long been attributed to force majeur and the unexplainable, inculpable 'acts of God'.

Most of the current scientific and political debates that rage on the climate front are focused on how we as, a global community, are to exercise that responsibility for a changing climate in the 21st century. The Philippines is by all means actively engaged in this global endeavor. This book documents that engagement in a collection of essays that can very well mark the beginning of a Philippine response to the complex issue of climate change.

The essays themselves are a blend of science and policy since an issue as complex and pervasive as climate change cannot but draw from these two streams. The climate change problem was raised initially by the scientific community. And even as a scientific problem, it already proved itself intractable since the manifold questions it posed demanded answers that had to be drawn from the knowledge pools of the natural (e.g. physics, chemistry, biology), mathematical and social sciences.

Even at the outset, it was already evident that solutions could not be found solely in the arcane confines of the laboratory or the computer model. The only effective response would have to be a concerted effort which bridges both science and policy, one that straddles the multidisciplinary worlds of economics, political science, ethics and ecology, among others. Such a response would also have to be multisectoral in character, engaging institutions on environment, energy, forestry, economic planning, industry, public works, transportation, academe, NGOs, and civil society. Indeed the composition of national climate change committees in the community of nations reflects this pluralism.

The essays in this volume have been written in view of that pluralism and the need to interface the sometimes disparate worlds of science and policy. Sound policy needs to be continually informed and grounded by good science insofar as science can provide the basis and validation for the climate effectiveness of the measures and programs that will issue forth from policy. On the other hand, science, particularly in resource-strapped developing countries, stands to gain much when its investigations are focused and guided by what the policy community considers as urgent, practicable, sustainable and just.

It is in this spirit that the scientists who contributed to this volume were asked about the policy implications of their work while policy people were asked to note the environmental and scientific soundness of their statements and positions. The nature of scientific and policy topics included in this volume attests to the breadth of expertise and knowledge that must be brought to bear on the climate issue. The book does not pretend to be comprehensive. If this collection of essays has achieved anything, it is perhaps the convergence of Filipinos, all experts in their field, who have been grappling with this issue for many years, and who now have generously shared the fruit of their talent and labor.

In many ways, the climate change issue has ushered in novel and exciting ways of bringing together people of various persuasions, ideologies and expertise. This demand for a collective, plural, yet integrally global response is new. It taxes the capacity of our institutions to work in creative ways and at varying scales in order to effectively address the issue. It has challenged us to converge as an international collegial community that is now faced with the formidable responsibility of tending the global commons.

The exigency of forging a collective and enduring response to the climate issue has never been more apparent. Despite the centrifugal forces and interests that threaten to stall global and national action, we do wise to know that if and when it happens, climate change will not be as fleeting as a typhoon to wait out.

Endangered Climate[1]

*Jose T. Villarin SJ**

The Greenhouse Effect

Climate is the very condition for the possibility of biological life on our planet. In its four to five billion years of existence, the Earth has been subject to dramatic extremes in temperature and weather. Only in the last tens of thousands of years has the climate stabilized enough to support the matrix of human life. The reasons behind the stabilization of the climate are still not exactly known but these are likely to be found in the complex physical and chemical processes in our atmosphere, oceans and the sun of our solar system.

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* Climate Studies Division, Manila Observatory

Atmospheric processes, in particular, are one of the most important climate regulating mechanisms of our planet. Together with the ocean, the atmosphere behaves in such a way as to redistribute the heat brought about by the uneven insolation of the spherical surface of the Earth. Winds and waves of various spatial scales and intensities are generated to transport heat and moisture from the tropics toward the poles. The surface itself is directly heated by incoming solar radiation but were it not for the atmosphere, this surface temperature would not be warm enough to sustain biological life as we know it today. The reason why the atmosphere plays such a pivotal role in further warming the Earth's surface is the presence of critical gases called greenhouse gases (GHGs).

In terms of regulating the surface temperature of the Earth, the greenhouse effect is a benign mechanism. These GHGs, many of which occur naturally in our atmosphere, act as the very thermostat of the planet. Interestingly enough, despite their important climate regulation function, these GHGs are not at all the major elements of our atmosphere (as nitrogen or oxygen are) but are, in fact, merely trace gases (i.e. their number and density are only minimal when compared with that of oxygen or nitrogen). These GHGs are water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). The last four are associated mainly with industrial production.

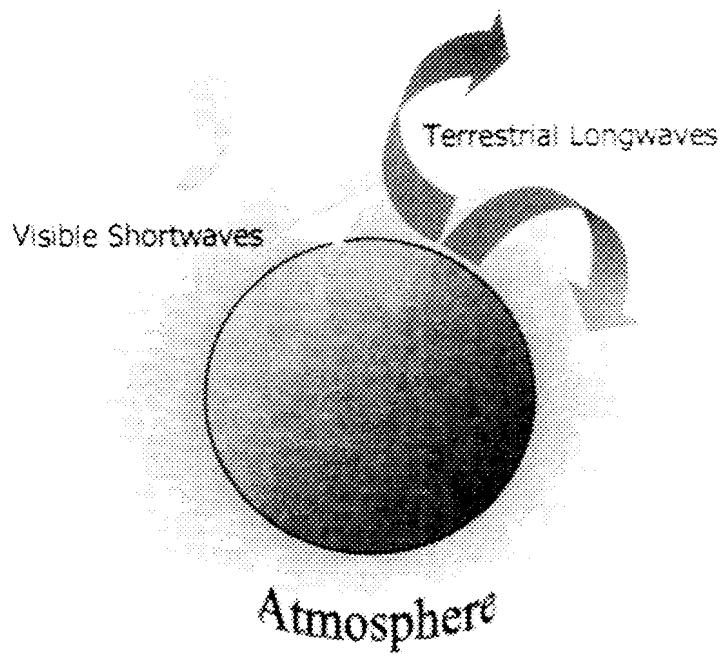
The ultimate mechanism that governs the warming effect of these GHGs is their capacity to absorb the outgoing longwave or infrared radiation of the Earth. Thirty percent of the incoming solar radiation (the so-called planet albedo) is reflected by clouds and the terrestrial surface. The remaining 70 percent of this solar radiation, on the other hand, is absorbed by the Earth's surface. The nature of our atmosphere is such that it is practically transparent to this visible (or shortwave) radiation. If the surface absorbed this radiation and did not release some of the energy back out

PHOTO BY ED BALATAN

into space, it would heat up indefinitely because of the sun's continual insolation of the planetary surface. Surface temperatures are bearable for life simply because the absorbed energy is radiated back to space in the form of longwave or infrared waves emanating from the planet. However, if all these terrestrial long waves radiated directly out into space, the Earth's surface temperature would plunge to about -18° C, too cold for water to liquefy, perhaps not warm enough to sustain life.

The GHGs in the atmosphere absorb some of this outgoing terrestrial longwave radiation and a fraction of this absorbed radiation is in turn radiated back to the Earth's surface. This increment of longwave, earthbound radiation is what critically regulates the temperature levels that make for the possibility of biological life. A schematic of this greenhouse mechanism is shown in Figure 1. The warming function of these GHGs has been likened to that of the glass roof of a greenhouse that allows solar radiation to pass through but traps the heat inside. The image itself is controverted since the heating mechanism of a greenhouse may be due more to the physical suppression of convection currents rather than the trapping of outgoing radiation, much in the same way a car with closed windows traps the heat inside.

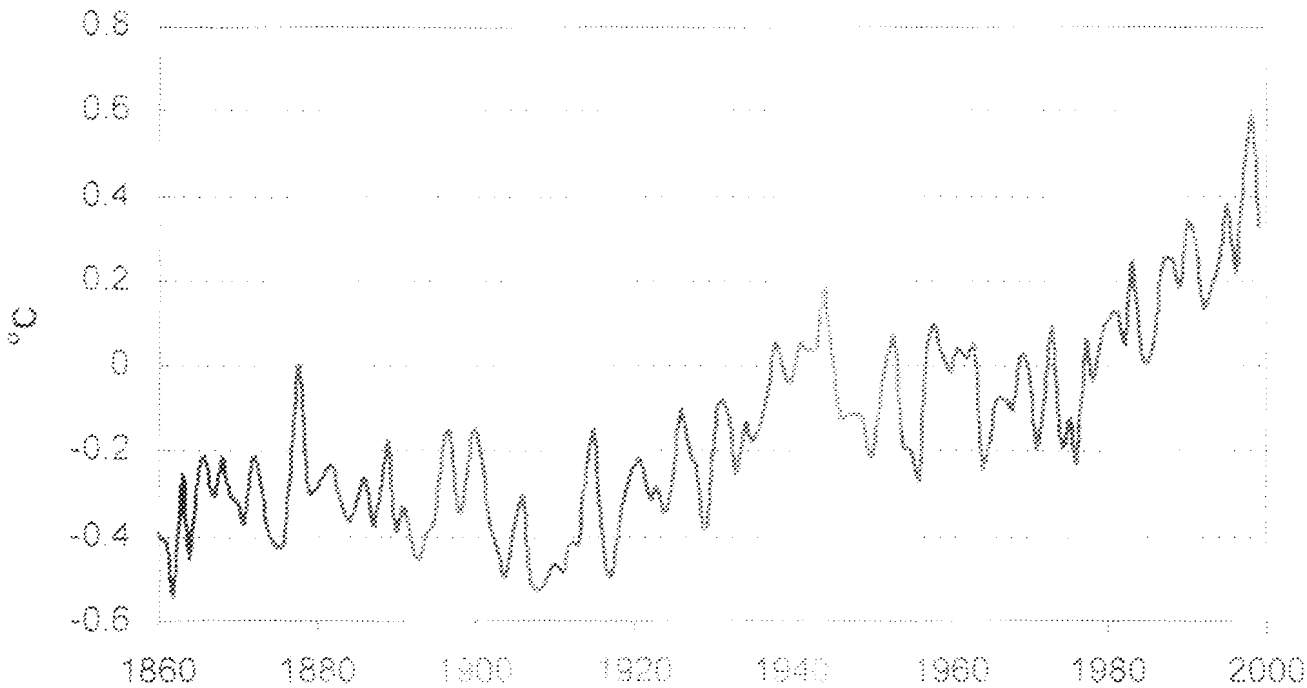
Figure 1. Simplified diagram of the greenhouse effect



The Enhanced Greenhouse Effect

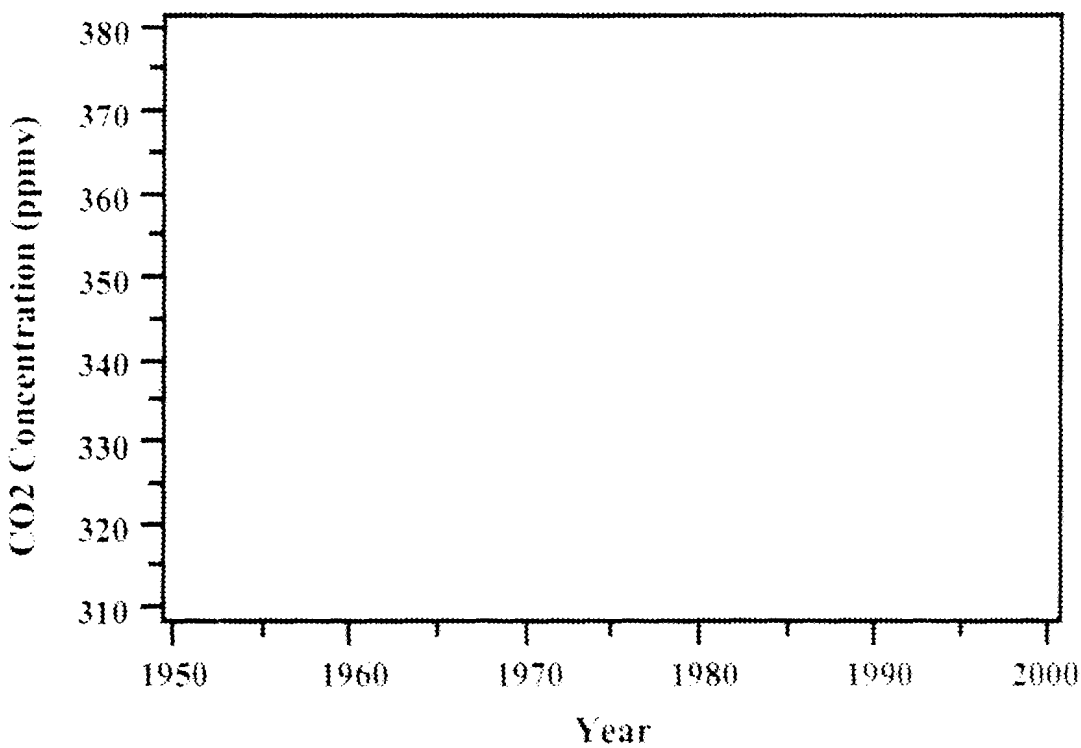
The concern for climate change in the last few decades has been driven by a consensus of scientific observations made all over the world regarding the progressive increase in globally averaged temperatures [Houghton et al., 1996]. This planetary "fever" has been detected on land, ocean and satellite-based observation networks. A plot of this continual increase in global temperature is shown in Figure 2.

Figure 2. Increasing global average temperature. (Source: Jones et al., 2000. Data archived at: http://cdiac.esd.ornl.gov)



Almost in step with this rise in temperature is the increase in concentration of one important greenhouse gas – carbon dioxide. The famous plot showing the progressive increase in atmospheric CO_2 in Mauna Loa, Hawaii, is reproduced in Figure 3. Mauna Loa is a remote site, free from nearby local sources of CO_2 and other pollutants. Measurements made at this site therefore reflect the baseline (or "clean") concentration of many atmospheric gases. The year-to-year oscillatory (i.e. wavy) behavior of the CO_2 concentration also indicates the influence of the seasons on the photosynthetic absorption and respiratory release of CO_2 into the atmosphere.

Figure 3. Increasing atmospheric CO_2 levels at Mauna Loa (Source: Keeling and Whorf, 2000. Data archived at http://cdiac.esd.ornl.gov/).



The general trend in these and other measurements is discernible: there has been, in recent decades, a pronounced increase in the baseline concentrations of CO_2 and other GHG in our atmosphere. This rise in GHG concentration may also be related to the increase in GHG emissions associated with our energy-intensive industrial, agricultural and urban activities. Figure 4 shows the geometric rise of global CO_2 concentration along with CO_2 emissions since the start of industrialization in the 19th century.

Figure 4. CO_2 concentration tracks CO_2 emissions since the start of industrialization in the 19th century. (Source: Marland et al., 1999 and Keeling et al., 1998. Data archived at http://cdiac.esd.ornl.gov)

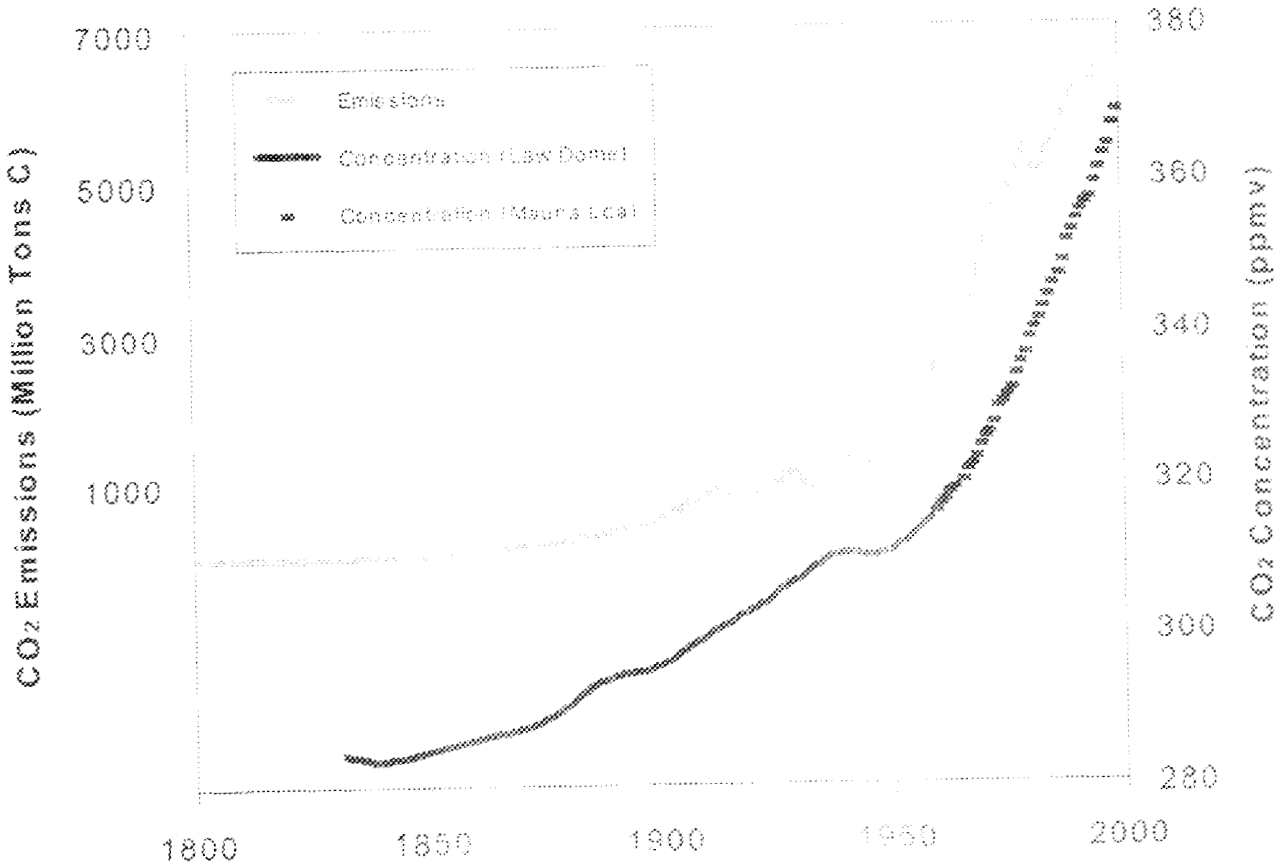
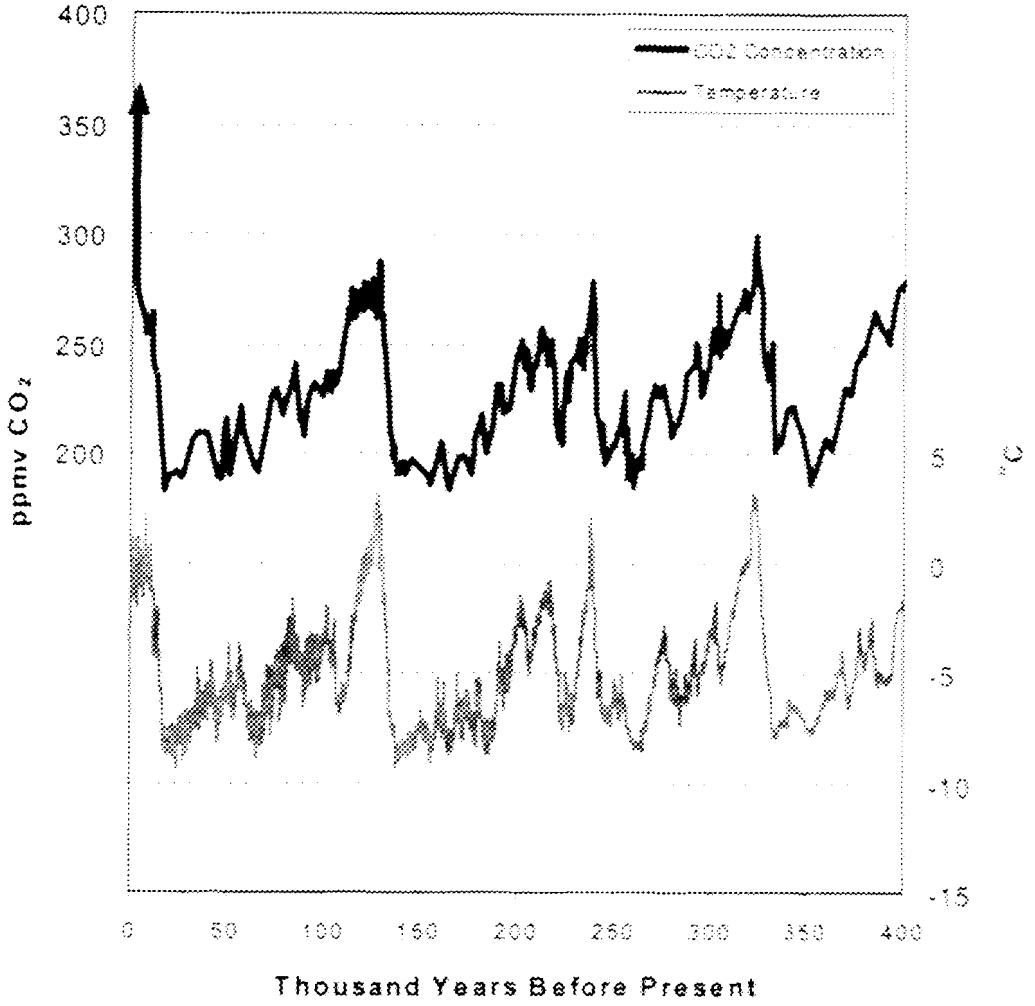


Figure 5. *Paleoclimatic record of temperature and CO_2.*
Arrow points to present level of CO2 in the atmosphere (~370 ppmv).
(Source: Barnola et al., 1999 and Petit et al., 2000).



It is important to note that in the last 400,000 years, our atmosphere has never contained as much CO_2 as what it has today. Paleoclimatic data (derived from ice cores) show in Figure 5 the evidence that current CO_2 levels of about 370 ppmv (as indicated by the arrow) are unprecedented. The plot likewise shows the near correlation between temperature and CO_2. The dramatic swings in temperature and CO_2 indicate the movement from glacial to inter-glacial periods that may have been brought about by orbital and other astronomical forcing mechanisms that modulated the amount of sunlight reaching the Earth's surface [Philander, 1998].

PHOTO BY MICHAEL ADAM

Current scientific debate wrestles with the causal connection between the rise in global temperature and the increase of GHG levels in the atmosphere. There are those who contend that the observed global warming trend is part of the natural variability of the planet's life. The Earth has been subject to natural warming episodes before. They also argue that the natural resilience of the Earth's system can withstand this positive rise in temperature, inducing negative feedback mechanisms that will bring the Earth back to an equilibrated state. Arguments on this side also cite the insufficiency of data and science as another reason for advocating caution regarding predictions of climate change. They mention, for example, current deficiencies in our understanding of the oceans and clouds, two pivotal variables that regulate the planet's climate.

On the other hand, there are those who see a discernible human imprint or influence on the global warming trend. They contend that even if the warming is naturally driven, it is being accelerated by the continuous emissions of GHG into the atmosphere. This human signature is now gradually becoming more evident from the data and from more powerful general circulation models. Because of so-called non-linear and chaotic feedback mechanisms, there is still no telling how the planet will react to the fast rate at which our climate is being perturbed by the increasing levels of GHG. Thus, for example, abrupt climate changes are possible in a matter of decades, leaving insufficient time for ecosystems to adapt to the potentially dramatic impacts of increased global temperatures. Their arguments hinge on the assumption that these trace GHG, however small in concentration, can be a catalytic forcing factor in affecting the distribution and concentration of water vapor, the most important GHG. They warn of an enhanced or runaway greenhouse effect that can potentially wreak havoc on the hydrological and biological resources of the Earth.

As global temperatures continue to rise in the next century, the impacts can be far more complex than the ordinary discomfort everyone experienced during exceptionally hot summers. Climate scientists monitor only a few variables such as temperature, precipitation, sea level rise, ocean and atmospheric currents, incident solar radiation, clouds, and water budgets in the biosphere and atmosphere. A warmer planetary surface can perturb the dynamical balance of all these variables, which balance has given us the benign conditions that have underlined the emergence and sustenance of human life.

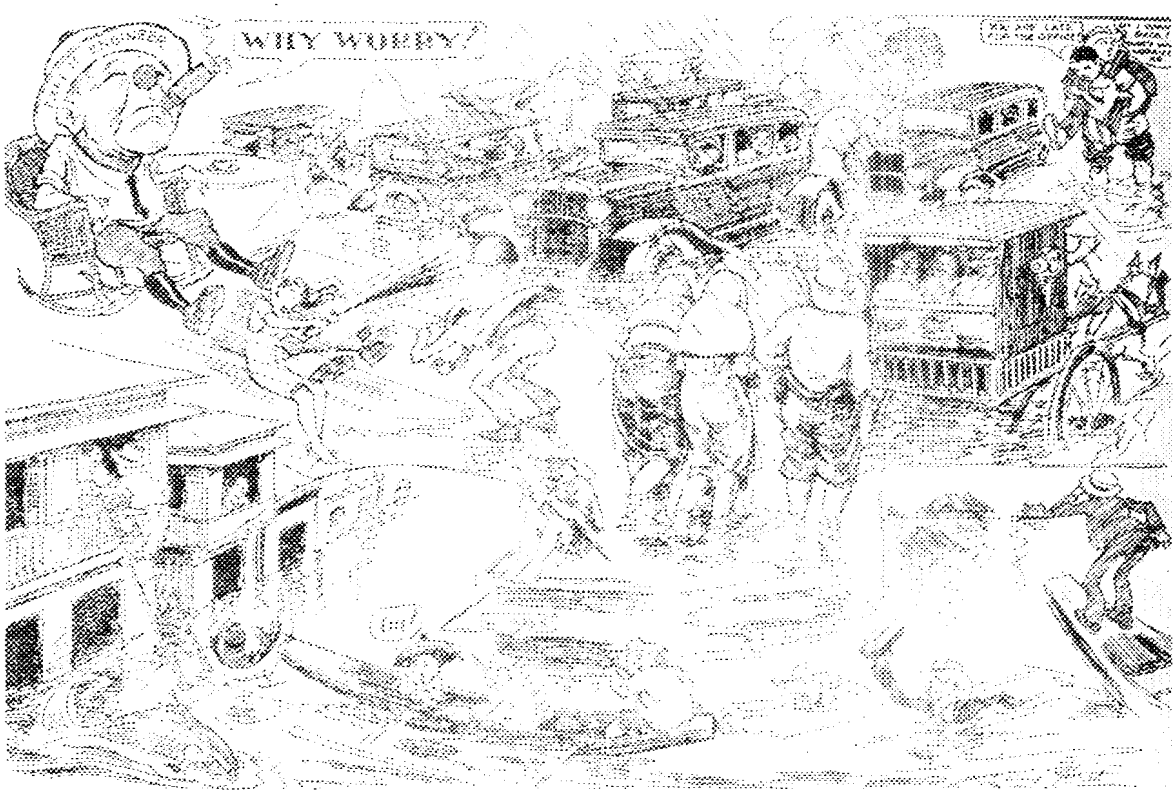
The impact of changes in these climate variables spans a whole spectrum of sectors that include agriculture, coastal zones, water resources, human health, terrestrial ecosystems and forests, and fisheries. In the Asian region, for instance (Sen, 2000), sea level rise threatens the socio-economic infrastructure and activities found in the many coastal and delta zones in this part of the world. Water resources are threatened by extremes of drought and flooding, and by saltwater intrusion. A change in climate can spell the degradation of important forest ecosystems, forest cover and biodiversity. Human health will likewise be affected as a changing climate can increase the incidence, duration and geographical extent of vector-borne diseases such as malaria, dengue, cholera, etc. Warmer ocean temperatures can affect the survival of coral ecosystems that are home to much of marine life.

the impact of changes in these climate variables spans a whole spectrum of sectors that include agriculture, coastal zones, water resources, human health, terrestrial ecosystems and forests, and fisheries

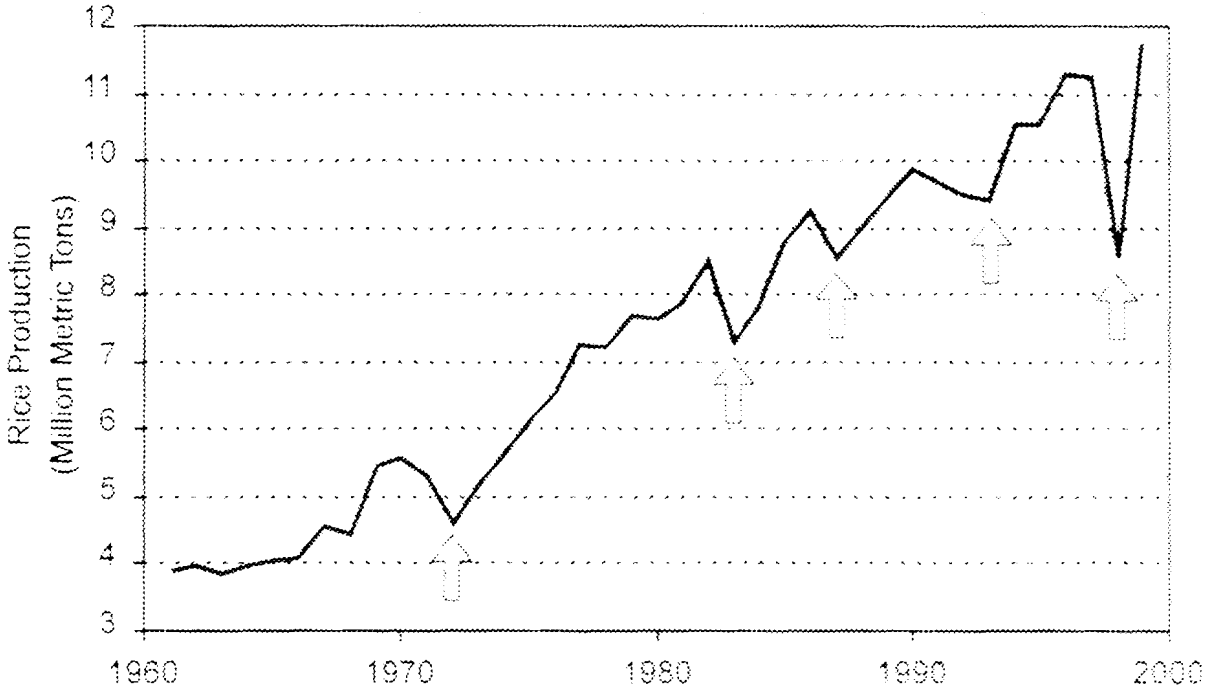
Some of the symptoms of this planetary fever are already evident. Coral bleaching episodes in the Philippines and all over the world were reported during the last and most destructive El Niño, which spawned warmer sea surface temperatures in 1997 and 1998. Sea level has risen at a rate of about 10 cm per decade in some Philippine coastal cities due, on the one hand, to the thermal expansion of warmer ocean waters, and, on the other, to excessive coastal development, groundwater extraction leading to subsidence and siltation. Saltwater intrusion may likewise affect the rice productivity of provinces like Bulacan or the quality of water resources in provinces like Cebu.

One only has to look at the interannual (i.e. year-to-year) performance of Philippine agriculture to see the critical role climate plays in the food security of the nation. Figure 6 shows the periodic decreases in rice production output during El Niño events, the largest dip (about 2.5 million metric tons of rice) occurring during the most intense El Niño of the 20th century (1997-1998). While the link between El Niño and climate change remains tenuous, there is no reason to assume that the wide ranging, multi-sectoral impacts of El Niño are outside the range of impacts arising from climate change. Even if the El Niño phenomenon were found to be independent of climate change, the potential impacts of warmer planetary temperatures can exacerbate the already critical situation in many El Niño-sensitive countries. Besides, some studies already do suggest that El Niño variability and intensity may significantly increase as global temperatures rise in the future (Zebiak, 1999).

Figure 6. Philippine rice production. Arrows indicate El Nino events. (Source: Food and Agricultural Organization. Data at: http://apps.fao.org)



Source: Hong Kong Press, August 22, 1931


Rice Production
(Million Metric Tons)
12
11
10
9
8
7
6
5
4
3
1960
1970
1980
1990
2000

The Global Response

Despite the uncertainties in the science of climate change, the global community has nonetheless decided to convene on those measures that may be collectively implemented to respond to or mitigate the adverse impacts, if ever, of global climate change. In view of the environmental precautionary principle, the UNFCCC has adopted as its main objective the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." Anthropogenic interference is here taken to mean human intervention via GHG emissions that can alter the climate system, thus leading to potentially adverse impacts on both regional and global scales.

The imperative of stabilizing GHG levels in the air is due to the fact that the atmospheric lifetimes or residence times of GHGs range from a couple of years to several decades. Arresting the cumulative emission of these GHGs in the near term will not immediately bring GHG levels down to what may be "safe" for the climate system. To shed light on this, the TPCC has generated various emission scenarios and the consequent CO_2 concentration levels associated with these scenarios, as shown in Figure 7. What is striking is that as the emission scenarios illustrate, even if anthropogenic emissions of CO_2 were to be stabilized by some amount relative to 1990 emission levels in the next century, atmospheric concentrations of CO_2 will continue to rise. In the A2 SRES (Special Report on Emission Scenarios) regime, for example, if global emissions were to rise to about five times the present rate, CO_2 concentration levels are projected to increase to 820 ppm – more than double the present level of about 370 ppm. In the optimistic B1 scenario, in which global emissions at the end of the 21st century are pegged to those of the year 2000, the CO_2 concentration continues to rise to about 560 ppm, still representing a 50-percent increase from present levels.

PHOTO BY E.D. BALATAN

Figure 7 SRES Emission Scenarios
(Source: SRES, 2000. Data at http://sres.ciesin.org).

Thus, recognizing the urgency of the issue, country parties to the UNFCCC have lined up emissions commitments and mechanisms to attain the ultimate objective of the Convention, in consonance with "their common but differentiated responsibilities". This differentiation highlights the historical and cumulative GHG emissions generated by the industrial growth of the developed countries in contrast with those associated with the emerging economies of the developing nations. Figure 8 is a simple illustration of the respective historical contributions of both Annex 1 (developed countries and the economies in transition) and non-Annex 1 countries. While Annex 1 countries began emitting GHGs as early as the middle of the 19th century, non-Annex 1 countries have only started in the 1940s. The disparity is further highlighted by the fact that Annex 1 countries comprise only 21 percent of the global population, while their emissions correspond to about 58 percent of the global total. Furthermore, in 1997, the per capita emissions of Annex 1 countries was about 11 tons of CO_2 per person per year while that of non-Annex 1 countries was only about two tons. The global average in 1997 was about four tons CO_2 per person per year. Geographical disparities in per capita CO_2 emissions are shown in Figure 9 to indicate those regions where carbon emissions are most intense.

Under the principle of equitably distributing the burden of climate protection, the Kyoto Protocol of the Convention has detailed mitigation targets for developed countries by stipulating an average GHG emissions reduction objective of about 5.2 percent of 1990 levels by 2008-2012, while at the same time encouraging developing country parties to proceed with their development in a sustainable manner. However difficult and politically disastrous these mitigation targets may be for developed country parties, these negotiated targets, even if complied with, may not be substantial at all to arrest the progressive degradation of the global climate.

Figure 8. Historical emissions from fossil fuel and cement of Annex 1 and non-Annex 1 countries. (Source: Marland et al., 1999).

PHOTO BY JOAN BOSCH

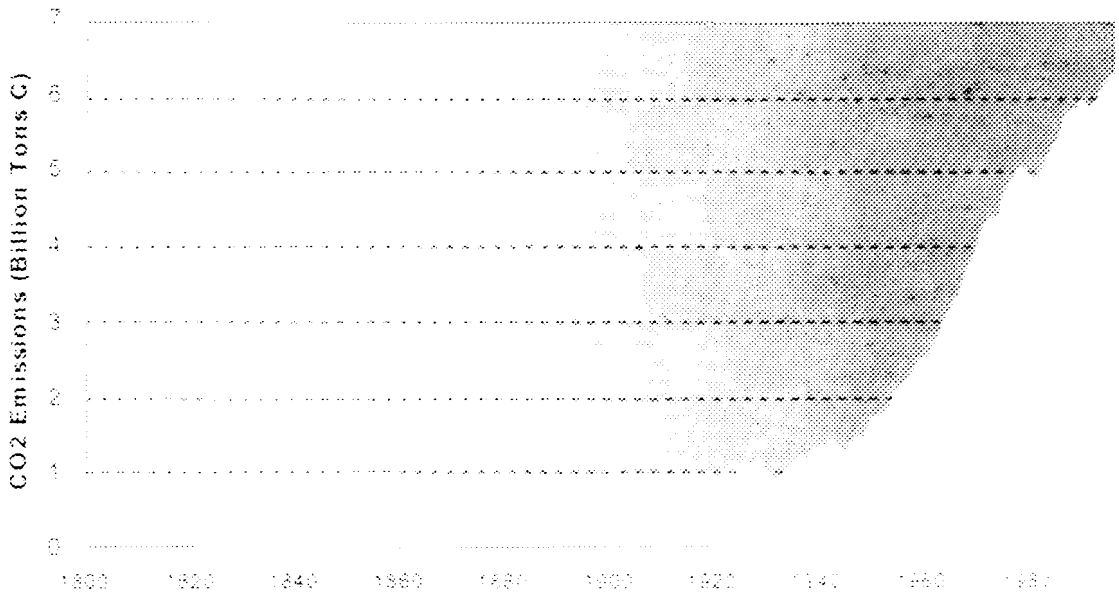
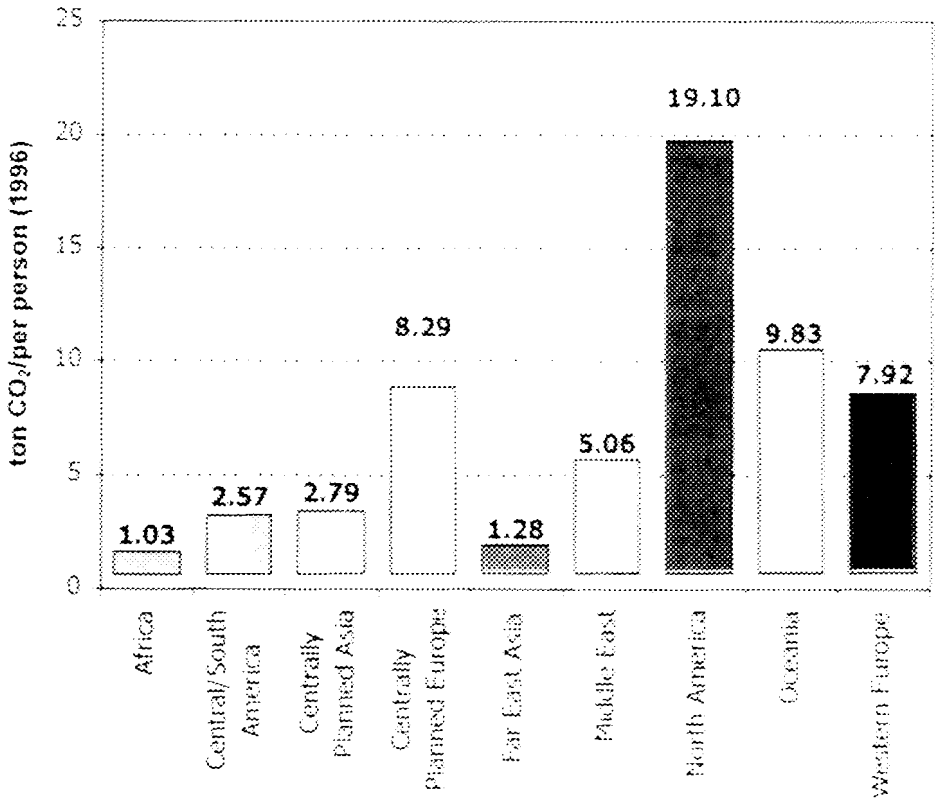


Figure 9. Per capita CO_2 emissions in 1996 (Source: Marland et al., 1999).



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1 Updated from the same essay in the Climate Change module of the "Science and Society" course of the Ateneo de Manila University

Responding to the Challenges of the Rising Sea

*Rosa T. Perez**

The Philippines, like any other island nation, faces the difficulty of confronting the adverse effects of global climate change. Considering that the Philippines has a discontinuous coastline of 32,400 kilometers, it becomes especially vulnerable to one projected impact of global warming – sea level rise.

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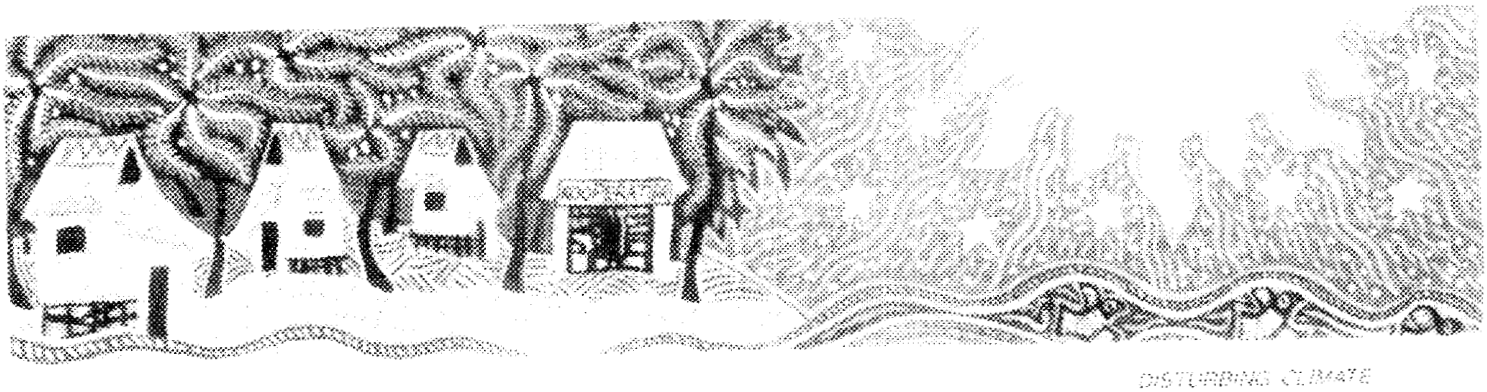
Studies conducted by the Inter-governmental Panel on Climate Change [IPCC, 1995] indicate that the need to implement strategies to cope with sea level rise is more urgent than what was originally perceived. Natural systems that protect marine and coastal resources are already degraded by human activities. Mangrove forests, which buffer the land from storm surges and the sea from land-based sources of pollution, are being depleted. Uncontrolled or ill-conceived development schemes, over-exploitation of marine resources, urbanization, tourism and agriculture all contribute to a decreased resilience of the coastal and marine ecosystems. The inadequacy of data and lack of either a suitable information system or a coordinated institutional structure in managing coastal and marine resources compound the difficulties.

Possible adaptation planning should include studies on the potential impacts of climate change to identify specific vulnerable areas or regions in the country. Identification of policy options for adaptation and appropriate capacity-building must be done to prepare for eventual sea level rise.

Coastal Impacts of Climate Change

Extreme Weather Events

Being in the Pacific Rim, the Philippines is a hot spot for natural hazards. It is highly prone to storm surges and riverine flooding, due mainly to the fact that an average of 20 tropical cyclones pass through the Philippines yearly, and about nine of them cross land [DOE, 1995]. Year to year climate variability greatly affects the amount of rainfall in the country – the El Niño causes drought (below-average rainfall) and La Niña causes floods. Climate changes are seen to increase the intensity and frequency of tropical storms, hence increased coastal flooding due to storm surges may be expected.



One of the most certain results of climate change is accelerated sea level rise (SLR). The potential impacts of an SLR would include an increase in erosion of beaches and cliffs due to the direct removal of materials by wave action. Direct inundation of low-lying areas can occur as they are submerged beneath the rising waters. This may include upland areas being converted to wetlands. Collectively, inundation and erosion will cause land loss. The threshing value at which inundation occurs is one specific. However there are sources indicating that inundation can occur for sea level rise values as low as three to four mm/year (Leatherman and Nicholls, 1994). Sea level rise will increase the risk of flooding and storm damage and water logging after heavy rains may also affect infrastructure. The danger of ground liquefaction during earthquakes would be highly enhanced, and tidal action in rivers and bays may be altered.

The following are the other potential impacts of accelerated sea level rise:

- Increased frequency and intensity of storms and storm surges causing backflows in rivers and bays.

- Saltwater intrusion into surface and ground water affecting the amount and quality of water supplies.

- Mangroves and other habitats of benthic organisms will be greatly affected by the changes in salinity.

- High precipitation would increase run-off, raise fresh water demand and result in low dissolved oxygen availability.

- The pattern of fish reproduction would be affected. Livelihood based on subsistence fishing would be put to risk. Low-pressure systems could pump nutrient-rich waters from outer to middle shelves, and affect spot fish yields.

Coral Reefs

The Philippine coral reef cover is about 27,000 square kilometers and 15 to 30 kilometers deep. These contribute to a 10- to 15-percent total annual fish yield, equivalent to anywhere between five and 24 metric tons per square kilometer of fish production. Unfortunately, human activities (e.g. such as destructive fishing practices) have greatly damaged the country's coral reef systems. Table 1 summarizes the present status of Philippine coral reefs.

Table 1. Status of the Philippine Coral Reefs.

Status	Percentage	Remarks
Excellent condition	5.50%	75 to 100% live cover
Good condition	25.20%	50 to 74.9% live cover
Fair condition	39%	25 to 49.9% live cover
Poor condition	30.50%	0 to 29.9% live cover

Corals are greatly affected by increases in sea-surface temperature (viz. the 1983, 1987 and 1997 bleaching events during El Niño episodes), but it is expected that other man made stresses will be more devastating. The most serious anthropogenic stresses include sedimentation, pollution and physical alteration. Sedimentation is usually caused by poor land use practices, while pollution and over-nitrification come from domestic agricultural and industrial wastes. Physical alteration of coral reefs can occur during coastal construction projects, destructive fishing practices (e.g., poison and blast fishing), ship grounding and coastal tourism. Scientists predict that within the next 20 years, more and more coral reefs will succumb as the intensity and frequency of the anthropogenic stresses increase along with the size and density of coastal human populations. Weakened corals and coral reefs due to these factors would not be able to respond positively to future sea surface temperature changes.

Mangrove Ecosystems

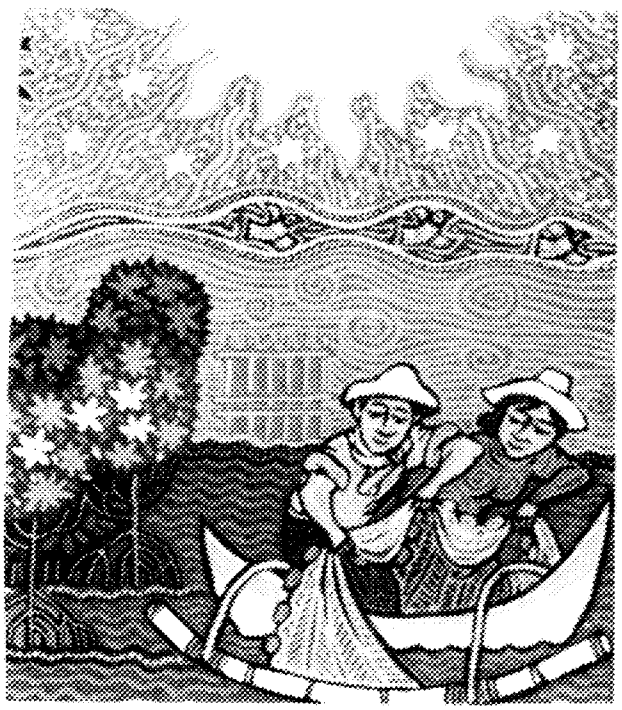
Mangrove forests are a unique feature of protected coastal shorelines of the tropics and subtropics. Their root systems stabilize sediment, dampen wave energy, provide habitat shelter for numerous organisms and provide the basis for the near-shore marine food web [Vicente et. al., 1992]. The best-developed mangrove forests are associated with the areas of high rainfall and upstream runoff. Thus, in

terms of climate change, future changes in rainfall pattern and runoff will have severe impacts on mangroves. Mangroves grow best in moderately saline environments and could keep up with a sea level rise of up to 12 cm/100 years. However, given the current rate of mangrove loss due to land clearing and habitat conversion, climate change may be an added factor in the fate of this important habitat. To date, we now only have about 100,000 hectares compared to 450,000 hectares at the start of the 20th century.

Present Initiatives in the Coastal Areas

Some of the coastal areas in the Philippines are already doing integrated coastal zone management (ICZM), such as those along the Lingayen Gulf, Davao Gulf, Cebu and Batangas Bay. The ICZM is a "process of governance consisting of the legal and institutional framework necessary to ensure that the development and management of the coastal zones are integrated with environmental and socio-economic goals in a community-participatory process" (Port et al., 1996). The ICZM addressed several issues that include the change of resource use patterns from single to multiple uses. Still lacking in these plans are appropriate responses to present-day climatic variability and natural hazards, and eventually to climate change and its impacts on coastal resources.

Local action planning to address climate change concerns in the provincial level (Perez, 1999) revealed that most of the prescribed responses to the identified issues are non-structural. They invoke the creation, enhancement or strict implementation of coastal laws (i.e., implementation of RA 8550 or the Fisheries Code of 1998, mining laws), regulations (i.e., on land use, zoning, setbacks etc.) and programs (i.e., Disaster Management Program, Coastal Environment Program, Coastal Zone Management etc.). Some provinces cited programs for information campaign and advocacy.



Recommended Responses

In general, disaster mitigation and preparedness should be strengthened. Institutional actions, such as the passage or implementation of policies and regulations on habitation and construction away from hazard-prone areas, would

likewise be helpful. Selective protection measures such as dikes or sea walls should be constructed only after thorough cost-benefit studies. Retreat or relocation can be an option for highly vulnerable areas.

Another strategy that could be used in adapting to future sea level rise is an ICZM program. However, to effectively respond to any of the threats of global climate change, constant monitoring of changes in the climate and sea level would have to be a high priority. Information and education campaigns must be carried out side by side with other initiatives.

Several coastal sectoral policy gaps need to be addressed, and these include the assessment of current practices on crisis management. Awareness of climatic variability and change, which are not well understood by the public or decision-makers, must be promoted. Increasing sensitivity to climate issues will facilitate adoption of measures.

- Guidelines and legislation for the implementation of an ICZM program that includes land use planning in coastal zones will have to be formulated.

- Mangrove resources development should be institutionalized through the formulation of additional policies and regulations or amending existing policies on sustainable mangrove management, highlighting the massive reforestation of degraded mangrove systems through a community-based approach.

- Local government units should be required to reserve foreshore areas for recreation/tourism purposes and other public uses and be excluded from disposition. Inclusion of wetlands, swamps and marshes in the National Integrated Protected Areas System, with a category of wildlife sanctuary or unique ecosystem, may be necessary.

- A multi-hazard mitigation or protection plan for natural coastal hazards must be developed with a priority on the maximum reduction in threat to life, structures and economic production. New anticipatory

approaches are needed to increase the resilience of vulnerable areas to improve their recovery from future disasters.

- Mining laws and reforestation of denuded watersheds must be strictly implemented to reduce river and coastal erosion. Geological, hydro-meteorological and structural engineering evaluation must be required as part of the environmental impact assessment prior to coastal development.

- Government subsidies or tax incentives to support the development of land sensitive to sea level rise, such as barrier islands, coastal wetlands, estuarine shorelines and critical wildlife habitats, must be discouraged. On the contrary, insurance and banking industries may be encouraged to factor risks of climatic variability into investment decisions, thereby, reducing reliance on government-subsidized insurance and disaster relief.

Climate change impacts on coastal zone systems are not well understood by the public or the policymakers. Hence, promotion of awareness about erosion, sea level rise, flooding risks, and storm and earthquake standard building codes could be a cost-effective means of reducing future expenditures.

These are only among the more general strategies that could be adopted to address future impacts of an accelerated sea level rise in the coastal resources sector. Detailed actions should be site-specific and must be done after a thorough impact analysis of the area involved.

Conclusion

Many may view climate change and sea-level rise as too overwhelming and too remote. That is because these changes are slow to occur and may not fit within the political or economic planning time frames of the country. Nevertheless, activities must begin in anticipation of the resulting impacts. Even if the future is not considered, many coastal resources in the Philippines are already highly stressed, leading to unsustainability, thus requiring urgent planning and action.

The issues and concerns on both the short- and long-term needs should be brought to the attention of the community who are the direct targets of the impacts, and of the policymakers who will direct the strategies for adaptation. Hence, information, education and communication are essential along with the technical and scientific efforts to achieve a well-balanced adaptation plan.

There is an urgent need to review and integrate all measures, policies and management plans to avoid costly duplication, and to increase the coordination between and among all the stakeholders. The involvement of the communities will serve as the strongest cohesive factor that will ensure the success of any program of the government. The LGUs should be equipped with the proper technical know-how, together with the power to execute all rules and regulations pertaining to the utilization, development and rehabilitation of their resources.

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Coral Bleaching in the Philippines

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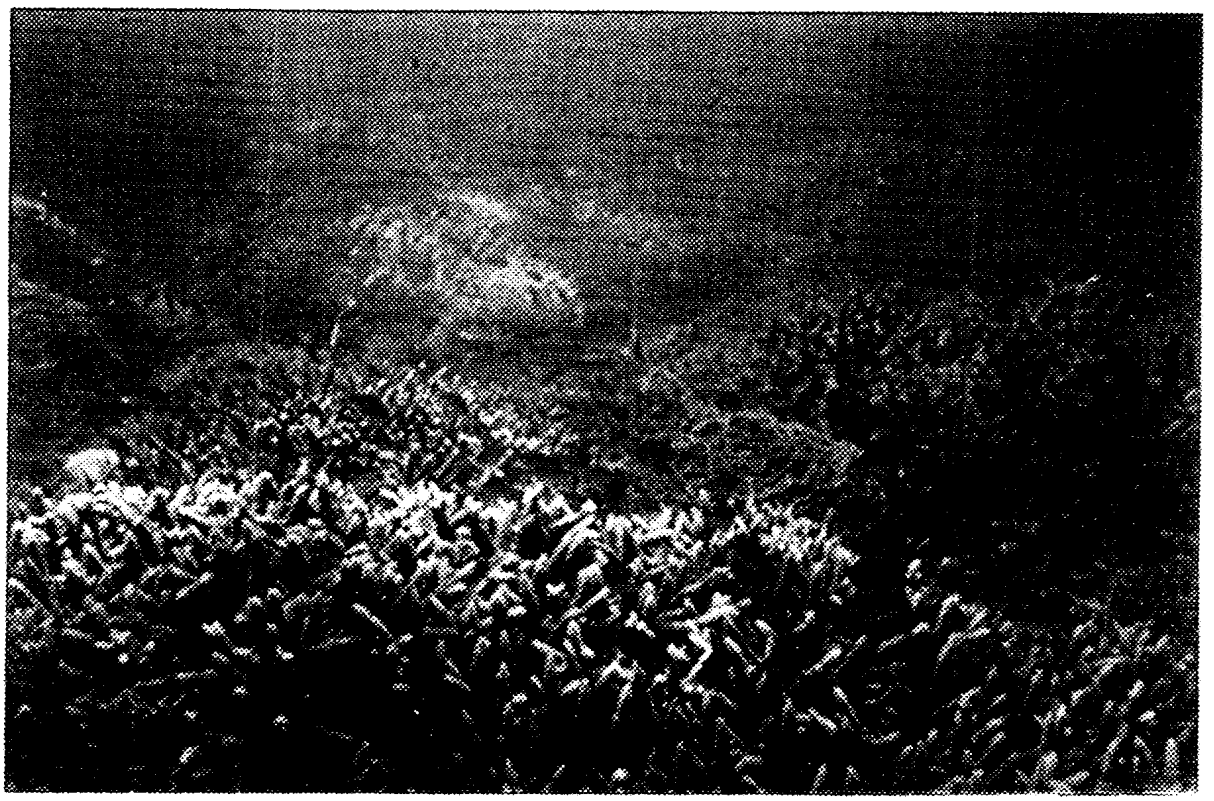

Philippine reefs are endowed with high coral diversity (~400 species) and contribute at least 15 percent to the total fishery production annually. Unfortunately, due to the unabated human-induced disturbances (e.g. destructive fishing practices, siltation, coral harvesting), Philippine reefs are now considered to be one of the highly threatened reef areas in the world.

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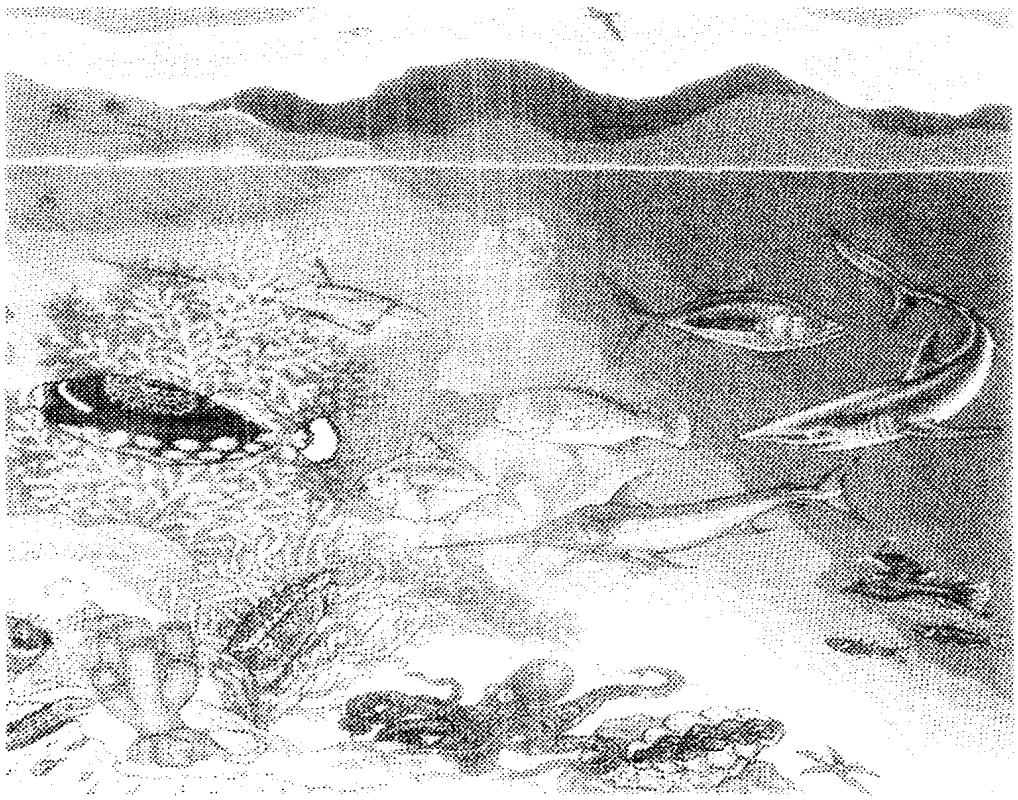
In the past, coral bleaching was not considered a major threat to Philippine reefs. From 1980 to 1997, only six coral bleaching reports were documented. However, the reports did not quantify the impact of coral bleaching in terms of its severity, extent and mortality, and the possible causal factors of these localized bleaching occurrences were not identified. Only Yap et al. [1992] documented the bleaching and mortality of corals due to elevated sea surface temperatures (SSTs) in Bolinao, Pangasinan in 1983. In 1998, using coral bleaching report forms, video transect surveys and NOAA satellite data, we were able to document the first mass bleaching event in the country. Elevated SSTs that surpassed the upper thermal limits of corals are implicated to be the major cause of bleaching. Changes in benthic lifeform composition derived from video transect surveys revealed that the impact of bleaching was variable across 15 sites (i.e. in areas of Bolinao, North Palawan, Tubbataha reefs, Kalayaan Island Group). Analyses of before-and-after bleaching conditions also showed that live coral cover significantly decreased (ranging from 0.7 percent to 46 percent) while dead coral cover increased (ranging from 2 percent to 49 percent). This review then aims to: a) summarize and update existing information on coral bleaching in the Philippines for the last 20 years, b) identify gaps in data gathering and analyses, and c) provide better understanding on the ecological and socio-economic implications of coral bleaching.



Bleaching Concepts and Perspectives

Bleaching has been described as the dissociation of the symbiotic relationships between algae and their respective hosts [Iglesias-Prieto et al., 1992]. Specifically, it is defined as the whitening of diverse invertebrate taxa, resulting from the loss of zooxanthellae and/or a decrease in photosynthetic pigment concentrations in the zooxanthellae residing within the host animal [Glynn, 1993; Glynn, 1994]. It can involve potentially all reef species in symbiosis with zooxanthellae, such as scleractinian corals, soft corals, sea anemones, giant clams, and even zoanthids. Generally the phenomenon is referred to as "coral reef bleaching" [Glynn, 1994].

The predominant factors that have been known to cause extensive bleaching are elevated sea temperatures, solar radiation (including ultraviolet radiation), and the combined effects of both high temperatures and solar radiation [Brown, 1997].

Identifying the Culprit

Elevated Sea Temperatures

Bleaching has often been observed when sea temperatures exceeded seasonal maxima [Brown, 1997]. Strong et al. [1998] state that a one-degree anomaly for a month could cause corals to bleach, while twice this magnitude can begin to cause appreciable coral mortality. Very high (3° to 4° C anomaly) sea temperatures at short-term exposures or slightly elevated sea temperatures (1° to 2° C anomaly) over a long period of time have been known to induce bleaching, leading to significant degradation of coral health and consequent mortality [Glynn and d'Croz, 1990; Jokiel and Coles, 1990].

Solar Radiation

Solar radiation could cause bleaching when the water movement does not allow organic and inorganic matter to be suspended in the water column to provide corals protection from direct ultra-violet (UV) radiation. Although they are also able to synthesize or accumulate UV-absorbing compounds, which can neutralize dangerous UV radiation, this may still be insufficient to protect them from extreme

conditions. Moreover, only UV-B wavelengths are screened while the longer UV-A wavelength and blue light are not [Fitt and Warner, 1995].

Combined Effects of High Temperature and Solar Radiation

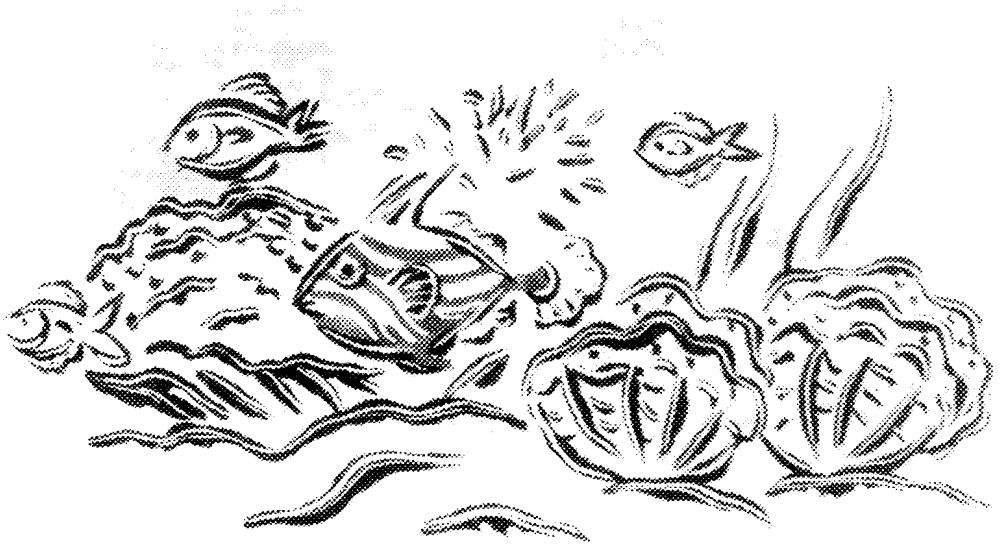
Bleaching reports have coincided with periods of low wind velocity, calm seas and low turbidity when conditions favor heating of shallow waters and high solar penetration [Brown, 1997]. The ENSO conditions seem to exhibit such characteristics, such that widespread mass bleaching events have often coincided with ENSO events.

Other Causes

Other perceived causes of bleaching include low sea surface temperatures [Brown, 1997; Glynn, 1993], reduced salinity such as from torrential rains and river discharges [Glynn, 1993], and localized bleaching from bacteria/disease (Brown, 1997). Extreme low tidal exposures and sudden sea level lowerings have also been implicated to cause bleaching [Glynn, 1993].

To Bleach or not to Bleach?

One recent hypothesis is that bleaching can be an adaptive mechanism which can promote long-term reef stability because it allows corals to be repopulated with a different, possibly more stress-resistant type of zooxanthellae, or to establish more stress-resistant host-symbiont combinations [Buddemeier and Fautin, 1993]. However, this "Adaptive Bleaching Hypothesis" is currently counter-argued by Hoegh-Guldberg [1999] because it is still not supported by facts. Initial evidence suggests that there seems to be a recombination of existing host and symbiont genetic diversities to adapt to increased irradiance [*sensu* Rowan et al., 1997], but further investigations are still needed to test the hypothesis. The concept that corals can eventually adapt to their changing environment awaits further validation. With the increasing rate of environmental degradation, rapid evolution in corals may be the only strategy left for them to survive. Warm-adapted colonies can survive, but paleontological evidence shows that coral species may be incapable of rapid evolution [Glynn, 1993].



Worldwide Bleaching Events

The worldwide coral reef bleaching events in the last two decades have been causes of great concern because of their apparently increasing frequency and scale (Glynn, 1993). In the past, bleaching episodes have been observed in relatively small areas or reef zones, whereas recent global episodes have been reported from larger geographic regions and at wider range of depths. Most of these episodes were observed following extensive warming of sea temperature brought about by the ENSO conditions, particularly in 1982-83 (Glynn and d'Croz, 1990; Glynn, 1984; Brown and Suharsono, 1990), and in 1987-88 (Reyes-Bonilla, 1993; Grigg and Maragos, 1990; Williams and Bunkley-Williams, 1988; Szmant and Gassman, 1993).

In the Philippines, mass bleaching was reported based on anecdotal reports coming from all over the country and from actual video transect surveys (Arceo et al., in press; Gubitan et al., manuscript in review). Philippine reefs are already considered to be one of the highly threatened in the world (Gomez et al., 1994; Bryant et al., 1998). Therefore, the impact of coral bleaching and how it synergistically exacerbates the condition of Philippine reefs requires a more serious look and proactive response (e.g. education campaigns).

Bleaching Reports: Philippine Setting

Unlike overfishing, siltation or *Acanthaster* infestations, coral bleaching, as an impact, has not been considered a major threat to the overall condition of Philippine reefs. This is probably due to the fact that there were more obvious immediate threats to Philippine reefs that contribute significantly and more rapidly to its decline [*sensu* Gomez et al., 1994]. In addition, past coral bleaching events in the Philippines may not have been dramatic (i.e. in terms of severity) to elicit concern. However, after the widespread coral mortality during the 1998 mass bleaching event, it may now be very important to seriously consider not only the ecological impact of bleaching to coral reefs, but also the impacts' socio-economic repercussions, specifically on fishery and tourism.

Historical Reports (1980-1997)

Prior to the 1998 mass bleaching event in the Philippines, reports of coral bleaching have been few and far in-between. Using documented reports generated from Reefbase 3.0 [1998], localized bleaching occurrences have been noted in Alcoy, Cebu [Abño et al., 1981], Panubulon and Unisan Islands, Guimaras [Baburan and Ingles, 1996], and Arthur's Rock, Batangas [White, 1992]. However, these bleaching occurrences may not necessarily be attributed solely to elevated SSTs, but to other factors such as *Acanthaster* predation, cyanide fishing, disease and siltation stress (i.e. polyp bail out). Only a study by Yap et al. [1992] reported coral bleaching in relation to elevated SSTs in Bolinao, Pangasinan in 1983. The authors discussed that the bleaching event coincided with the end of the 1982-83 severe El Niño, parallel to the observations in the Java sea [Brown and Suharsono, 1990]. Knop [1996] also noted bleaching of giant clams in Silaqui Island, Bolinao, Pangasinan in 1994.

1998 Mass Bleaching Event

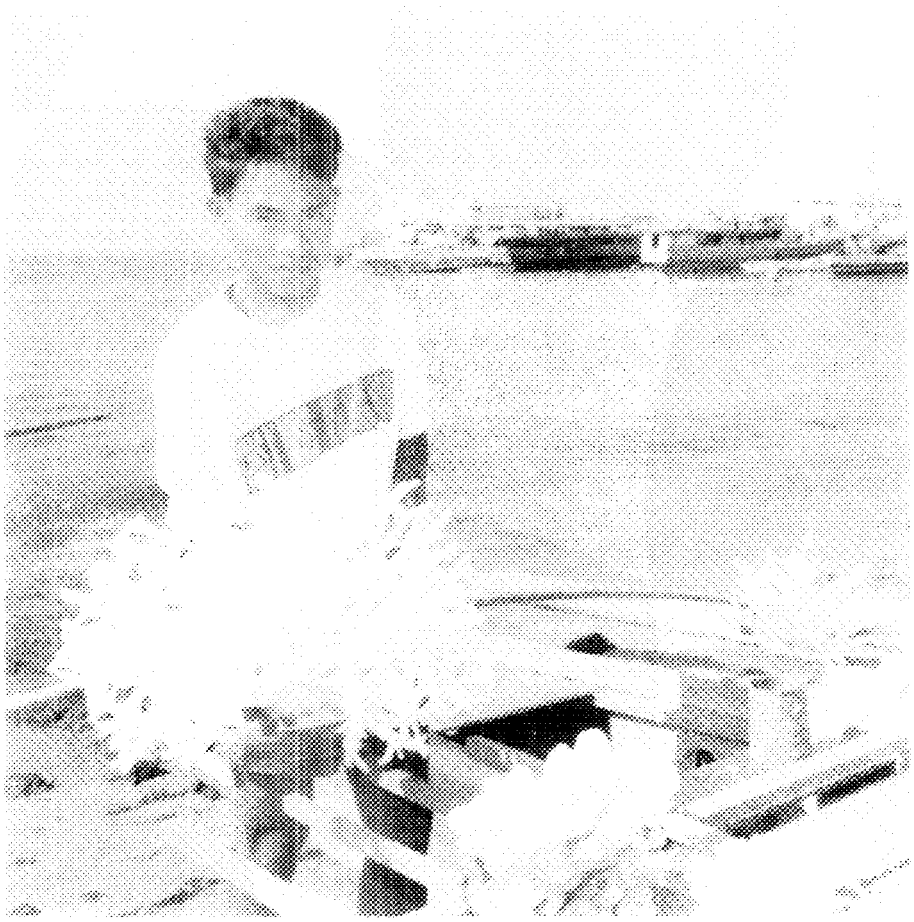
In 1998, bleaching reports from various reefs in the Philippines were obtained from Philreefs partners, with reports starting to come in early June until late November 1998. Bleaching was most widely observed in August 1998, suggesting that this period was the height of the bleaching

event, especially in the northern and central parts of the country. Up to 30 to 70 percent of hard corals was reportedly bleached at depths of five to 10 meters. The mass bleaching event has been attributed to El Niño-related elevated sst (Arceo et al., in press).

Susceptibility Patterns

It was observed in 1998 that the level of susceptibility to elevated sea temperatures was highest in the northwestern part of the Philippines facing the South China Sea (Arceo et al., in press). For example, extensive bleaching was seen in Bolinao, Pangasinan. In July 1998, Gomez and Mingoa-Licuanan (1998) reported fish kills and high mortality of cultured giant clams in ocean nurseries and attributed them to abnormally high sea temperatures of up to 35° C. It is suggested that the high level of susceptibility in this region is possibly due to the corals' longer exposure to warmer-than-normal sea temperatures (Arceo et al., in press). Hot Spot (1° C thermal anomaly) activity obtained form the website revealed that positive thermal anomalies persisted over this region for nearly seven months (from late April to November) in 1998.

Furthermore, Chu et al. [1997] have identified a warm pool occurrence, with SSTs of higher than 29.5° C, in the central South China Sea (west of Luzon) during boreal spring. The warm-core eddy shows a warming phase starting in early April, with a size of about 500,000 sq. km near the western coast of Luzon. Positive thermal anomalies also become evident west of Palawan. The warm pool strengthens in mid-May, moving southwards with an average temperature anomaly of >1.8° C and a size of around 200,000 sq. km. Villanoy et al. [manuscript in prep.] analyzed SST variability in Philippine seas (i.e. Philippine, Celebes, Sulu and South China Seas), using time-domain Empirical Orthogonal Functions (EOF) of monthly satellite-derived SST. Their results show that three EOF modes reflect various significant characteristics, linking the SST variations of Philippine seas to ENSO events, which are: 1) reduced inflow of cold water in the northern extremities of the South China Sea, 2) reduced upwelling along the Vietnam coast, and 3) weak seasonal variation. Moreover, the basin-wide circulation in the South China Sea during strong ENSO weakens and the cold upwelled water off Vietnam during non-ENSO years did not develop as ENSO occurred. Hence, based on these studies, the western side of the Philippine archipelago (particularly the northwest sector) was already exposed to high temperatures when El Niño-related warming occurred. This could then explain why the earliest and most severe bleaching observations came from this area.



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Recovery Potential

Recovery depends on severity or intensity, but varies largely with location [Glynn, 1993]. Rapid recovery rates may occur in areas where presence of coral survivors nearby

could serve as seed populations facilitating recruitment, while rates could be low in areas with unusually frequent disturbances or continued predation on remnant coral prey. Moreover, the levels of susceptibility of reef areas can greatly influence their potential for recovery. Preliminary investigations on recovery patterns indicate that areas protected from subsequent disturbances and stresses (such as offshore reefs or marine protected areas) exhibit positive signs of recovery compared to areas where the negative effects of bleaching are aggravated by anthropogenic stresses [Arceo et al., in prep.].

Socio-economic Implications

Given that Philippine reefs contribute at least 15 percent of the total annual fishery production [Murdy and Ferraris, 1980], and that coastal communities derive their income (either directly and indirectly) from tourist-related activities, it is possible that the impacts of coral bleaching may also translate to significant economic losses. A study is now currently being undertaken to address this question.

Future Outlook and Research Directions

It is the current opinion that rising sea temperatures are now pushing corals above their upper thermal tolerance, which eventually cause bleaching [Hoegh-Guldber, 1999]. Hence, the role of global climate on the increasing frequency of El Niño and subsequent bleaching should no longer be overlooked. Anthropogenic impacts that directly (i.e. destructive fishing practices, pollution or siltation) and indirectly (i.e. increasing inputs of atmospheric greenhouse gases which eventually contributes to global climate change) affect reefs should continually be regulated and closely monitored.

The interaction between natural and human-induced stresses is crucial for determining reef recovery. Coral reef research should focus on methodologies that will enable to de-couple the effects of bleaching with other human-induced stresses. There are indications that reef sites like the Tubbataha atolls in the Sulu Sea, which are less affected by human-induced stresses, are able to "bounce back" more quickly compared to reefs in Bolinao, Pangasinan, [Areceo et al., in prep.].

There is also a need to undertake coral reef studies that are geared towards understanding the mechanisms for reef recovery (e.g. recruitment) in order to provide empirical data in developing effective management plans and programs (e.g. establishment of marine protected areas). Direct interventions to improve damaged reef habitats, such as coral transplantation experiments and replenishment of reef population by coral seeding, should continually be explored.

To further validate sea surface temperature anomalies derived from satellite data, we recommend that *on-site* temperature loggers should be deployed in shallow (between five to 10 meters in depth) and deep (~20 m) waters for key reef areas in the Philippines (i.e. for low, medium or high bleaching-susceptible reef areas). Information gathered from these temperature loggers will be important to determine the: 1) onset of coral bleaching, 2) duration of anomalous SSTs for a particular area, and 3) deviations/ anomalies from normal temperatures.

Information on species-dependent susceptibility can be potentially used for the development of indices (based on the extent to which part of the genera are affected) for monitoring the severity of mass bleaching events [Hoegh-Guldberg and Salvat, 1995]. However, Hoegh-Guldberg and Salvat [1995] also reiterates that this should be interpreted with caution, taking into account observer differences and biogeographical considerations.

Long-term monitoring is also important to further understand the mechanisms and specific causes of bleaching. Glynn [1993] noted that attempts to relate the severity and extent of large-scale coral reef bleaching events to particular causes have been hampered by a lack of continuous, long-term monitoring databases and standardized methods to assess bleaching. Standardized methods to quantify the extent of bleaching (i.e. using manta tow) to cover a broader spatial scale are immensely recommended. One recent method explored has been the use of underwater videos to detect not only reef changes spatially but also temporally (i.e. through time) [Quibilan et al., manuscript in review].

Information dissemination (e.g. educational campaigns) on coral bleaching is essentially needed in the Philippines, especially on how human-induced stresses can aggravate its effects. Likewise, a systematized reporting scheme for bleaching in the country also needs to be developed so that

trends in bleaching occurrences, severity and extent can be monitored. Coral bleaching report forms, a preliminary version of which was used for the 1998 bleaching reports is presently being improved to gather more data that are relevant and standardized.

Finally, some mechanisms on how reports should be administered will also have to be identified. Currently, PhilReefs is starting to provide a national database management system for coral reef data in the country. A database system for bleaching reports can be added to the main system. Furthermore, the PhilReefs website (http://msi01.cs.upd.edu/philreefs) could be considered as a venue for this reporting system, especially if interactive routines are integrated in the website such that bleaching reports can be submitted *on-line*.

Acknowledgements

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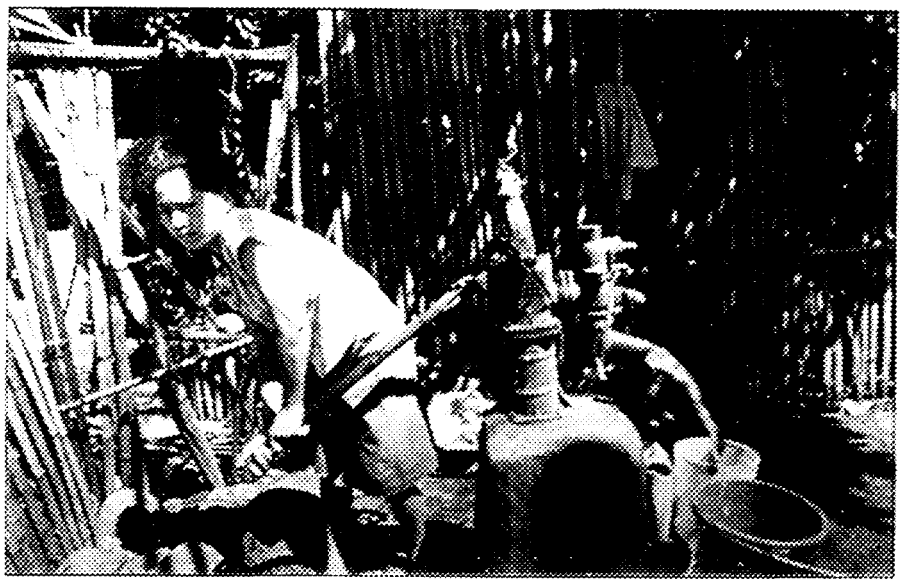
CC Impacts on Water Resources

*Nathaniel A. Cruz**



Concentrations of greenhouse gases such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) in the atmosphere have grown significantly for the past several years. The increase was mainly brought about by the increased use of fossil fuel, land use change and agriculture. The doubled concentration of GHGs in the atmosphere can lead to an alteration of the Earth's energy balance, resulting in an increase in global temperature.

Based on the latest estimates of the IPCC, a 1° to 3.5° C-increase in global temperature by 2100 is to be expected [IPCC, 1996]. Recent analyses show that the global mean temperature has increased by about 0.3° to 0.6° C since the late 19th century, and just over the last 40 years, it has increased by about 0.2° to 0.3° C. The 1990s have been recorded as the warmest decade since 1860, despite the cooling effect of the Mt. Pinatubo eruption in 1991.

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Potential Impacts of Climate Change on Water Resources

Climate change could disrupt the global hydrological cycle. Changes in CO_2 concentrations are projected to lead to regional and global changes in climate and climate-related parameters such as temperature, precipitation, soil moisture and sea level. A change in the volume and distribution of water will affect both ground and surface water supply for domestic and industrial use, irrigation, hydropower generation, navigation, instream ecosystems and water-based recreation. Changes in the total amount of precipitation and in its frequency and intensity will directly affect the magnitude and timing of runoff, and the intensity of floods and droughts. In the lower latitudes or in the tropics, runoff may decrease due to an increased evapo-transpiration and decreased precipitation.

At present, the country's water resource is manageable. Substantial supply brought about by abundant rainfall could very well satisfy the national requirement. However, as viewed from the regional or provincial level, the supply is not enough to meet the demands. Due to uneven distribution of rainfall with time and space, some areas are not endowed with enough water supply. Occurrence of extreme weather events such as droughts and floods associated with the El Niño and La Niña phenomena, and the passage of strong tropical cyclones have magnified the situation, thus affecting the country's water resources. Domestic sewage, industrial wastes, uncontrolled groundwater extraction and watershed degradation are some of the threats being encountered by the country's water resources. Trends also show that a significant increase in future demand is to be expected based on the high population growth rate, particularly in highly urbanized areas.

Recognizing the potential impacts of climate change/variability on water resources, several studies have been conducted to investigate long-term rainfall and temperature trends in the Philippines (Jose, 1989; Jose et. al., 1992). Results of these studies reveal a general temperature increase in most areas in the country. Rainfall analyses show large variability in geographical distribution patterns. Inflows in some multipurpose reservoirs such as Angat, Pantabangan, Magat and Ambuklao were examined and they exhibit a decreasing trend.

PHOTO BY BID BALATAN

Potential Impacts of Climate Change on Water Demand

Future changes in the climate system will not only affect water supply but will likewise have a significant impact on the usage of water. The water resource analyses do not estimate the impact of climate change on basic socio-economic activities such as population, energy-related demand, agricultural demand and industrial production.

Industrial water uses. In most industries, temperature and precipitation have little direct impact on water use. However, reduced river flow may increase the pressure on waste treatment processes, leading to an increase in water recycling and a decline in industrial water use. For the most part, though, climate change should have little or no effect on industrial water use.

Energy-related water use. Energy-related water use is usually in hydroelectric form. Reduced water flow and warmer temperatures will affect reservoir storage and its potential for energy generation. These two impacts will require more stream flow to maintain the same energy production.

Agricultural use. Irrigation and livestock raising could be greatly affected by warmer temperatures.

Domestic use. On a per-household basis, it was observed that water use is inversely correlated with rainfall, and is positively correlated with the average temperature, that is, water use seems to increase with decreasing rainfall and with increasing temperature. Little work has been completed on the impact of long-term climate change effects on domestic water use. Most analyses to date have drawn information from water users' responses to short-term drought or warm periods. Responses could be much different when users are faced with permanent acceptance of water restrictions and possible lifestyle changes.

Adaptation Strategies

Although there are many potential water resource adaptations available to respond to climate change impacts on water supply and demand, it is important to identify adaptation measures that would be most potentially effective, taking into consideration the financial capability of the country to implement such measures, and the social and cultural behavior or traditions that may inhibit adoption of some measures. Screening of possible adaptation measures were based on the following criteria:

- Does the adaptation measure address high priority adaptation which responds to irreversible or catastrophic consequences of climate change, long-term decisions and unfavorable trends?
- Is the adaptation measure likely to be effective?
- Will the measure be inexpensive to implement?
- Is the measure feasible? Are there significant barriers to implementation such as institutional/legal, social and cultural, market and technological impediments?

One of the major impacts of climate change are changes in the temporal and spatial distribution of precipitation and temperature, thus affecting runoff and hydrological resources. A change in the distribution of runoff with respect to time and space could greatly affect the effectiveness of an existing system. Adaptation for the water resource sector could be divided into two major classes:

Supply Adaptation

- construction of new infrastructure
- modification of existing physical infrastructure
- alternative management of the existing water supply systems

Demand Adaptation

- conservation and improved efficiency
- technological change

Vulnerability analyses conducted at Angat and Lake Lanao showed that these reservoirs would be highly susceptible to climate change. Runoff for both pilot areas could be dramatically altered with changes in rainfall. General circulation models show an increase in temperature for all water resource regions in the country and large variations in rainfall. It would therefore be reasonable to identify possible adaptation measures, for both short term and long term.

Adaptation Measures	High Priority	Effectiveness	Low Cost	Low Barriers
Supply Adaptation				
Alternative management of existing water supply system	Y	Y	N	N
Plan and coordinate use of water basin/groundwater source	Y	Y	Y	Y
Improve monitoring and forecasting systems for flood and drought and water quality	Y	Y	Y	Y
Demand Adaptation				
Treated and untreated water supply/pricing	Y	Y	N	Y
Water treatment and recycling for major water users	Y	Y	N	Y
Introduce low water use crops and farming practices	Y	Y	Y	Y

After a series of workshops, fora and round table discussions among concerned government agencies, private institutions, academe, non-governmental organizations, media and other stakeholders, a number of relevant issues and concerns related to water resources were identified. Possible adaptation measures were also noted and evaluated based on some of the criteria explained above.

Supply Adaptation

a. Comprehensive watershed management

One major concern of the water resource sector is the considerable decline of watersheds. Excessive logging and shifting cultivation in the watersheds trigger widespread degradation and consequent erosion, and siltation of rivers, lakes and reservoirs [Santos, 1997]. Angat and Lake Lanao watershed areas face this kind of problem in the future.

Watershed management programs of the government aimed at rehabilitating watershed areas are key steps in preventing further degradation. Both government and private entities should also undertake strict implementation of existing forestry rules and regulations.

b. Water Allocation System and Procedures

Water allocation is a powerful tool for managing the demand for water. In the Angat reservoir, irrigation and hydropower have the priority of allocation over domestic water supply. However, in times of drought or emergency, domestic water supply gets priority over all others within the limits of water rights. Conflicts arise when water distributors withdraw water from the reservoir over and above existing water rights, in the process expropriating a portion for irrigation. Several studies are now being conducted that would provide recommendations on water reallocation and compensation schemes which would meet the demand of the sectors drawing from the reservoir, particularly in the event of droughts/floods in the future.

PHOTO BY SID SALATAN

a. Enhancement of Irrigation Efficiency

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

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

Majority of farms in the Philippines is planted to rice, particularly in the northern part of Luzon. Therefore, they have high demand for water. The need to look for alternative rice crops that use less water would then be imperative. With the necessary support and assistance from the Department of Agriculture, introduction of such crops can be started.

Use of drip irrigation, mulching, improved irrigation practices and the use of windbreakers to reduce wind speed and evapotranspiration are some farming practices that could also be adopted [Baradas, 1996].

c. Recycling (Reuse) of Water

Due to recurrent water shortages, the policy of the government is to encourage reuse of effluents in agriculture and industry. Industries are encouraged to save water and adopt measures to reuse their effluents for other secondary purposes. In the case of irrigation systems, drainage water reuse is another possibility for extending the water supply.

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

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

One adaptation measure that would be less costly and would encounter fewer constraints relative to other measures is the improvement of drought/flood monitoring and forecasting capability. It has been shown that droughts and floods have tremendous effects on water resources, and climate change is likely to affect the frequency of droughts and floods. Improvement of the present system of forecasting future occurrences of such events is essential for better water management. It is worthwhile to mention that monitoring systems will help in coping with these changes and would still be beneficial even without climate change.

e. *Use of water pricing policies and structures*

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

f. *Awareness promotion of climatic variability and change*

The public or policymakers frequently do not understand climatic variability and the potential risks of climate change. Because climatic adaptation will affect the individual, organizational and policy levels, broad, multi-sectoral awareness of the impact of climatic variability is important. Increasing sensitivity to climatic issues will facilitate adoption of measures to prepare for climatic variability and change.

Conclusion

Assessment of the water sector's vulnerability to climate change is relatively new in the country. At present, there are only few studies that have been undertaken in this regard and are confined to selected areas. Initial vulnerability analyses show that these areas would be highly vulnerable to future changes in the climate system. Impacts of past extreme weather events on the socio-economic condition of the country can serve as bases in coming up with adaptation plans. Likewise, population increase and environmental degradation have to be addressed as these are two important factors that affect the water sector.

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Philippine Agriculture in a Changing Climate

*Rhoda S. Lantin**

In recent years, discussions on climate change have largely focused on the effects of enhanced atmospheric concentrations of trace gases caused by human activities. The effects of GHGs on the global climate have been thoroughly appraised by the IPCC [1990, 1992, 1996], governments have ratified the UNFCCC, and Agenda 21 was drafted to address the environmental and development issues in climate change and agriculture.

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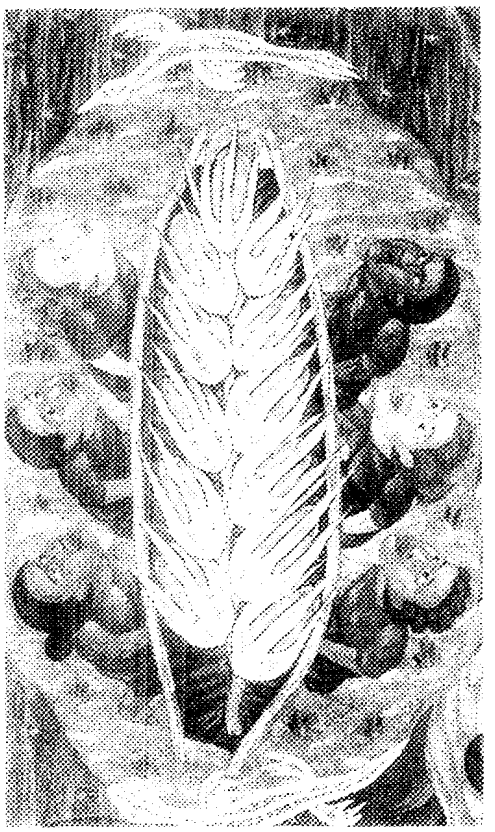
The increase in carbon dioxide (CO_2) concentration is central to the greenhouse effect, accounting for approximately 50 percent of the projected increase in mean surface temperature [IPCC 1990]. The key process for changing the atmospheric environment is the combustion of fossil fuels, but agricultural activities are also associated with the release of GHGs. Net releases of CO_2 by the agriculture sector are mainly related to land use change. Other GHGs such as methane (CH_4) and nitrous oxide (N_2O) are emitted through a variety of processes: enteric fermentation, manure management, flooded rice fields, burning of grassland and agricultural waste, and agricultural soils. The pressure to increase agricultural production for food sufficiency and industrialization is projected to increase GHG emissions.



Proof of ongoing global warming is hindered by a relatively short span of observations, but manifestations of an anthropogenic impact on the environment strongly urge against complacency. This essay presents an overview of climate change and agriculture: GHG emissions, mitigation options as well as an assessment of the vulnerability and adaptability of the agriculture sector.

Greenhouse Gas Emissions from Agriculture

Two human activities contribute tremendously to global GHG budgets – the burning of fossil fuels and land use. An inventory of emissions indicates the agriculture sector is a significant source of GHGs: CH_4 from rice and livestock production, and N_2O from fertilizer use in various cropping systems. Climate models commonly predict increases in global temperature which occur with increasing levels of GHGs. However, a more critical issue is the impact of climate change on agriculture.

The pressure to increase agricultural production for food sufficiency and industrialization is projected to increase GHG emissions.

Methane and nitrous oxide. The national GHG inventory showed that the agriculture sector represented 33 percent of the net total CO_2 emissions of the Philippines [PAGAS 1998; Manila Observatory, 1998]. Of this, rice cultivation was the biggest source of CH_4. Methane is generated in the anaerobic layers of rice soils by the decomposition of organic materials (Fig. 1). The CH_4 produced in the flooded rice soil can be transferred to the atmosphere by different pathways (Fig. 1).

Nitrous oxide, on the other hand, is emitted from virtually all cropping systems with high nitrogen inputs including intensive rice cultivation and livestock management [Rennenberg et al., 1992]. However, there is a need to improve the quantification of the alleged 75-percent contribution of agriculture to the global N_2O budget. Inventory of this N_2O has the largest uncertainty [van Ham, 2000].

The projected increase in CO_2 concentrations will significantly affect the physiological basis of plant production.

Impacts of Climate Change on Agriculture

The impacts of climate change on agriculture remain tentative not only because of uncertainties in climate projections, but also because of the lack of understanding of the critical processes in agriculture.

Rice production has so far kept up with population growth, but an increasing population will need an increased rice supply. Land resources are shrinking and present trends suggest that cultivated land will even shrink at a faster rate.

Elevated CO_2 and temperature. The CO_2 level in the atmosphere has increased from the pre-industrial concentration of 270 ppm to a current concentration of 335-360 ppm [IPCC, 1990]. Global studies suggest that agricultural production is sustainable under doubled CO_2 concentrations as expressed by GNP. Despite this, Southeast Asia appears to be most vulnerable to doubled CO_2 concentrations.

The projected increase in CO_2 concentrations will significantly affect the physiological basis of plant production. Most plants need sub-optimal levels of CO_2 to achieve maximum photosynthetic capacity. But the beneficial effect of higher CO_2 levels on plant growth may be outweighed by concomitant changes in other environmental factors [Rosenzweig and Parry, 1994]. Therefore, emphasis has to be given on the synergistic effects of CO_2 and temperature on crop growth, weed competition and water demand.

The impacts of elevated CO_2 concentrations on agricultural production will depend on water balance and nutrient supply. Crop models coupled to global climate change scenarios yield divergent results, depending on the model and the scenario used. Simple crop models usually

indicate higher rice production. For example, Leemans and Solomon [1993] predicted an 11-percent increase, but the more sophisticated IBSNAT model showed a two- to four-percent reduction in global rice production [Rosenzweig and Parry, 1994]. These losses are mainly attributed to low latitudes. Crop yields in mid and high latitudes, on the other hand, are predicted to increase. Matthews et al. [1995] coupled two process-based crop simulation models, the ORYZA and SIMRIW, to different climate change scenarios and obtained an overall impact on rice production in Asia ranging from +6.5 percent to -12.6 percent. The average of these computations suggests that rice production in Asia may decline by 3.8 percent.

Experiments on crop performance at elevated CO_2 concentrations show a positive but variable increase in productivity for annual crops [IPCC, 1996]. In rice production, a doubling of the CO_2 level is predicted to increase productivity and yield by 30 percent. The ultimate linkage between atmospheric CO_2 and temperature results in a number of uncertainties about the overall benefit from CO_2 "fertilization" [Dowling et al., 1998].

Temperature affects plant development independently, such as shorter vegetation periods and spikelet sterility. Shorter cropping periods may allow a shift in planting dates and the introduction of long-maturing varieties at some locations. High temperatures during flowering may result in abundant spikelet sterility, which was shown to be a decisive mechanism in determining rice yields in a future climate [Matthews et al., 1995]. The effect of an increase in temperature is complex and varies with the crop. Temperature change can lead to loss of pollen viability in maize and reduced formation of tubers in potatoes, resulting in severe yield losses.

Temperature change can lead to loss of pollen viability in maize and reduced formation of tubers in potatoes, resulting in severe yield losses.

Climate Change Abatement

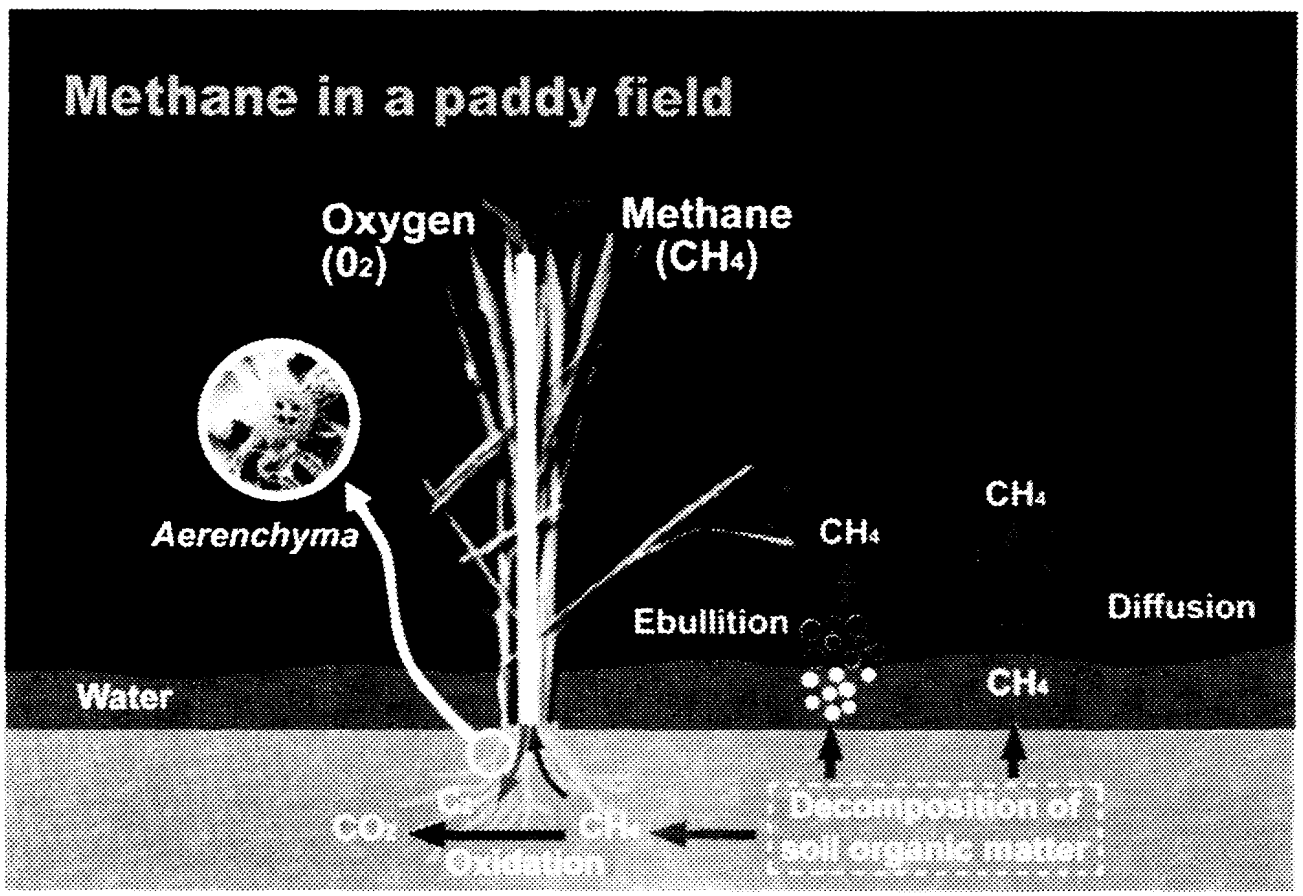
In most rice-growing areas in South, Southeast and East Asia, the overall GHG emissions from rice fields are too high to be ignored as an avenue for reduction [Wassmann et al., 2000]. The interaction between climate change and rice production has encouraged the development of strategies to reduce CH_4 emissions [Peng et al., 1995; Dowling et al., 1998]. A wide range of policy and technology options that could be considered to reduce GHG emissions have been identified [Wassmann et al., 2000]. The most promising

approach is to target irrigated rice systems that have high CH_4 emission potential. The shift from organic manure to mineral fertilizers substantially reduces CH_4 emission. Likewise, intermittent drying of soils reduces the flux. New high-yielding cultivars also reduce CH_4 emission as compared with traditional varieties. These findings help identify promising strategies to mitigate CH_4 emission without yield losses.

Vulnerability of Philippine Agriculture

The Philippines is an archipelago with more than 7000 islands. Agriculture is the driving force of Philippine economic development and it contributes about one-third of the total GDP, and employs about 46 percent of the total

Figure 1. Methane production in a rice field.



labor force. Agricultural productivity may be hindered by an increasing population, the spread of urbanization, lack of adequate water resources and environmental pollution exacerbated by stresses of climate change.

Climate change is linked to GHG emissions. Its potential effects are complex and diverse. The Philippines is physiographically susceptible to the vagaries of climate variability. Yearly agricultural production is exposed to environmental hazards including floods, droughts, typhoons, storm surges, the ENSO (which has changed in frequency and severity), increase in temperature, change in precipitation intensity, and sea level rise in coastal areas [Boling et al., 1991; Perez et al., 1996]. The challenge is to forge policies and development strategies to prepare for future changes in climate and the environment.

The quality and quantity of agricultural yields is susceptible to climate-induced effects. Simulation studies [Escaño and Buendia, 1994; Matthews et al., 1995; Peng et al., 1995] indicate that corn would be more negatively affected than rice. The vulnerability of rice is indicated by numerous general directions of changes in yield (Table 1). At double CO_2 climate, annual rice production increases for most regions under GFDL scenario but decreases under GISS scenario. Under the UKMO scenario, the north regions would experience increases and the south, decreases [Matthews et al., 1995]. The effects on other crops in the Philippines have not been reported.

Modeling studies provide a general indication of the effects of climate change but are not site-specific. No single measure has been developed to quantify vulnerability.

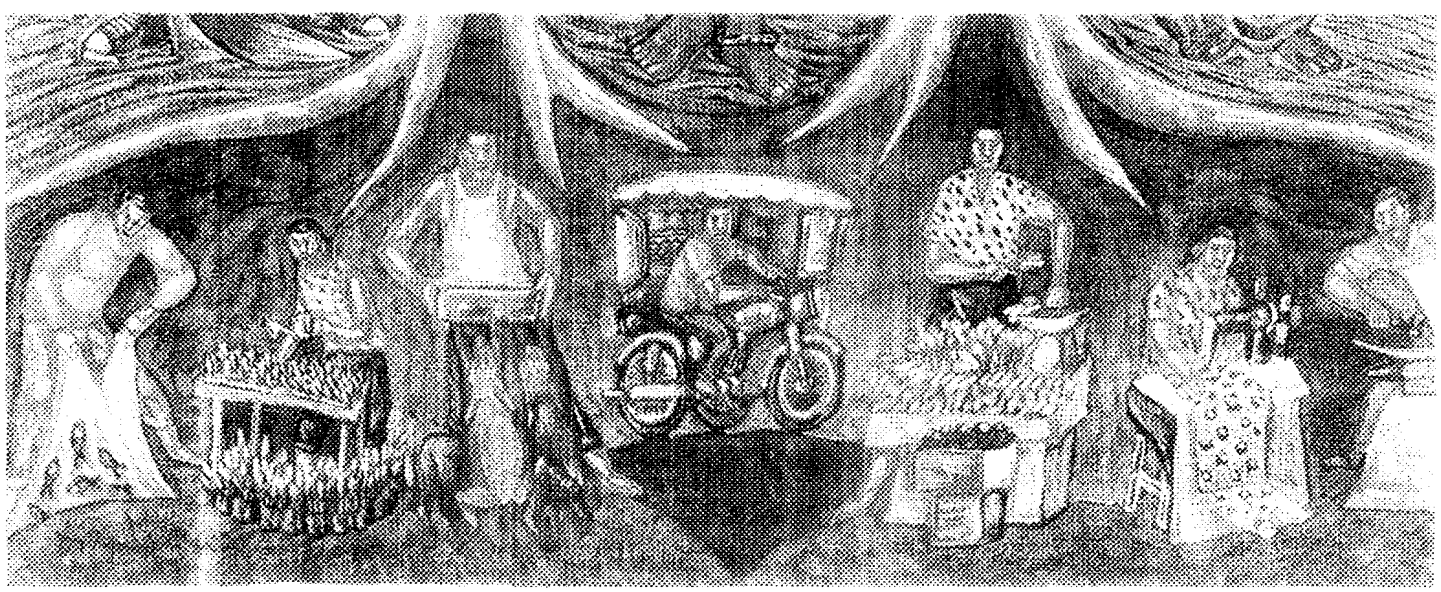
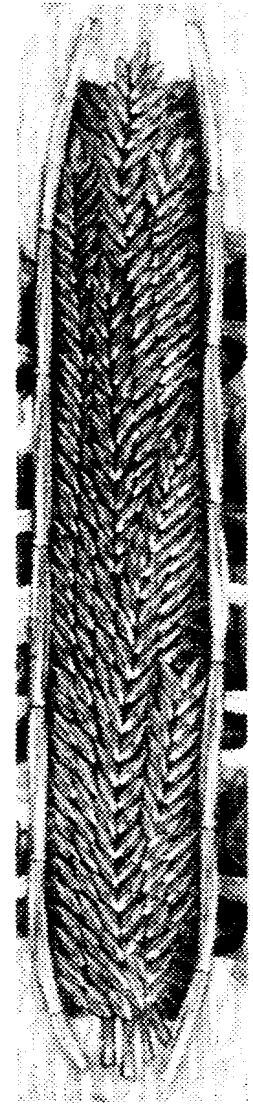


Table 1. *Estimated changes in rice production from each of the administrative regions in the Philippines, and from the whole country*

Region	Current	GFDL % Change	GFDL t	GISS % Change	GISS t	UKMO % Change	UKMO t
NCR	152,559	2.6	156,476	-111.1	135,669	16.9	178,319
I	898,584	-3.8	864,238	-17	745,538	2.2	918,241
II	1,033,615	-3.8	994,108	-17	857,571	2.2	1,056,226
III	1,748,491	2.6	1,793,379	-11.1	1,554,911	16.9	2,043,730
IV	1,118,085	10.2	1,232,604	-6.2	1,048,730	-0.4	1,113,437
V	744,223	5.4	784,357	-32	506,260	-20.5	591,716
VI	1,183,887	11.9	1,324,583	-11.1	1,053,064	-7.4	1,096,816
VII	207,700	11.9	232,384	-11.1	184,749	-7.4	192,424
VIII	382,954	11.9	428,465	-11.1	340,637	-7.4	354,789
IX	399,038	18.5	473,040	5.7	421,617	11.1	443,166
X	531,777	10.5	587,861	-22.1	414,386	-39.5	321,805
XI	688,302	13.3	779,593	-16.9	571,880	-1.4	678,580
XII	584,047	13.3	661,510	-16.9	485,259	-1.4	575,798
Totals	9,673,262		10,312,598		8,320,271		9,564,847
% Change from current		6.6		-14		-1.1	

GFDL: General Fluid Dynamics Laboratory; GISS: Goddard Institute of Space Studies; UKMO: United Kingdom Meteorological Office (Matthews et al., 1995)



Preliminary assessment reveals a mosaic of consequences of climate change as identified by stakeholders (local action plan (unpublished report), 1999). These include low/unsustainable yield and productivity of crops and livestock; change in livestock pest distribution that threaten livestock quality; degradation of soils through leaching/erosion; nutrient imbalance from overuse of agricultural chemicals; alteration in land use, including infringement of agriculture to the uplands; change in severity/distribution of pests and diseases; decline in the quality and quantity of water resources that include competition of water resources with industry, urban, commercial and domestic use; sea level rise that result in the salinization, water logging and deterioration of fresh water supplies; and damage/loss of

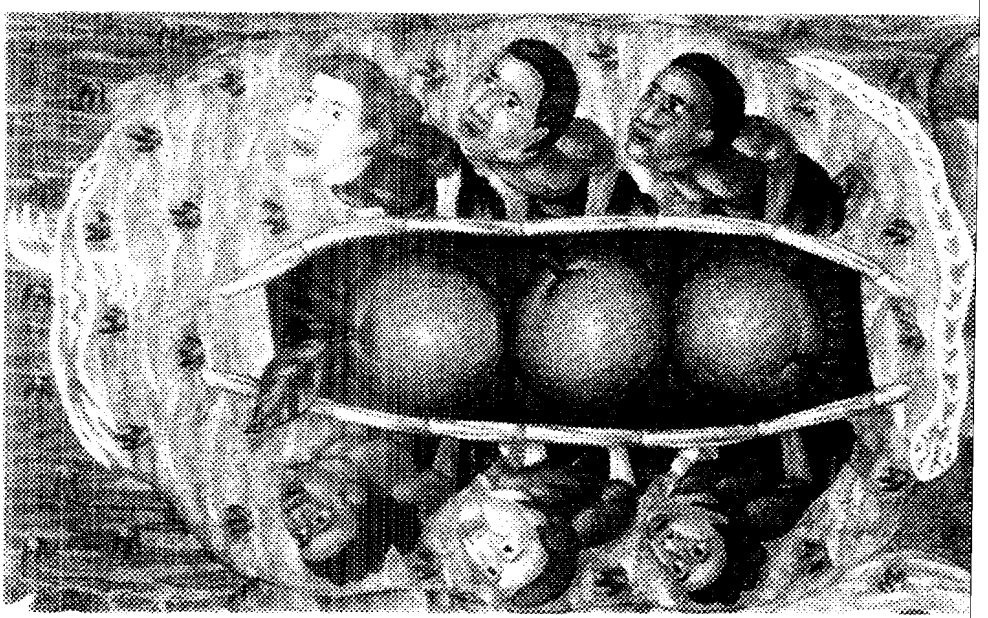
resource base resulting from extreme climate events. These are qualitative impacts indicating the need for more detailed and integrative studies in the future.

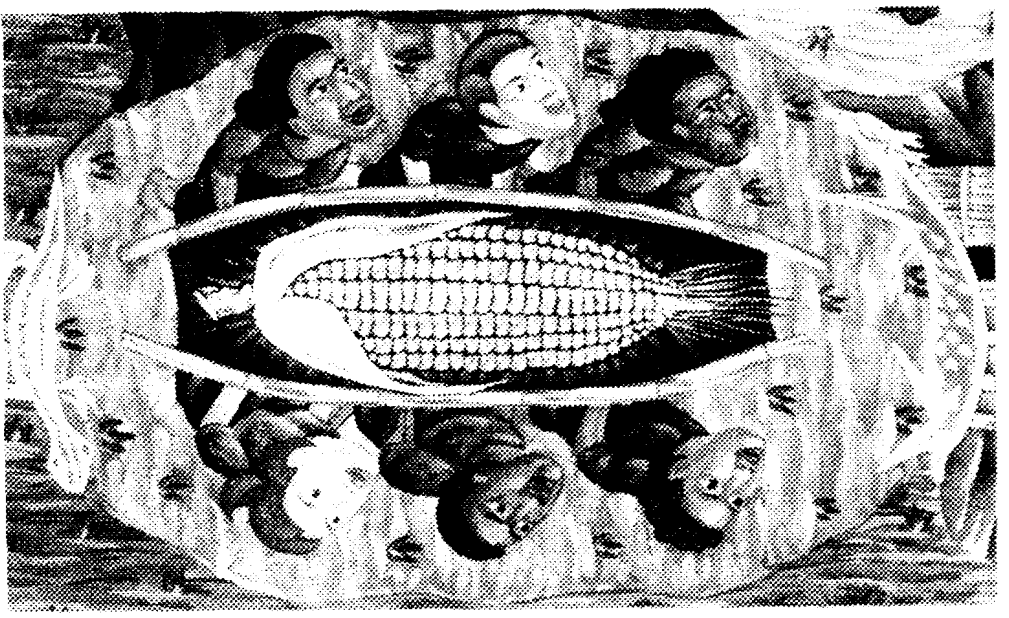
Controlling GHG emissions through mitigation does not forestall climate change. In addition to mitigation, adaptation is key to how a country could respond to the potential impacts of climate change. The Philippine local action planning recognizes not only the high risks that could be experienced by the agriculture sector but also its interaction with the other sectors. Assessment of susceptibility allows the formulation of intervention actions that minimize loss or prevent any damage. Agriculture, while resilient to change, is relatively more vulnerable because it affects a large percentage of the population, characterized by limited access to technology, inadequate infrastructure and government support, and lack of information on both local and global consequences of climate change.

Adaptation measures call for farm-level soil and crop management, soil conservation, crop diversification, use of improved varieties, improvement of water resources, protection of the watershed, acclimatization to the effects of sea level rise, and information/education of target groups. Development policies and objectives, as articulated by local government codes, if implemented, will benefit agriculture even if predicted adverse effects of climate change do not occur. Some adaptation measures may appear as the consequence of policy and technology.

Policy Responses to Climate Change

The Philippines is a signatory to the UNFCCC. It participates in the global initiative with the establishment of the IACCC by virtue of Presidential Administrative order No. 220 in 1991. The IACCC coordinates climate change-related activities, proposes policies and prepares the Philippine position to the UNFCCC negotiations.





There are a number of other national policies that aim to ease the burden on the environment, but they are generally not focused on climate change impacts alone. The Philippine Agenda 21, endorsed in 1996, and the Medium-Term Philippine Development Plan 1999-2004 articulate strategies for sustainable development with equity. The Philippine Agriculture and Fisheries Modernization Act of 1997 (RA 8435) aims to conserve prime agricultural lands, ensure watershed areas and preserve aquifers. The Balanced Fertilization Strategy (Presidential Proclamation 1071) enjoins the management of crop residues with a balanced use of organic and inorganic fertilizers.

The policies and programs both at the national and local levels have to be strengthened if any adaptation to and mitigation of climate change impacts are to occur. The benefits of these plans accrue even if climate change predictions do not occur.

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Responding to the Threats of CC to Philippine Agriculture

*Lourdes V. Tibig**

The issue of increasing concentrations of greenhouse gases (GHGs) in the atmosphere has become very important because of projected impacts of climate change. The agriculture sector is projected to be the most vulnerable to climate change because it is not just warmer temperatures and increased carbon dioxide concentration in the atmosphere but also changes in water resources that could spell the increase or decrease in agricultural production.

* Philippine Atmospheric, Geophysical and Astronomical Services Administration

Given the uncertainties in the magnitude and direction of projected impacts of climate change, the vulnerability of certain sectors, like agriculture, is also uncertain [Ibid. 1996]. Current scientific assessments are likely to confirm that the temperature rise in the 20th century is the biggest during the past 1,000 years for areas above the equator.

Several international initiatives are currently being undertaken to address the issue of climate change. At the national level, country parties that are signatories to the UNFCCC are trying to come up with "win-win" solutions.

The Philippine Agriculture Sector

Agriculture is the economic lifeline of the Philippines. Total agricultural land amounts to about 10 million hectares, 45 percent of which is located in lowlands and 33 percent in the uplands. Rice and corn remain our most important crops. Coconut, sugarcane and some cash crops like bananas constitute important export commodities.

Rice, being the staple food of most Filipinos, plays a dominant role in agriculture and the economy as a whole. Approximately one-third of our total agricultural land is devoted to rice crops, and national figures indicate that the national yield average for rain-fed areas is 1.9 tons per hectare, and for irrigated areas, 3.4 tons per hectare – a combined national yield of 2.8 tons per hectare. Rice production growth rate has been pegged at 2.53 percent annually. However, with population growth rate estimated to be 2.4 percent per annum, the Department of Agriculture concedes that the Philippines will most likely continue to depend on rice imports for about five percent of its national requirements.

A low increase in the country's economic growth rate has been seen and this positive growth rate does not reflect the deterioration of our natural resources. Rapid urbanization has resulted in the almost indiscriminate conversion of agricultural land to residential/industrial/commercial use. Our entry into international economic agreements such as the GATT-WTO, the APEC, the AFTA, etc., can spell multi-faceted challenges to our agricultural producers.

One positive development, however, is the fact that the DA has set into motion a number of initiatives that could lead to increased agricultural production not just in rice and

corn but also in other crops. These initiatives have focused government support on priority areas to produce, process and market specific products, an action which will augur well for fast agricultural growth provided sufficient government support is given.

Current Threats to the Agricultural Sector

Weather and climate are key factors in agricultural productivity. For example, the very severe 1982-1983 El Niño episode caused extensive droughts in all parts of the country. This resulted in reduced rice production, and for the first time in years, after we attained rice sufficiency due to improved rice production, we resorted to rice importation from neighboring countries.

Current threats to agriculture include impacts of climate variability as a result of:

- seasonal occurrence of droughts mainly due to El Niño events,
- high frequency and variability of occurrence of tropical cyclones and attendant extreme rainfall and wind, and
- natural variability of rainfall and extreme rainfall events.

El Niño or warm episode events during the last few decades have become increasingly frequent as can be seen in Table 1.

The Philippines is situated in a region most favorable for the formation of tropical cyclones. An average of 20 tropical cyclones affects the country every year. Figure 1 depicts the frequency of tropical cyclone occurrences in each of the designated geographical zones of the country. The northernmost part of the country has the most frequent occurrence while the southern tip has almost none. These tropical cyclones bring rains that could be beneficial to agriculture. However, excessive rains result in floods, severely affecting agricultural production. For instance, in 1993, six destructive typhoons affected a total area of 1.06 million hectares, resulting in Php 3.6 trillion in production loss.

Table 1. El Niño and La Niña years

Warm Episode (El Niño) Years	
1902	1953
1905	1957
1911	1965
1914	1969
1918	1972
1923	1976
1925	1982
1930	1986
1932	1991
1939	1994
1941	1997
1951	

Cold Episode (La Niña) Years	
1904	1955
1908	1964
1910	1970
1916	1973
1924	1975
1928	1988
1938	1995
1950	1998
	1999

Source: NOAA

Results of local studies done to determine the variability of annual rainfall, recession of the rainy season [Boling et al., 1992] and temperature trends [Manton et al., in press] in the country show that:

- there are significant differences in annual rainfall totals and in the onset
- and recession of the rainy season, and

- there is an increasing trend in temperatures during both the day and during night.

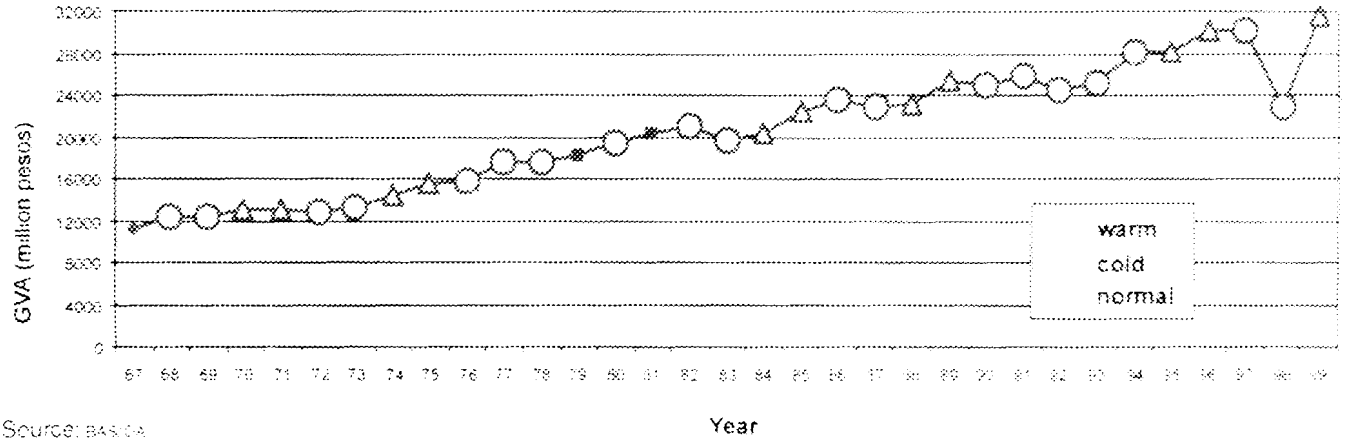
These could significantly influence agricultural production, planning and overall productivity of farming systems in the affected areas.

A recent joint study done by the PAGASA/LOST and the BAS/DA graphed the yearly agricultural production in terms of Gross Value Added (GVA) estimated at constant 1985 prices for each crop to determine impacts of extreme climate events such as El Niño and La Niña. The GVA is defined as the difference between gross output (gross value of goods and services produced during the accounting period) and the intermediate outputs (value of goods and services used in the production process during the same accounting period).

Figure 1. *Frequency of tropical cyclones over each of the geographical zones in the Philippines*

Source: PAGASA/LOST

Figure 2. *Gross Value Added in Palay at Constant 1985 Prices*



Source: BAS/DA

Results of the analysis indicate the following:

- Rice is highly sensitive to water stress, hence, El Niño years caused a slump in yield (Figure 2).

  Corn is impacted negatively during La Niña events (Figure 3).

LEGEND:

- 4 cyclones in two years
- 2 cyclones per year
- 3 cyclones in 3 years
- 3 cyclones in 2 years
- 1 cyclone per year
- 1 cyclone in 12 years

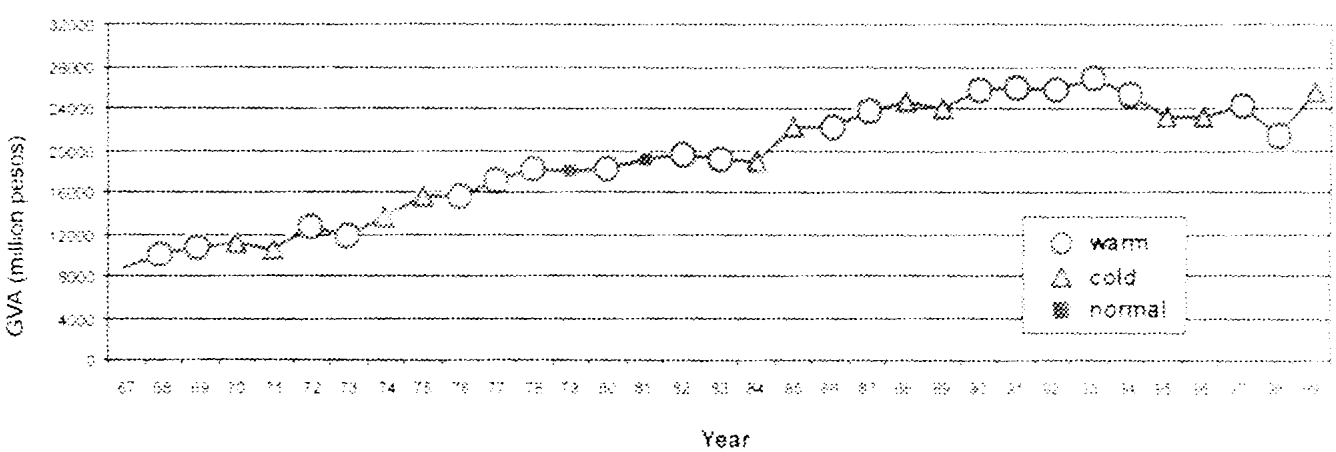
Projected Yield under Climate Change

Climate is expected to continue to change in the future. A warmer world spells a number of impacts both on man and the environment. A more vigorous hydrological cycle will affect the severity of droughts and floods in various parts of the country. The increase in rainfall intensities could result in more extreme rainfall events. On the other hand, changes in rainfall distribution could also increase the probability, intensity and duration of drought in currently drought-prone areas. When this happens, drainage and irrigation systems could be damaged resulting in reduced yields.

Other serious concerns are the possibility of inundation resulting from an increase in sea level. Salt-water intrusion could affect groundwater, and flood-prone areas could increase due to increased rainfall intensities.

However, there are expected positive impacts that our farmers could exploit. One of which is that higher levels of carbon dioxide (CO_2) concentrations may enhance the growth rates of some staple crops, especially rice. This is called the CO_2 fertilization effect.

Figure 3. Gross Value Added in Corn at Constant 1985 Prices



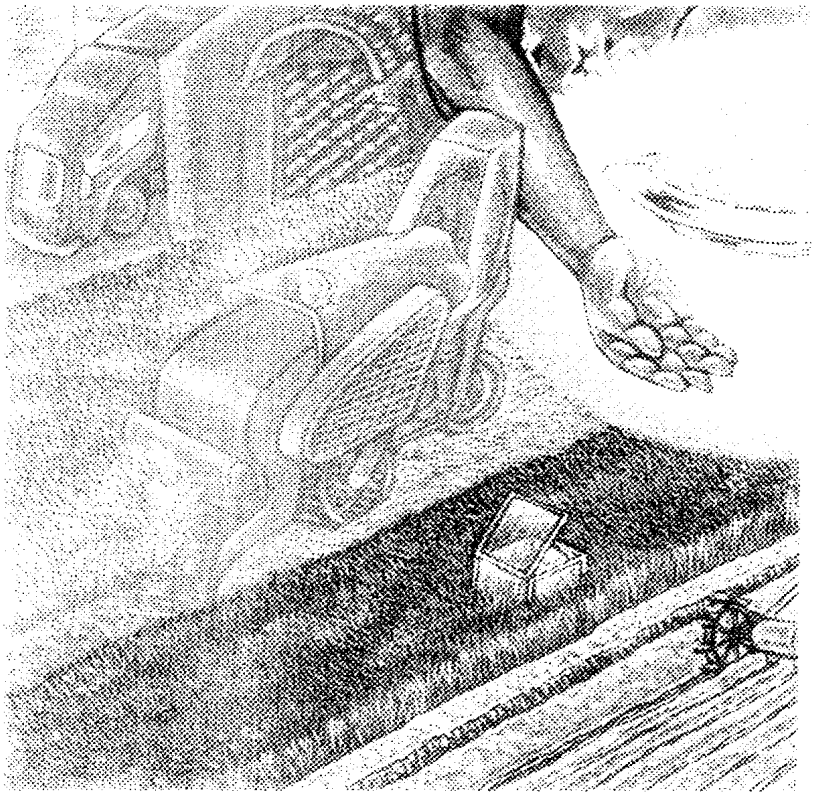
Vulnerability assessments done on rice and corn production using global circulation models gave varied results. Simulations showed general increases in rice yield but decreases in corn yield [Centeno et al., 1995; Buan et al., 1996]. Estimated changes in rice production from each of the administrative regions in the Philippines are shown in Table 1 found in R. Lantin's essay [cite page number later].

Response Strategies

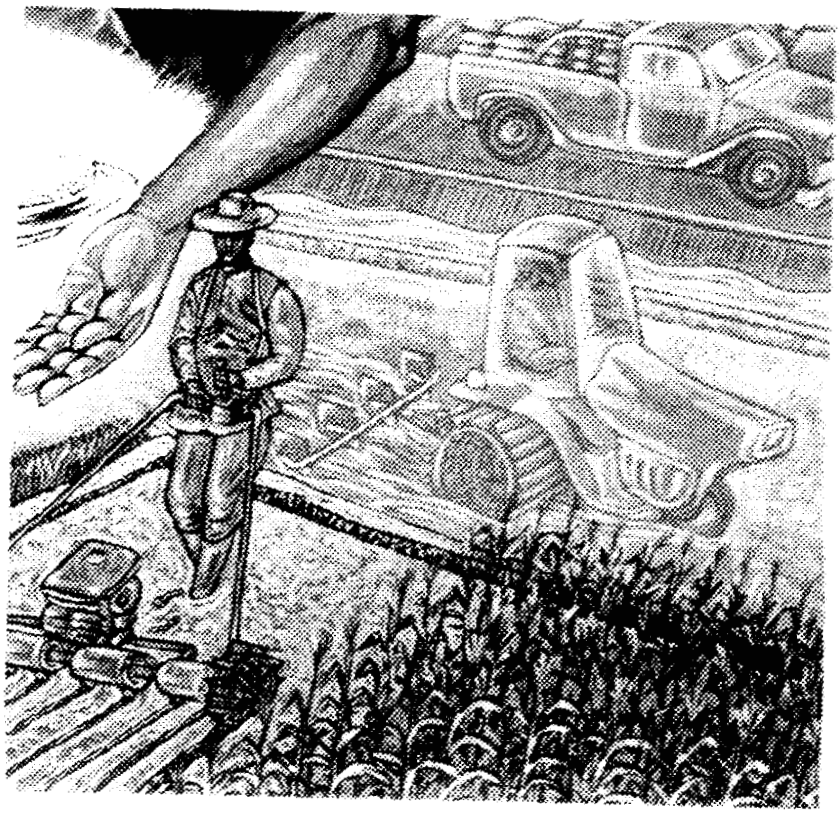
The close link between agriculture and weather/climate, and the sensitive nature of food trade and security are compelling reasons for policymakers to closely examine what response strategies could be put in place to address the already known adverse impacts of a highly variable climate and the potential impacts of a warmer world.

As a response, the government, through the DAFF, developed a sectoral plan for agriculture. Relevant past and present studies on the vulnerability of crop production (rice and corn only) to climate variability and climate change were reviewed, and resulted in the identification, screening and assessment of adaptation and some doable mitigation strategies.

The chosen adaptation options is a mix of economic, technological, institutional and research measures. They include measures that are already being implemented like the Balanced Fertilization Strategy and cropping pattern adjustments according to onset of rainy season and observed frequency of tropical cyclones. Economic measures believed necessary are the liberalization of agricultural trade barriers and changes in existing subsidies. Technological measures are mainly changes in agricultural management practices, such



as natural rainfall management (water-impounding dams and evaporation control) and/or improved water management, increasing effectiveness/flexibility of existing irrigation facilities, improved farm management (organic farming, diversified farming, and timely provision of information like farm weather advisories), introduction of new least-cost technologies such as hydroponics, and improvement of post-harvest facilities. Institutional measures are institutionalizing agricultural drought management, legislation of measures for land use conversion and strengthening of extension services. Lastly, research measures are to address the improvement of policies on production, processing storage, transport and marketing of agricultural products.



Available mitigation options for rice production were assessed by a team of experts using a decision matrix and the ARAKI model. Four technologies are recommended. These are composting of rice straw, use of sulfate fertilizers, water management and use of short-season cultivars (Magat variety). The water management and the short-season cultivar options give a 30- and 50-percent reduction in methane emission, respectively, with the least incremental costs.

Options for mitigating emissions in animal production recommended by the Bureau of Animal Industry team are the use of urea-molasses feed supplement and biogas digesters which are very cheap and can give positive effects on the environment such as cleaner air, decreased cutting of wood for fuel and use of effluent as fertilizer.

A number of policy, data and research gaps have also been identified. Foremost among policy gaps are the absence of a national land use policy, inadequate support for farmers and low adoption of technologies. Data gaps are vulnerability and adaptation assessments for other crops, a more comprehensive assessment of vulnerability of each region to drought, assessment of changes in geographical and seasonal distribution of thermal (temperature) and water resources important to crop and livestock production, and assessment of reduction in greenhouse gas emissions from the implementation of the Balanced Fertilization Strategy and from the different mixes of adaptation/mitigation options. Research gaps are on management methods and also long-term effects of climate change on soil fertility and effectiveness of fertilizers and chemicals.

Conclusion

Climate variability has already rendered our agricultural production highly vulnerable and projected climate change may cause a further burden on the sector. Projection of our national production under climate change scenarios remains inconclusive since there are inherent limitations in the available climate models. Yet, not planning for whatever is to come may spell enormous undesirable consequences. Planning, therefore, for adapting to/mitigating the projected adverse impacts of climate change through a careful and exhaustive choice of adaptation strategies could ensure food security and possibly, increased economic growth.

In order to arrive at an effective plan for the agriculture sector, the planning process evolved from a review and analysis of all available information on national/regional studies and efforts addressing the sector, including that of research institutions, and current

and possible threats on the agricultural sector. The analyses made were then presented to the representatives of the major stakeholders in focused group discussions, and finally, to a multi-sectoral consultation, during which the participants reviewed, recommended and also made suggestions regarding the gaps. Assessments of the effectiveness and desirability of the adaptation and mitigation options were also done during the technical workshops and the multi-sectoral consultation.

The assessment of adaptation options resulted in a mix of choices designed to offset negative impacts (that is, make agricultural systems more robust with an increased capability to withstand climate change or more resilient with a capability to quickly recover from climate changes) and take advantage of positive impacts. Economic measures include liberalization of agricultural trade barriers. Existing subsidies, if any, should be reviewed and revised according to what is needed. Technological options are natural rainfall management, including increasing effectiveness of irrigation, changes in agricultural management practices like cropping pattern adjustment, development of heat-resistant varieties, promotion of organic and diversified farming, safe and judicious use of fertilizers, balanced fertilization, introduction of new least-cost technologies like hydroponics and improvement of post-harvest facilities. Institutional measures will include institutional arrangement among managers of data, water resources, farmers, policymakers and extension workers, institutionalizing agricultural drought management, passing legislative measures especially on land use conversion and strengthening extension services at the LGU level. Research needs are those on what could improve existing support services and on technological development.

Assessment of mitigation options for rice production using a decision matrix and the ASAM model indicates that the use of sulfate fertilizers has the largest impact on methane emission reduction. Other options being considered are composting of rice straw, water management and use of low-emitting cultivars. As for animal production, two strategies are recommended: one, the use of tubular polyethylene digesters for power generation, and two, the use of urea-molasses block as nutrient supplement.

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CC and Public Health in the Philippines

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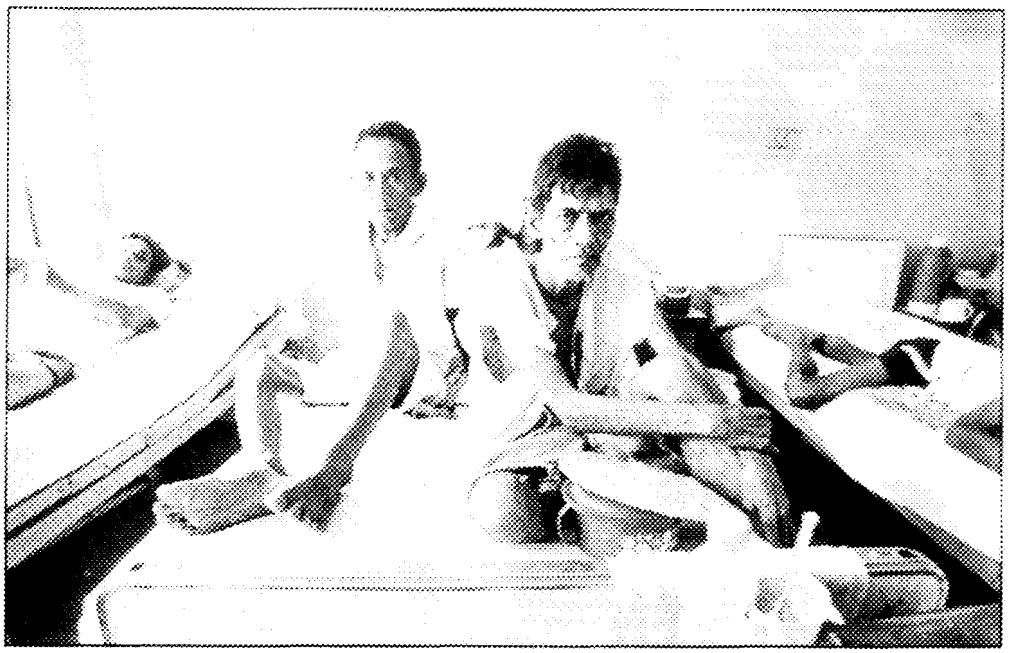

Consideration of climate change effects is relatively new to people in public health in the Philippines. In our country, it is laid on a setting of previously poor health. Poverty and inequity, the emergence of new challenges in the midst of unresolved problems, a very low government budget for health, and poor allocation of the limited resources aggravate the underlying health situation. Compounded by the effects of climate change, a combination of immediate vertical and longer-term horizontal approaches is called for.

* Philippine Rural Reconstruction Movement

Our government and partners are called upon to provide an awareness of the broader range of factors affecting health, including climate change. It becomes necessary to encourage contribution for health impact assessments to enable us to determine risks, analyze adaptation options, and – in a setting of limited resources – provide some basis for policy formation and prioritization.

Context of Association between Health and Climate Change

History has demonstrated human engagement and occasional success with various disease agents – infectious and communicable diseases, diseases of old age, and non-communicable health conditions like heart problems and most cancers. Recently, there have been emerging health issues related to lifestyle changes and environmental hazards like traffic accidents and pollution-related diseases.

From a consideration of the environment, important health issues emerge. These come in the form of new sources of solutions – from biodiversity and the rich pool of medicines from nature – like most probable climate change effects. Where there may be beneficial health outcomes for some populations because of climate change, in most cases the outcomes would be adverse (McMichael, 1996).

Ways climate change can affect human health:

MEDIATING PROCESS	HEALTH OUTCOMES
DIRECT EFFECTS	
Exposure to thermal extremes →	Heat and cold related illness and death
Altered frequency and/or intensity of other weather extremes →	Deaths, injuries and psychological disorders, damage to public health infrastructure
INDIRECT EFFECTS	
Effects on range and activity of vectors and infective parasites →	Changes in geographic ranges and incidence of vector-borne diseases
Altered local ecology of water-borne and food-borne infective agents →	Changes in incidence of diarrheal and certain other infectious
Altered food productivity due to changes in climate, weather, pests and diseases →	Regional malnutrition and hunger, consequent impairment of growth and development
Sea level rise, with population displacement and damage to infrastructure →	Injuries, increased risks of various infectious diseases, psychological disorders
Air pollution, including pollen and spores →	Asthma, allergic disorders, other acute and chronic respiratory disorders and deaths
Social, economic and demographic disturbance →	Wide range of public health consequences (e.g. civil strife, nutritional impairment)

Direct Health Effects of Climate Change

"One near-certain outcome of climate change is an increase in heat-related morbidity and mortality, particularly in response to episodes of stressful weather" [WHO as quoted by Silberschmidt]. According to the report, these health effects are not just caused by absolute temperatures but are often combined with other factors like humidity and wind velocity.

A healthy person has heat regulatory mechanisms to cope with increases in temperature up to some threshold level [McMichael et al., 1995]. However, the very old and the very young are more vulnerable to thermal stress because of their limited physiological capacity to adapt. Considering socio-economic factors, people living in poverty in many urban populations in developing countries are particularly affected by heat stress. Poor housing, the urban heat island effect[1] and the lack of air conditioning are among the primary causes cited. While there is less evidence for non-fatal episodes, it is assumed that such stressors also increase morbidity.

Floods, storms, droughts, fires, other extreme weather events and sea-level rises will have serious direct health impacts as well. Changes in weather variability may alter the frequency and severity of such events [McMichael et al., 1995]. In such cases, health impacts would be greatest on those people who are most exposed and have the fewest resources to adapt with.

Indirect Health Effects of Climate Change

In the above catastrophic settings, we could also have indirect health effects from contamination of drinking water and susceptibility to infectious diseases. We may also expect some adverse effects on food production that could lead to more hunger, malnutrition and even starvation [IPCC, 1992].

Another important indirect effect of climate change is on the increasing number and range of climate-sensitive vector organisms. This would change the patterns of infectious diseases spread by such carrier

Source: [illegible] Press, [illegible]

organisms [McMichael, 1996]. Among the important examples of such cases in our country are:

- Malaria – 45 percent of the world's population live in areas where malaria is transmitted. With climate change, this area is expected to enlarge to include 60 percent of the world's population and bring an expected 50 to 80 million new cases of malaria each year [McMichael et al., 1996]. Specific to the tropical Asian region, GCM scenarios suggest that climate influences would cause an increase in epidemic potential of 12 to 27 percent for malaria [Watson et al., 1997].

  Dengue Fever – As of now, there are no drugs to kill the virus and still no vaccine against it. Warmer climates have allowed the Dengue mosquito vector to thrive in higher mountain areas and spread into newly affected areas [as quoted by Silbersammist]. GCM scenarios suggest that climate influences would cause an increase in epidemic potential of 31 to 47 percent for Dengue [Watson et al., 1997].

  Filariasis – Other mosquitoes carry filarial nematodes. Higher temperatures allow the carriers to increase their range [Watson et al., 1997].

  Schistosomiasis – The snails that carry this fluke survive longer in warmer temperatures and therefore, they can carry the parasite further.

GCM scenarios specific to the tropical Asian region suggest that climate influences would cause a decrease in epidemic potential of 11 to 17 percent for Schistosomiasis [Watson et al., 1997]. This study shows an increasing trend in the last 30 years [Flavier et al., 1998].

We are also in danger from non-vector borne diseases:

- With climate change, Cholera and diarrhea caused by Salmonella, Shigella, Amoeba, Rotavirus and other agents may also become more frequent. When higher temperatures and higher humidity are superimposed on existing conditions in the tropical Asian region, water-borne and water-related diseases are also likely to become more common [Watson et al., 1997].

- The incidence of viral encephalitis may also be increased with climate change. This disease and the other notifiable diseases were collected showing the change in incidence rates over the period from 1961 to 1993.

Aside from these, non-infectious health problems are also believed to be brought on or aggravated by climate change. Among these are:

- Shellfish poisoning – "The increased duration, persistence and biological diversity of recent coastal algal blooms and the appearance of novel, noxious species during the past two decades may be some of the first detectable signals of climate change" [WHO quoted by Silberschmidt]. In the Philippines, this includes poisoning from mollusk and fish contamination due to pollution [ADB, 1994, citing Sosmeña G.].

Climate change would also worsen air pollution and increase the incidence of cardio-vascular and respiratory problems. With warmer weather, higher concentrations of air-borne pollen and spores may also occur. The higher temperatures, accompanied by increased humidity, would also favor the growth of some harmful molds. Consequently, there would be more cases of asthma and other allergic disorders [WHO quoted by Silberschmidt].

Limitations in Establishing Association between Health and Climate Change

While the previous presentation describes seemingly discrete health impacts, the systemic quality of climate change must be considered [McMichael et al., 1995]. There are often many cross-links and interactions between climate change and other co-existing environmental changes – involving ozone depletion and the increase of photochemical oxidants for example [Ando, 1993]. Furthermore, in some cases, the attempt of people to address the health effects of climate change may result in the exacerbation of other impacts. Like the use of more fertilizer to compensate for declining food production, leading to algal blooms and shellfish poisoning. Another example is the migration from drought-stricken areas, exposing people to new and unfamiliar pathogens [McMichael et al., 1995].

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

In *Climate Change and Human Health*, the same paper cited above, two information requirements are identified: the best estimate of the 'dose-response relationship' between climate change and the health outcome; and an estimate of the current and future exposure profile of the population under consideration.

Local data gathered from six PAGASA Synoptic Stations – in the Provinces of Zambales, Camarines Norte, Albay, Palawan and Misamis Oriental, and the City of Davao – representing each of the four climate types, yielded results on the following diseases:

Disorders of the heart and AIDS (acquired immuno-deficiency syndrome) were excluded because of the absence of data for most of the study and baseline period. TB meningitis, pulmonary tuberculosis and other forms of TB were all grouped under tuberculosis. In the same manner, amoeblasis, food poisoning and enteritis were all classified as diarrhea.

Types	Diseases
Viral infections that are spread by droplets from coughs/colds	1) influenzae (flu) 2) varicella (chicken pox) 3) measles 4) mumps 5) viral encephalitis
General respiratory diseases	6) bronchitis 7) pneumonia
Bacterial infections spread by droplets from coughs/colds	8) tuberculosis 9) diphtheria 10) whooping cough (pertussis) 11) meningococcemia 12) leprosy
Infections that are spread from feces to contaminated food or water	13) diarrhea 14) cholera 15) typhoid 16) hepatitis 17) polio
Diseases coming through the skin	18) tetanus 19) schistosomiasis
Sexually transmitted diseases	20) syphilis 21) gonorrhea
Mosquito-vector borne diseases	22) malaria 23) dengue or h-fever 24) filariasis
Animal-borne diseases	25) rabies 26) anthrax
Other diseases	27) cancers 28) nutritional deficiencies

Coping with the Health Effects of Climate Change in the Philippines

Major health improvements have been evident during the last 30 years. However their pace and scope are now at risk of being overwhelmed by a growing population, rapid urbanization, a constrained economy and the various challenges to service delivery [DOH, 1993; Jamison et al., 1993].

Most of the current proposals for dealing with anticipated climate change focus on mitigating predicted human-induced global warming through the limitation of GHG emissions. In contrast to mitigating and preventive options, adaptation strategies adjust the environment or society's ways of using the environment to reduce the consequences of a changing climate [La Viña, 1997]. La Viña presented two adaptation approaches: 'passive adaptation', where society simply adapts to changes in the climate as they occur, and 'active adaptation', where vulnerability to climate change is minimized.

The American Council on Science and Health states that the optimal approach to dealing with the possibility of adverse climate change-related health effects would be largely adaptational [Shindell S. and Raso J., 1998]. According to these authors, the primary goal would be to ensure that economies, healthcare systems and living conditions address existing and anticipated challenges to human health. Whether human-induced climate change will occur or not, we need to implement policies for coping with infectious diseases, extreme weather conditions and other existing health problems.

The underlying causes of the major public health problems of today and our future world are rooted in inequity, poverty and over-consumption in a market-dominated economy [McMichael, 1996].

We are experiencing a health transition brought on by the changing character of diseases, the effects of environmental degradation and climate change. Beyond these, there are also demographic shifts in the age structure and composition of our population, and other socio-economic changes.

The correlation between health status and the wide range of socio-economic factors is recognized [Smith and Bryant, 1988]. The

experiences in China, Costa Rica, India's Kerala State and Sri Lanka [Warren, 1990] suggest that the attainment of an acceptable level of health in lower income countries is a result of four factors. These are:

- political and social commitment to improve health;
- equitable distribution of public health measures and primary health care services;
- assurance of adequate caloric intake for all – this was observed to be related to improved incomes and fostering agricultural production; and
- the provision of primary and secondary education, especially for girls.

What more has to be done?

At the last few international fora on climate change, the Philippine government representatives expressed the following [Muller, 1998]:

- A commitment to address the levels of GHG to prevent dangerous interference with climates without sacrificing national development. This refers to a greater priority to alleviate poverty and undertake sustainable development, for example.
- Calling for a balance of such commitments between developed and developing countries. This is in recognition of the greater amount of emissions that have come from countries that went into industrialization earlier and the increased vulnerability of developing countries like the Philippines.

To act on climate change from an individual national context. This is dependent on corresponding commitments from the developed nations, their obligation to provide new and additional financial support, and the transfer of technology and resources for mitigating and adapting to the impacts of climate change.

It is up to responsive partners in the government, people form civil society and allies in the academe to [PSRM, 1997]:

- Follow up on the gains made at the global conferences – at various levels.

- Translate these gains into national and local demands to enable communities to collect on commitments made at these global conferences.

The demand directed at our government and governments from the more developed countries come in two forms. The first are 'horizontal' development concerns involving the need for more social spending and the need to address inequity. This is in consideration of the broader approach to the health impact of climate change. Secondly, there are 'vertical' or specific health programs for adapting to the impacts of climate change.

Improving Allocation and Levels of Resources for Health

Our government, and even foreign bilateral or multilateral aid agencies, does not allocate enough resources for health. On a per-person basis in 1993, the government spent only Php 55 (around US$ 1.38) according to the DOH [1993]. Without considering the amount from private spending, this is below the Php 300 (approximately US$7.50) total per capita government expenditure for low-income countries suggested by the World Bank [1993].

The government allocation for health has even been decreasing from 5.85 percent of the budget in 1989 to 2.3 percent in 1993 [DOH, 1993]. In contrast, more than a third of the national budget is allocated for debt servicing and almost three times the allocation for health is spent for domestic security and military expenditures [Tan, 1995].

The experience of some developing countries show that with very limited funding for health services deteriorate. It is almost impossible to have efficiency and effectivity without addressing the low level of overall resources [Abel-Smith, 1993].

The Need to Address Inequity

Although reduced in many parts of the world, inequity is becoming worse in the Philippines [NSO, 1998]. In our country, the 1994 family income of the richest 10 percent of our people was 19 times higher than that of the poorest 10 percent. After three years, that same affluent group increased their share of family income while the family income share of the majority of Filipinos decreased. Now, the average income of families of the richest group in the 10th decile is 24 times higher than those in the first decile. The good picture of the economy reported at the macro level fails to show the fact that the Philippines has one of the most unequal income distributions in the world [Steinberg, 1990].

The correlation between health and inequity is supported by Barker [1997], who refers to the work of Wise and Pursley in 1992, and Murray and Chen in 1993. Barker points out that mortality rates were better when there was less inequity. The authors looked at countries with increasing incomes but constant class differentials like the U.S. and the U.K., and compared them with poorer but more egalitarian societies like the Kerala State in India, China and Sri Lanka. The need to address inequity in health is also expressed in the World Development Report [World Bank, 1993], calling for more investments in health.

The Importance of Immediate Action

While the broad horizontal approaches mentioned above require longer-term efforts, specific vertical campaigns can readily address the impacts of climate change on health.

Among these are: environmental management and sanitation, disaster preparedness, protective technology (housing, providing potable water and vaccination), public education directed at personal behavior, and appropriate professional research and training [McMichael et al., 1995].

Examples of vertical campaigns include sharply focused primary health care approaches like oral rehydration therapy and the ORT program for control of diarrheal diseases. This has been a successful means of addressing cases of acute diarrhea and the danger of dehydration. With projected problems from climate change, these programs are proven tools against infection and some of the dangers of heat exposure. The worldwide Expanded Program of Immunization has been very successful for the problem of polio. The incidence of paralytic polio in the country has decreased with good routine immunization [Tangermann, Costales and Flavier, 1997] even if there were climate change effects over the last decade.

Finally, there are also vertical but broader-based programs like family planning and associated reproductive health activities. While FP-RH has direct health effects, there are also less direct but equally important impacts on the environment and human-induced climate change in particular. We have to attend to two significant causes of global environmental degradation. While we criticize the "energy-intensive hyper-consumption by the rich" we also have to address "continued population growth among the poor" [McMichael, 1996].

Challenges for the Government and Partners in Civil Society

There are several gaps in our understanding of climate change and its health effects. Reliable information from the health sector in the Philippines is not easily available [ADB, 1994]. The following are therefore important areas of scientific inquiry

- Studies on the causal relation between disease and climate change
- Measurements aimed at detecting new trends in the environmental or health status of populations [McMichael et al., 1996].

These two – epidemiological research and monitoring of populations – are interrelated and interdependent.

Monitoring activities aimed at detecting new trends in the environmental or health status of populations allow us to develop countermeasures in response to health impacts. As an example, research on geographical abundance of major vector species and assessment of incidence of vector-borne diseases [Ando, 1993] becomes important in this respect. Overall, there is still a need for better baseline data – climatic and socio-economic – in relation to health [Watson et al., 1997].

In the Philippine setting, such monitoring – specifically environmental health impact assessment – is defined by a framework and guidelines issued by the DOH [DOH EHS, 1997]. Unfortunately, attention is directed towards environmental pollutants and other chemical hazards, but not yet on the issue of human-induced climate change.

In the assessment of climate change, there are several layers of uncertainty that make precise prediction of health impacts extremely difficult. While the conventional epidemiologic study involves actual experience, the task of evaluating potential health impacts of future climate change involves a consideration of "potential effects of an anticipated exposure" [McMichael et al., 1996]. As such, we have to study events that go beyond the range of recorded human experience.

Even then, it is believed that health impact studies using current or recent climate change situations are likely to be valid analogues for future climate change [McMichael, 1996]. Though far from being certain, the use of such analogues for environmental epidemiology research provide some indication of climate change impacts on the environmental determinants of human health and a corresponding idea of effects on human health. On this basis, we can be able to identify the appropriate responses to adapt to such impacts – policy evaluation, reformulation and policy implementation.

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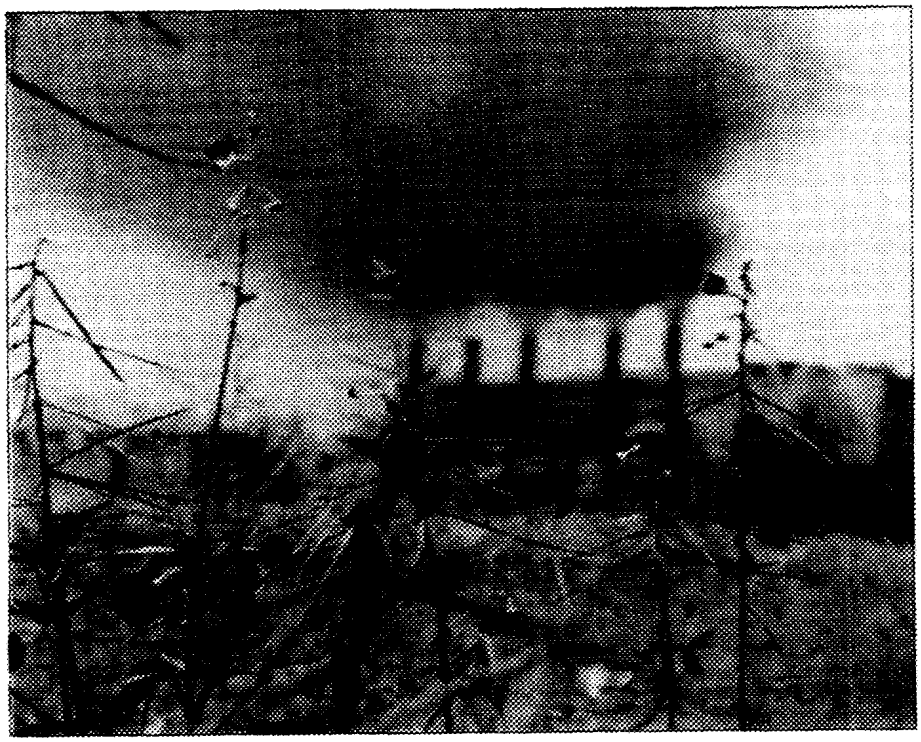
1 Local human-induced high temperatures in urban areas caused by heat absorption in concrete, brick and pavement surfaces; reduction of convective cooling due to the presence of tall buildings and reduced evaporative cooling [McMichael et al., 1995].

Policy and Legal Responses to the Challenges of CC

*Ma. Cecilia G. Dalupan**



The International Context

The United Nations Framework Convention on Climate Change (UNFCCC) is one of a growing number of multilateral agreements which seeks to address global environmental problems. The ultimate objective of the UNFCCC is to achieve "stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system"[1].

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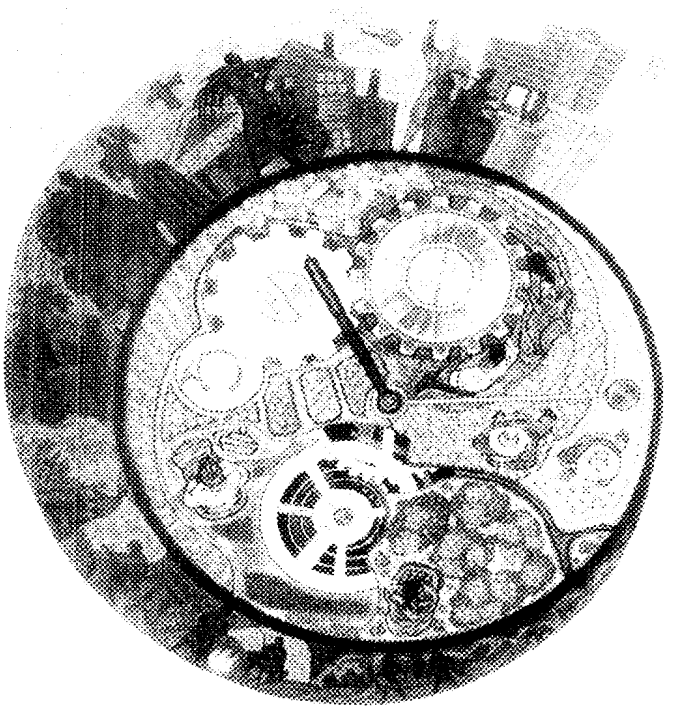
The UNFCCC is, by definition, a *framework* convention, that is, an agreement of general scope, arrived at through consensus on basic principles and "soft" obligations. This approach allows flexibility in further rule-making, since concretizing these obligations can be achieved through the elaboration of further protocols containing more detailed commitments. The Kyoto Protocol is the first attempt by the parties to the UNFCCC to formulate legally binding targets and timetables for developed countries to reduce their GHG emissions.

This framework approach also reflects both the complexity of the issues involved in the global problem of climate change, as well as the complexity in the process of obtaining consensus on addressing these issues. The complexity on both levels stems largely from the fact that both the issues themselves and the procedures to address them involve fundamental scientific, economic, social, political and equity considerations which must, by consensus, be balanced and ultimately embodied in a legal document.

These different considerations are reflected in the UNFCCC itself, particularly in Article 3, which details the principles on which the convention is founded. These include, among others, intra- and intergenerational equity, the right to sustainable development, the precautionary principle[4], cost-effectiveness of measures, recognition of the special circumstances and vulnerability of developing countries, the cooperative approach, and the recognition of common but differentiated responsibilities.

The concept of common but differentiated responsibilities is found in multilateral environmental agreements that have been adopted since the end of the 1980s. It finds further development in the UNFCCC where this concept translates into the commitment that developed country Parties take the lead in combating climate change and the adverse effects thereof in view of their historical contribution to the present state of GHG concentrations in the atmosphere. Consequently, only these parties have concrete and legally binding targets and timetables for reducing their GHG emissions under the Kyoto Protocol.



significant economic growth and poverty alleviation, while also giving due regard to environmental, specifically climate change, considerations.

This is not to say that developing country parties like the Philippines have no commitments under the UNFCCC. Article 4(1) enumerates responsibilities that apply to all parties, taking into account, however, their common but differentiated responsibilities and their specific national and regional development priorities. These include, among others, the commitment to develop national inventories of anthropogenic GHG emissions by sources and removals by sinks, and to take climate change considerations into account, to the extent feasible, in relevant social, economic and environmental policies and actions.

The succeeding sections of this paper shall identify certain policy and legal initiatives the Philippines has undertaken in responding to the challenges of climate change and in meeting its commitments under the UNFCCC. The overview of these initiatives is not intended to be comprehensive nor to include detailed activities. Rather, the policy and legal initiatives identified and discussed are broad in scope, national in character and are thus representative of the seriousness with which the country has approached climate change issues.

And while developing countries like the Philippines have no concrete emission reduction commitments under the Kyoto Protocol, they remain intensively involved in current negotiations, particularly with regard to the market-based mechanisms provided to assist developed countries in meeting their concrete targets. Thus, this essay shall also touch on general legal implications of these mechanisms and the operationalization of the Kyoto Protocol in the Philippines.

Significant National Policy and Legal Initiatives

One of the challenges the Philippines continues to face is how to achieve significant economic growth and poverty alleviation, while also giving due regard to environmental, specifically climate change, considerations. As previously stated, developing countries like the Philippines are not obligated to limit their GHG emissions. However, the Philippines' commitment to respond to climate change issues has long been evident and is driven by its sustainable development objectives. This is reflected in the institutional, legal and policy initiatives discussed hereunder.

Institutional Developments

On the level of policy and law, substantive developments have taken place which address climate change concerns. Even prior to the signing of the UNFCCC at the World Conference on Environment and Development in 1992 (the "Rio Summit"), the Philippine Inter-Agency Committee on Climate Change (IACCC) was established in 1991 by virtue of Presidential Administrative Order No. 220. The IACCC is tasked to coordinate various climate change-related activities, propose climate change policies and prepare the Philippine positions to the UNFCCC negotiations. It is co-chaired by the Secretaries of the DENR and the DOST, and includes the NEDA, the DOE, the DOTC, other government agencies and representatives from non-government organizations.

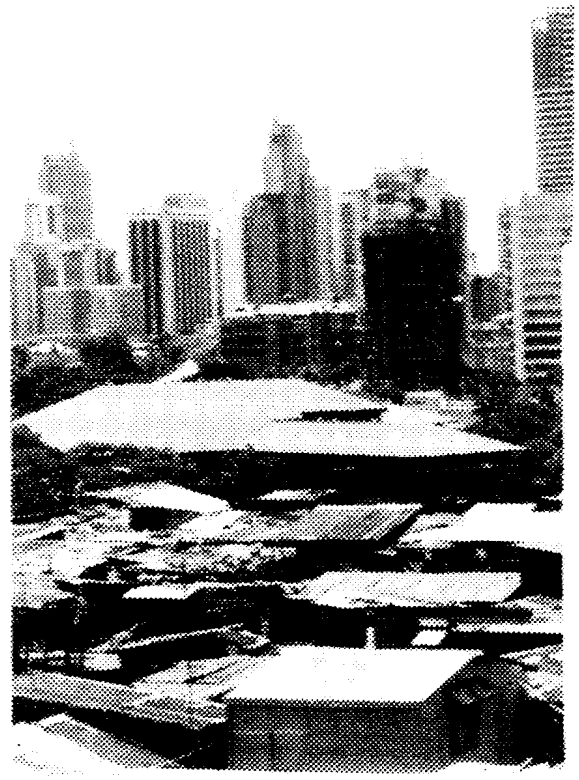
Correlatively, the Philippine Council for Sustainable Development (PCSD) was later established in 1992 to oversee the implementation of the country's commitments under the Rio Summit. The PCSD coordinated the formulation and oversees the implementation of Philippine Agenda 21, the broad sectoral environmental blueprint for the Philippines. The PCSD is chaired by the Director-General of the NEDA and vice-chaired by the Secretary of the DENR, and, like the IACCC, includes among its members the different departments of government as well as representatives from civil society.

Legal Developments

As earlier noted, one of the general commitments of all parties to the UNFCCC is to take climate change considerations into account, to the extent feasible, in relevant social, economic and environmental policies and actions. In this regard, two laws have recently been enacted which make express reference to climate change concerns.

The Agriculture and Fisheries Modernization Act of 1997[3] provides that the Department of Agriculture shall, in coordination with the PAGASA and such other appropriate government agencies, devise a method of regularly monitoring and considering the effect of global climate changes, weather disturbances and annual productivity cycles for the purpose of forecasting and formulating agriculture and fisheries production programs[4].

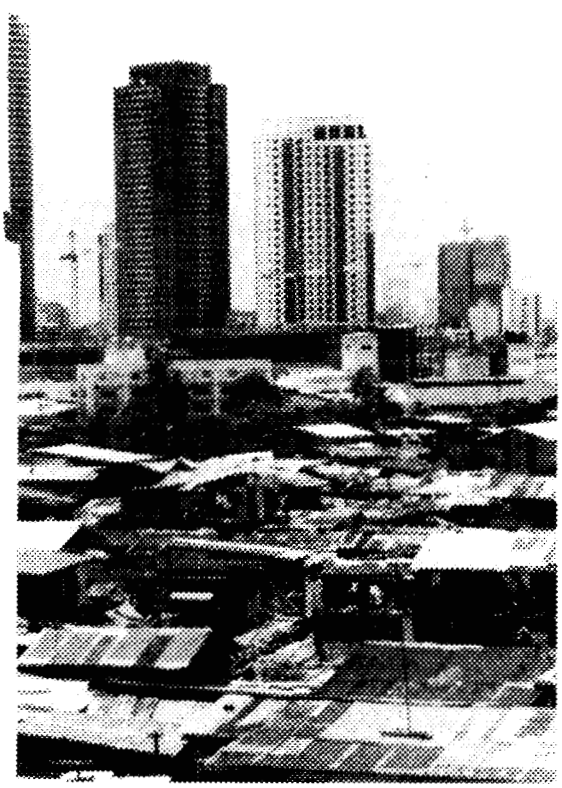
take climate change considerations into account, to the extent feasible, in relevant social, economic and environmental policies and actions



More recently, the Philippine Clean Air Act of 1999[3] provides that the DENR, together with concerned agencies and local government units, shall prepare and fully implement a national plan consistent with the UNFCCC and other international agreements, conventions and protocols on the reduction of GHG emissions in the country. In addition, the PAGASA shall regularly monitor meteorological factors affecting environmental conditions including ozone depletion and GHGs, and coordinate with the EMB in order to effectively guide air pollution monitoring and standard-setting activities.[4]

Among the bills pending in Congress that are relevant to climate change concerns are the New and Renewable Energy Program Act, an Act to Institutionalize Energy Conservation and Enhance Efficient Use of Energy, and an Act to Strengthen the National Program for the Development and Promotion of the Use of Nonconventional Energy Systems. These are particularly relevant since the energy sector is the leading contributor to GHG emissions and the successful implementation of programs under such laws will likely lead to decreased dependence on fossil fuels.

PHOTO BY GIL NARTEA



Policy Initiatives

Policy initiatives on climate change have largely been cooperative efforts among concerned government agencies, non-government and international organizations. This reflects the fact that climate change concerns are so complex and far-reaching that a wholistic approach is necessary. These are not the province of any one sector or agency, but rather, require coordinated efforts to address these issues that have economic, social, political and other dimensions.

In fulfillment of its commitments under Article 12[5] of the UNFCCC, the Philippines submitted in December 1999 its Initial National Communication to the Conference of the Parties, the supreme body of the UNFCCC. This important document contains the 1994 national inventory of anthropogenic emissions by sources and removal by sinks of GHGs, a description of measures taken or planned, and other information relevant to the achievement of the objectives of the Convention.

In recent years, a broad process was also undertaken toward the formulation of a National Action Plan on Climate Change (NAP) by both the government and civil society. The general objectives of the NAP were to identify climate change-related issues, raise awareness on these issues and its impacts in both the public and private sectors, identify policy gaps, and recommend strategic thrusts. Both adaptation and mitigation measures with respect to different sectors were discussed in the NAP.

The adoption of GHG mitigation or, more accurately, avoidance measures are reflected in existing sectoral plans such as those pertaining to energy. The energy sector is listed under both the 1990 and 1994 national inventories as contributing the most GHG emissions. The basic policy framework for the Philippine energy program is set forth in Republic Act No. 7638, creating the DOE in 1992. Pursuant to this law, the DOE formulates the Philippine Energy Plan (PEP). Among the specific programs falling under the current PEP are programs on new and renewable energy, energy efficiency, demand side management and environmental programs. While these are primarily driven by the goal to achieve energy self-sufficiency and local environmental improvements, these are also relevant to the attainment of climate change objectives.

Multilateral donor agencies and other international organizations have also undertaken various projects dealing with climate change concerns. One such initiative is the ALGAS, which formulated the least cost mitigation options for the Philippines and 11 other Asian countries under the guidance of the ADB, with funding from the GEF through the UNDP.

Finally, and among other significant initiatives, the Climate Change Information Center (CCIC) was established in 1999. Located at the Manila Observatory within the campus of the Ateneo de Manila University, the CCIC sources national and international information on climate change and related issues, and disseminates these to concerned sectors. The establishment of the CCIC represents the combined efforts of the government, international and non-governmental organizations and the academe.

The establishment of the CCIC represents the combined efforts of the government, international and non-governmental organizations and the academe.

Climate Change Information Center

The Parties to the UNFCCC assembled for the important 6th Conference of the Parties (COP) in November 2000 at The Hague.

From a developing country perspective, the global community is faced with the challenge of formulating a governance regime for climate change that will be both climate-effective and equitable. Specific issues for deliberation include Land Use, Land Use Change and Forestry (LULUCF), Compliance, Policies and Measures, Technology Transfer, and Financial Mechanisms. However, a great deal of focus is on the Kyoto Mechanisms, particularly the CDM.

Should there be consensus on the many complex issues relative to the CDM, the legal implications for the Philippines will include ratification of the Kyoto Protocol and the establishment of domestic mechanisms to facilitate the country's participation in the CDM. Additional enabling legislation, by virtue of new laws or executive orders, may be needed for this purpose.

Regardless of the outcome of COP 6, the continuing challenge remains for the Philippines to strengthen its domestic legal and institutional framework so that it effectively integrates and addresses climate change concerns without curtailing economic growth.

Whether the governance regime for climate change is formulated on the domestic or global context, the effectiveness of the policy instruments adopted will be measured by whether these sufficiently embody and balance a broad range of considerations in a manner that is both legally binding and enforceable. Specifically, these legal instruments should meet general criteria: whether these are flexible so as to accommodate new scientific, technological and other relevant information; whether these are economically and politically feasible; whether these are equitable and give due consideration to the most vulnerable sectors; whether these are consistent with sustainable development objectives; and, finally, whether these are climate change effective and contribute to the ultimate objectives of the Convention.

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United Nations Framework Convention on Climate Change and the *Kyoto Protocol* to the UNFCCC.

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1 UNFCCC, Article 2.

2 The precautionary principle in international environmental law is articulated in Principle 15 of the Rio Declaration and echoed in Article 3(3) of the UNFCCC. This principle provides that where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

3 Republic Act No. 8435, *An Act Prescribing Urgent Related Measures To Modernize The Agriculture And Fisheries Sectors Of The Country In Order To Enhance Their Profitability, And Prepare Said Sectors For The Challenges Of Globalization Through An Adequate, Focused And Rational Delivery Of Necessary Support Services, Appropriating Funds Therefor And For Other Purposes* (22 December 1997).

4 Section 16, Republic Act No. 8435.

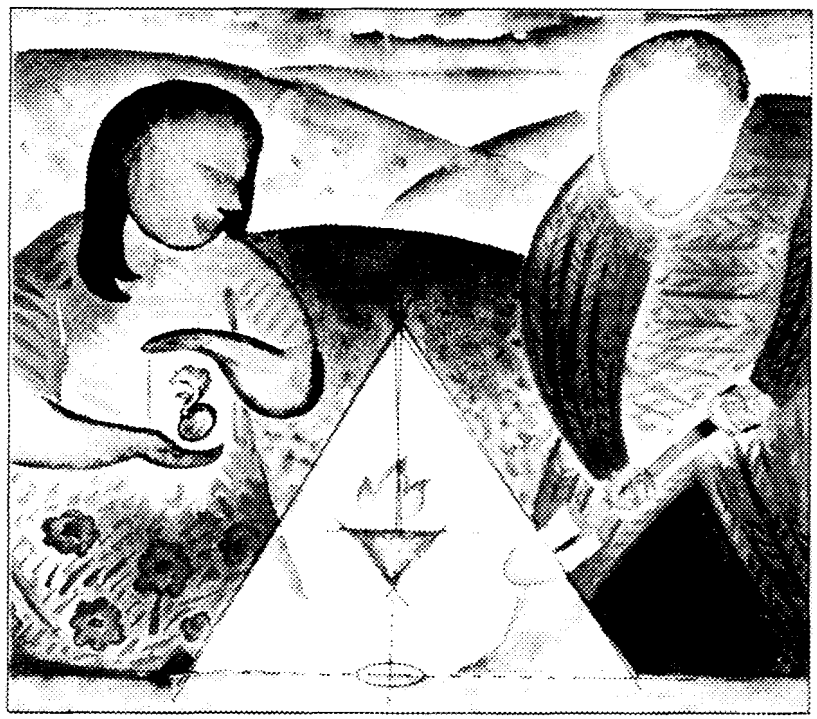
5 Republic Act No. 8749, *An Act Providing For A Comprehensive Air Pollution Control Policy And For Other Purposes* (23 June 1999)

6 Section 31, Republic Act No. 8749.

7 *"Communication of Information Related to Implementation"*

North and South, States and Communities: Reflections on the Global CC Negotiations

*Antonio G. M. La Viña**



The history of the climate change negotiations has been dominated by the tension between developed and developing states, between North and South. It has often been said that the over-arching issue in climate change negotiations is of a North/South nature. After years of involvement in the climate negotiations, particularly in those that led to the adoption of the Kyoto Protocol on Climate Change, I have serious doubts about the adequacy and fruitfulness of this paradigm. This article explores the reasons for my skepticism and proposes ways to move forward.

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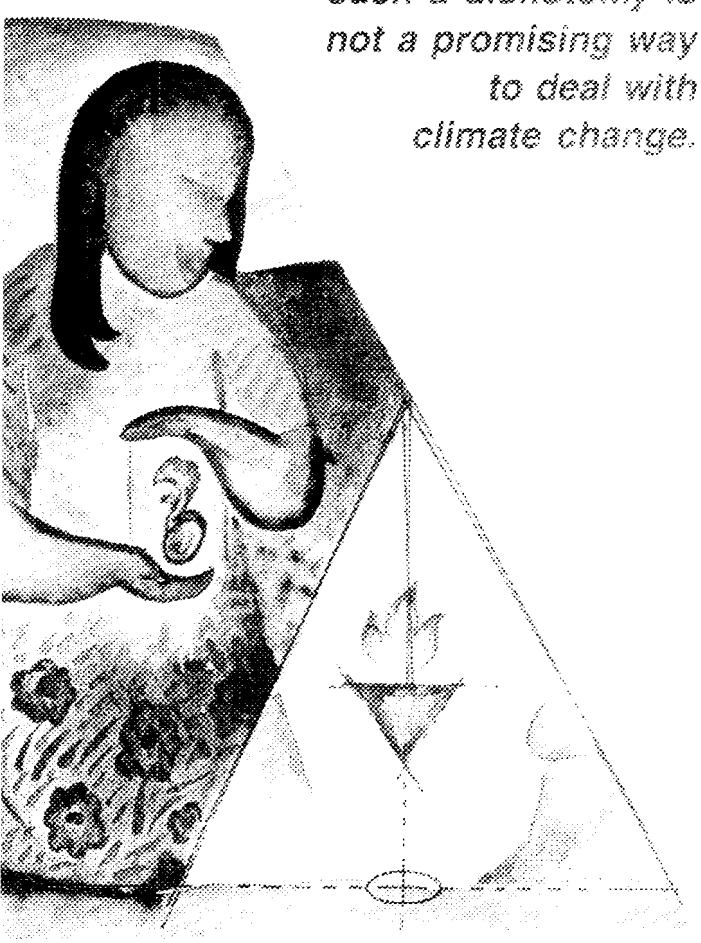
While the North-South paradigm is valuable in understanding the historical evolution of the international economic and political order, it is an inadequate tool for dealing with global environmental issues and for finding solutions to contemporary ecological problems. As the climate change negotiations demonstrate, the paradigm frequently results in quagmires. First, the nature of global environmental issues and the strategies that must be put into place to confront them demand that we rethink the way we understand the world. Second, the North-South paradigm, from a practical point of view, often leads to deadlocks or unsatisfactory compromises. Third, that there is such a thing as Southern or even Northern solidarity can be validly questioned. And fourth, the North-South paradigm is in some respects an inadequate and outdated paradigm because it is "statist" and ignores the roles of communities and other non-state actors.

Dividing the world into North and South and the consequences of such a dichotomy is not a promising way to deal with climate change.



The Nature of Global Environmental Issues

Climate change is a classic example of a global environmental issue. The threat of global warming in the future hovers in varying degrees among countries of the North and South. While there will be, in the short-term, winners and losers in climate change, in the end, all countries of the world will be adversely affected. While countries of the North are historically the major sources of greenhouse gases, countries of the South are expected to increase their emissions in the future. The global nature of environmental problems like climate change, therefore, requires the transcending of special interests.

Dividing the world into North and South and the consequences of such a dichotomy is not a promising way to deal with climate change. It is a challenge that cannot be met without the full participation of both the developed and the developing world.

Deadlocks or Unsatisfactory Compromises

A look at the negotiations between North and South on economic as well as environmental issues reveals the inadequacy of the North-South paradigm as a practical tool for resolving disputes. For example, with all the energy that has been put into the issue of resource transfers, the fact remains that development cooperation has failed. The history of the debate on a New International Economic Order (NIEO) is also instructive of the limits of the North-South paradigm. In that debate, the developing states collectively tried

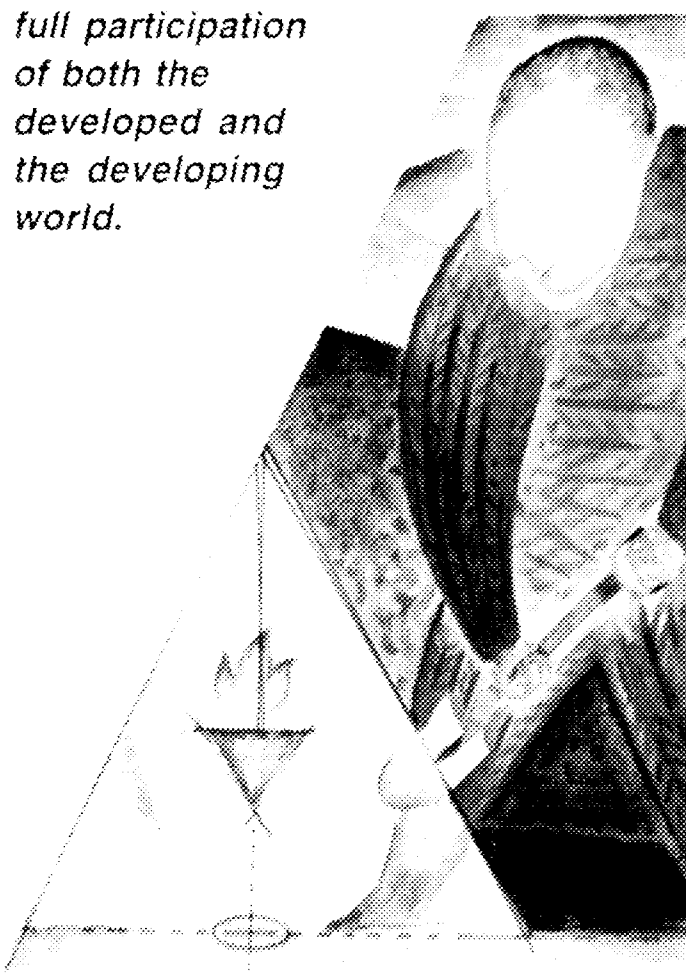
to get the North to accept the need to make the world economic system more equitable, demanding, among other things, greater benefits from world trade and finance. In pursuing the NIEO, developing countries made use of the UNCTAD conferences and even succeeded in getting the UN Special Session in 1974 to adopt the NIEO Declaration. These principles included: sovereign equality of the States; cooperation of all states based on equity, whereby prevailing disparities in the world may be banished; the right of every country to adopt its own economic and social system; full permanent sovereignty of every state over its natural resources and economic activities; regulation and supervision of activities of transnational corporations; just relationship between the developing countries' export and import prices, and improvement of their terms of trade; reforming the international monetary system to promote development and adequate flow of real resources to developing countries; preferential and non-reciprocal treatment for developing countries in all fields of international economic cooperation; and facilitating the role of producers' associations.

More than 20 years after that NIEO Declaration, the same issues continue to remain on the table, resurrecting themselves at almost every opportunity, essentially remaining unresolved.

The UNCED, held in Rio de Janeiro in 1992, is another good example of how compromises on North-South issues end up being inadequate. Developing countries wanted to use the UNCED to address the core issues of the international economic system and the unsustainable patterns of economic growth and consumption in the North, and the development models pushed in the South. The compromise at UNCED was unsatisfactory and continues, and will probably continue, to be a bone of contention in the future. As shown, what frequently happens when the North-South perspective dominates the discussion is the resort to historical debates which often diverts attention from the demand to deal with the problems that require solution.

The same type of unsatisfactory compromise has characterized agreements in the climate change negotiations. While such compromises are inherent in international negotiations, it would be much more efficient, honest and, in the end, more rewarding if the differences are acknowledged and then to move on from there in looking at the problem. A confrontational approach would be no more likely to bear fruit in the climate change negotiations than in the NIEO or UNCED debate.

It is a challenge that cannot be met without the full participation of both the developed and the developing world.



Southern Solidarity

It is a valid point to ask whether or not there is really such a thing as Southern solidarity, whether developing states can really talk of common interests in specific environmental issues as well as in other global issues. As the climate change negotiations illustrate, Southern solidarity is often a myth. Given the divergence of interests among developing countries, it is not surprising that the Group of 77 has not been able to form a united and effective coalition in the negotiations.

Beyond Southern solidarity is national self-interest and, when forced to choose between the two, it is the former which is more often conceded by a state. On this point, the problem of climate change presents many sources of disunity. For example, it is difficult to blame small island states if they break Southern solidarity by accepting compromises from the North in terms of funding for adaptation or in terms of the commitments made by the latter for reducing emissions. After all, the national interests of small island states compel them to pursue a workable climate change regime as early as possible. They cannot afford to hold hostage the climate change negotiations as it is these states which will first bear the brunt of climate change. On the other hand, that Saudi Arabia and other oil-producing countries have hurled obstacles in the negotiations is hardly surprising and is certainly expected given their national interest in a continued business-as-usual use of fossil fuel.

Similar to the issue of Southern solidarity is whether or not there is a monolithic Northern position on all global issues. For example, it is absurd to lump together the United States and the European Community with Australia, New Zealand and the

Scandinavian countries and conclude that they all have the same Northern position on climate change.

The point is that when it comes down to specific national interests and specific positions on the most important issues, the North-South dichotomy is, at times, simply untrue.

The North-South Paradigm As Statist

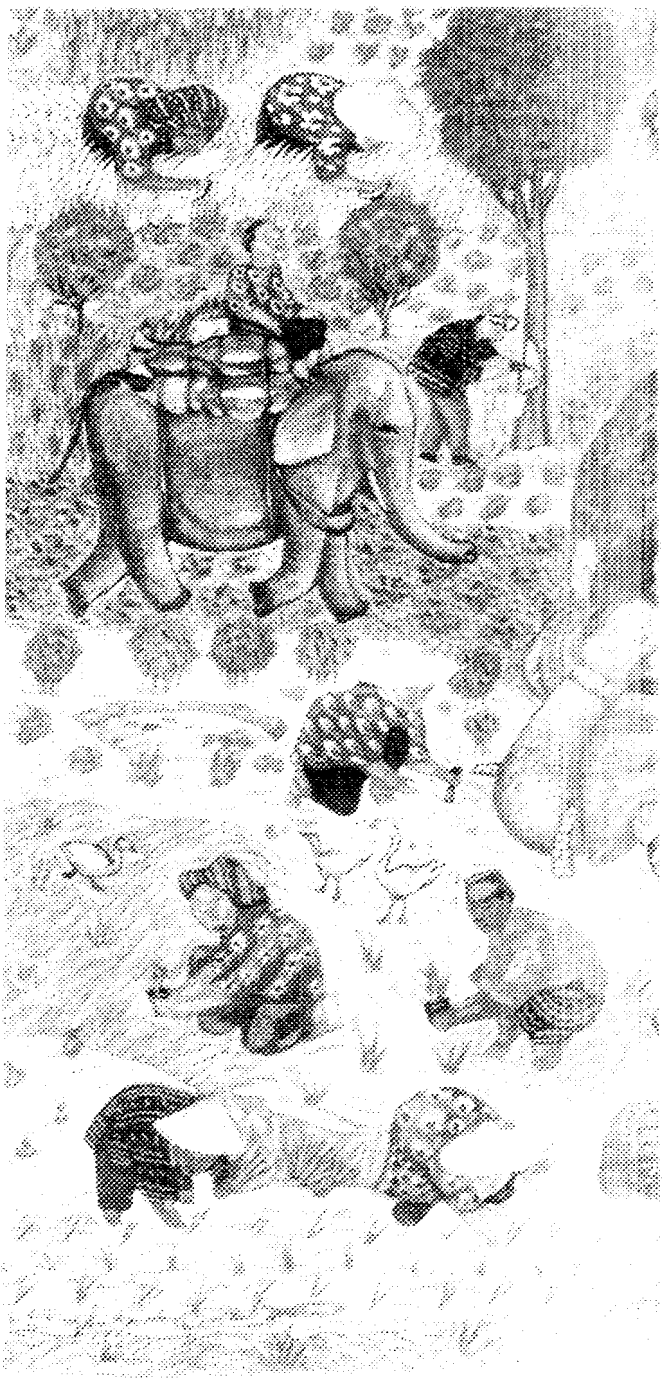
The North-South perspective emphasizes the primacy of states. In fact, the whole notion of North and South is premised on the concept of nation-states, as the North-South dichotomy historically originated from the division of the world into colonizers and colonized. This, to the author, is the most significant inadequacy of the paradigm. Just as important as state actors in global environmental issues are non-state actors. In particular: what is the role of communities of people in responding to an issue like climate change?

The concept of the nation state is basically a northern (more accurately, western) concept and it is a concept which is not very sympathetic to the notion of communities and non-state participants playing fundamental roles in the social decision process. By dividing the world into North and South, we often fail to distinguish the communities and sectors within these monolithic groupings. And this omission often leads to unworkable solutions or, worse, to grave injustices committed against such communities or sectors. Indeed, the gap between rich and poor is not only between the North and South but also within developing countries where the disparities are much higher. Certainly, a wealthy family in Manila, owning six cars and with centralized air-conditioning in the house contributes more to global warming than a

poor family living in the inner city of New Haven, Connecticut, with barely enough oil for heating during the winter months.

Towards a New Paradigm

The critique of the North-South paradigm in the preceding sections illustrates the need to refashion the perspective into a new, potentially more fruitful, paradigm that should be used in the climate change negotiations. The most important elements of this new paradigm are: First, Southern positions must always be based on the specific needs and interests of each developing country. Second, there must be a commitment to realize on the ground the principle of sustainable development and intergenerational equity. And third, the new paradigm must emphasize the role of communities in designing and implementing response strategies to climate change.



1. *The South: Grounding Positions on Needs and Interests*

In formulating its positions in the climate change negotiations, developing states must first identify their specific national interests on the issue. These interests can be found in two areas: (a) What is the projected impact of climate change for a particular country? (b) If certain strategies are to be adopted, what is the impact of such strategies on the development options of the specific country that adopts them?

For Southern governments, the basis of any negotiating position must be an honest look at its national needs and interests. A frank and candid assessment of the projected impacts of climate change and climate change response strategies must be conducted. A troubling aspect of the international negotiations is the diversionary character of the debate on funding mechanisms. Instead of having an internal logic for responding to climate change, developing countries are often compelled to look externally for reasons and [illegible] to join a global regime. The better approach is to identify first its national interests in climate change – the impact of global warming, the response strategies that have been proposed, and then to adopt

policies and programs which reflect these interests. Only then can the debate on funding mechanisms be relevant to these countries.

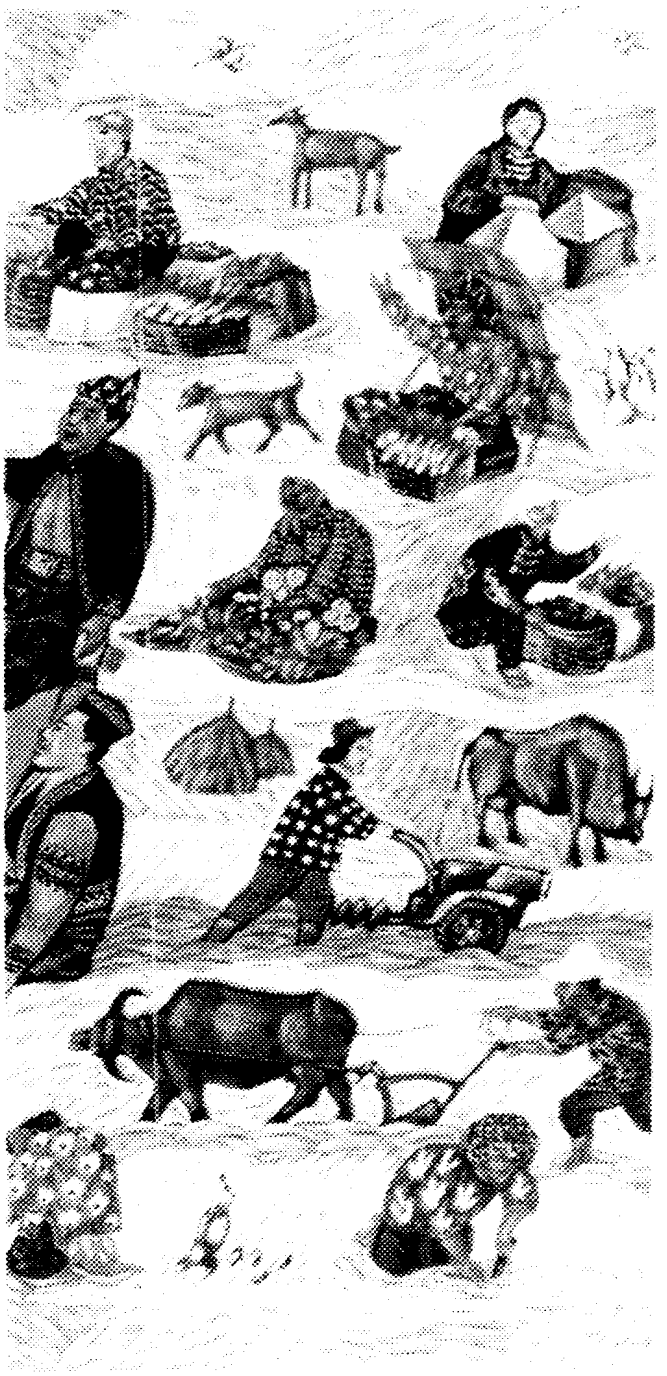
2. Sustainable Development and Intergenerational Equity

Going beyond the North-South paradigm requires a commitment to realize on the ground the principles of sustainable development and intergenerational equity.[1]

Sustainable development has been described as a strategy seeking "to meet the needs and aspirations of the present without compromising the ability to meet those of the future". "Sustainable development" contains within it two key principles: (a) the concept of "needs", in particular, the essential needs of the world's poor to which overriding priority should be given; and (b) the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

Sustainable development does not imply cessation of economic growth. Rather, it requires a recognition that the problem of poverty and underdevelopment and related environmental problems cannot be solved without vigorous economic growth. Sustainable development will require changes in current patterns of growth to make them less resource- and energy-intensive and more equitable. Inequalities in international economic relations, coupled with inappropriate economic policies in many developed and developing countries alike, continue to cause environmental degradation and limit the sustainability of the development process. Growth derived from rapid resource depletion is neither ecologically nor economically sustainable. No single blueprint of sustainability will be found, as economic and social systems and ecological conditions differ widely among countries. Each state will have to work out its own concrete policy implications.

Sustainable development, as a concept, cannot be separated from the principle of intergenerational equity. Intergenerational equity is the international legal articulation of sustainable development. The theory of intergenerational equity assumes that each



generation receives a natural and cultural legacy in trust from previous generations and holds it in trust for future generations. Intergenerational equity does not demand sacrifice by the present generation for the benefit of future generations but balances their interests by providing that where there is threat to the global environment, steps can and should be taken that will mitigate suspected adverse impacts on future generations.

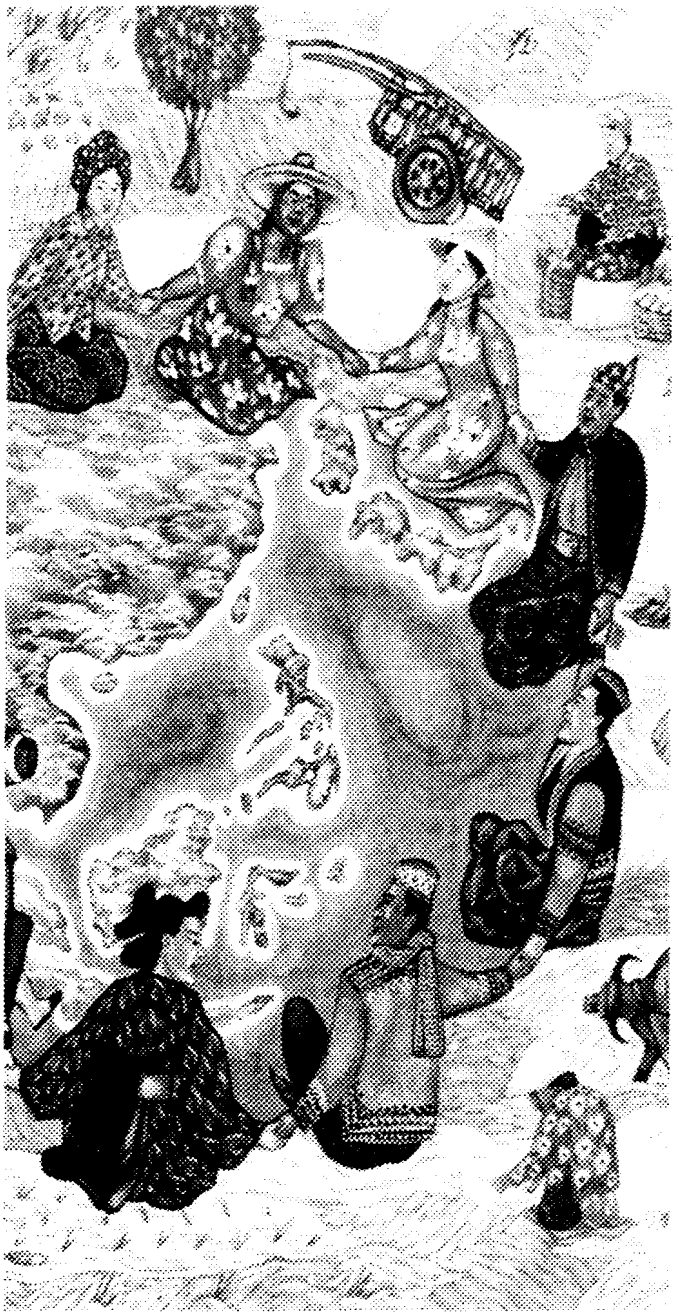
Climate change satisfies all the criteria for the application of intergenerational equity. All three types of intergenerational equity problems which may arise in the use of planetary resources are present in climate change: (1) depletion of resources for future generations; (2) degradation of the quality of resources available for future generations; and (3) reduced or barred access to the use and benefit of resources passed on from previous generations.

Both sustainable development and intergenerational equity have been incorporated into international law by the Rio Declaration, which provides:

> Principle 3: The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.
>
> Principle 4: In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

A new paradigm for dealing with climate change and other global environmental issues demands the realization of these principles on

the ground. This requires that states, whether in the North or the South, do not perceive environmental protection and economic development as contradictory goals. For developing countries particularly, the imperative is clear: it should not and must not repeat the experiences of the developed countries. Unfortunately, the dominant



assumption is still that the Northern industrial model is a desirable one for replication in the South. This assumption is frequently the basis for planning economic policies in most developing countries. It is an assumption that must be challenged if the principles of sustainable development and intergenerational equity are to be realized.

3. The Role of Communities

A third element in the new paradigm is the necessity to emphasize the role of communities in dealing with the climate change issue. At first glance, communities seem to be irrelevant to a global problem such as climate change. After all, we are dealing here with problems that transcend national boundaries. A second look, however, reveals that communities are at the center of the dilemma. First, looking at the impacts of global warming, it is obvious that the burden will be borne by communities, particularly poor communities within developing states. Second, if response strategies in developing countries will focus on energy, forestry and agriculture, again the costs (in energy efficiency, maybe the benefits also) might have to be shouldered by such communities.

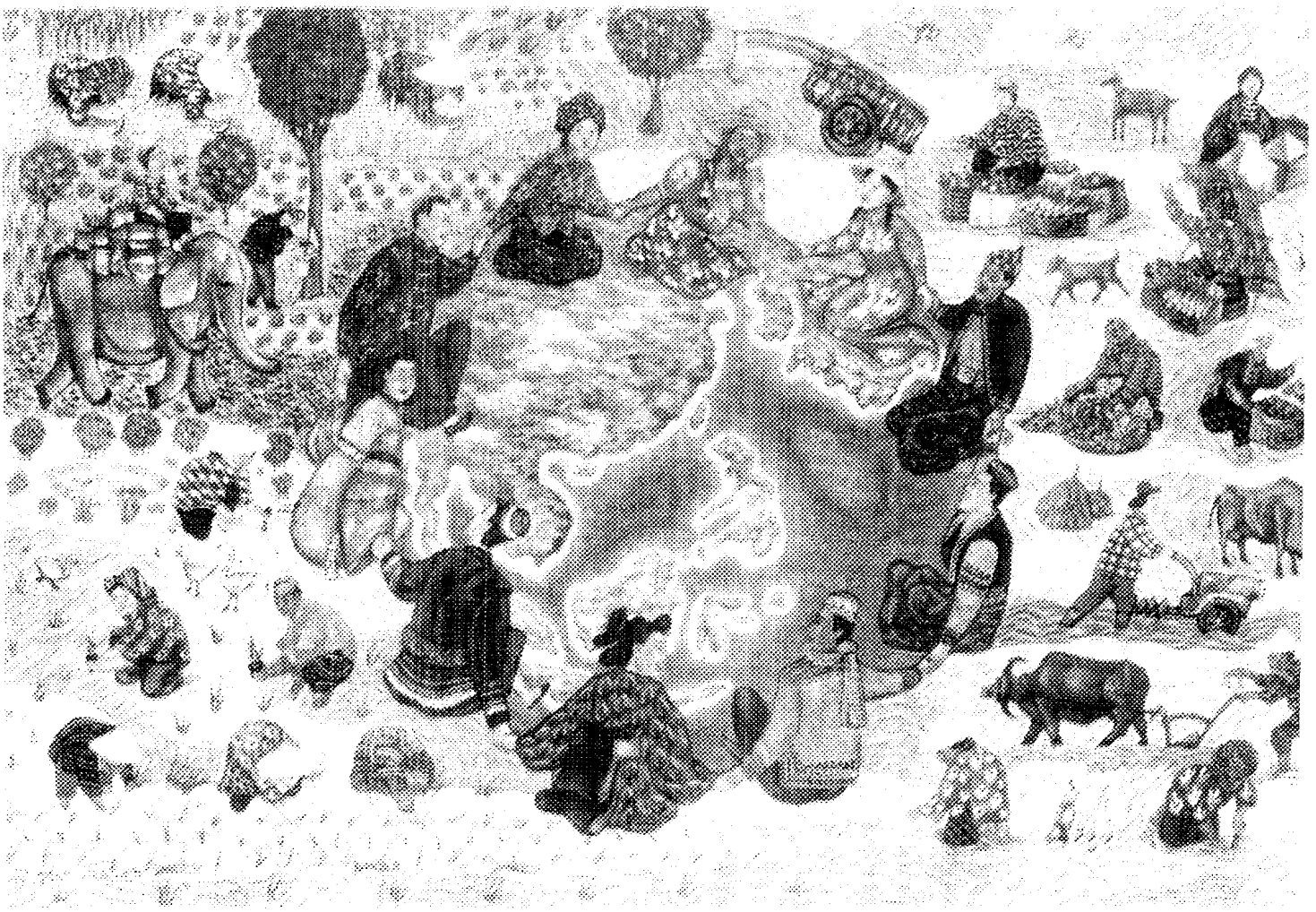
Unfortunately, the role of communities has not been significantly discussed in the climate change negotiations. This is because of two reasons. First, the North-South paradigm has dominated the negotiations and, as earlier pointed out, this is essentially a statist perspective. Second, since climate change began essentially as a Northern issue, Northern and Western strategies have occupied central stage in the negotiations.

A look at the strategies, global and domestic, that have been proposed to deal with climate change reveals its bias for two classically Northern or western regulatory regimes: the "command-and-control" system and the free market approach. The truth is that the choice between the free market and command-and-control strategies is also a false choice. In the South, the strategy that many people's organizations and nongovernment organizations are pushing is community-based resource management - an approach which is just as relevant to climate change as it is to forest and biodiversity issues.

Community-Based Resource Management

In the South, particularly in issues concerned with natural resource utilization, the strategy of community-based resource management systems has been proposed as a better alternative to command-and-control or free market mechanisms in environmental regulation. Community-based resource management systems can range from the right of the community to be consulted before any development project is imposed on it to actually recognizing community control and management of natural resources. Recognizing these systems would also mean developing and accepting common property regimes in international and national legal regimes – among others, by recognizing communal title to lands, ceding the control and management of rainforests to the communities that occupy them, protecting the intellectual property rights of indigenous and local communities to their traditional knowledge, and in institutionalizing community participation in environmental risk and impact assessments.

There is obviously a lot of work to be done in climate change if community-based approaches are to be incorporated in the global and national response strategies that are now being formulated. In the South, there is a clear demand to undertake massive



education programs concerning climate change – its impacts, causes, possible response measures communities can take. In projects supported by the GEF and in the implementation of a flexibility mechanism like the CDM, it must be ensured that the approach is integrated into the programs that are now being put in place. For example, a community-based resource management system must be integrated into all forestry and energy projects that may be undertaken under the CDM.

For community-based approaches to be adopted in response to climate change, a new global principle and ethical code of conduct must be developed, such as resource sharing and utilization within and between NGOs, community groups, governments and civil society. It is in the creation of stronger bonds not only between states but between peoples and communities within and between the North and the South, that both equity and environmental quality – in the local, national and global planes – can be attained.

Recapitulation

In the climate change negotiations, the dominance of the North-South perspective often results in historical debates that divert attention from the demand to deal with the problem that requires a solution. The demand is not to reject the paradigm totally, but to rethink and refashion it in such a way that the historical baggage of the past is put aside, and the paradigm becomes not an obstacle to devising a global regime on climate change but a facilitator for such a system. Appreciating the global character of climate change, going beyond the North-South dichotomy, realizing sustainable development and intergenerational equity, and, above all, integrating communities at the center of the debate are all essential elements of this new paradigm.

Three years ago, in Kyoto, it became clear to me why we are working so hard to arrive at a climate agreement. A Japanese poem explained this all for me:

I do not want to be afraid of the rains
and long for the memory of how they once made
our mountains more beautiful to see,
and I do not want to weep for my children as I watch the sea.

I also reminded myself that I must have faith in people. Human beings and human societies are capable of change. Political interests and negotiating positions are not permanent and the perspective of common interest can prevail. This new paradigm is a step towards this direction.

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1 For a more detailed understanding of sustainable development, see The World Commission on Environment and Development, Our Common Future (1987). For intergenerational equity, see E. B. Weiss, In fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity (1989).

Philippine Policymaking and the UNFCCC

*Bernadittas C. Muller**

The Philippines, as a State Party to the UNFCCC, was among the first countries to set up a national committee, the IACCC , to discuss and develop positions on climate change even prior to the establishment of the Intergovernmental Negotiating Committee, which then negotiated the UNFCCC. Setting up national committees is the Philippine contribution to the start of the negotiating process, and an important initiative made by Dr. Roman L. Kintanar, former director of the PAGASA and twice President of the Congress of the World Meoteorological Organization. Dr. Kintanar was the first IACCC Chairperson and he helped set the tone for the active participation of the Philippines in the UNFCCC negotiations.

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This essay seeks to lay out the bases for Philippine policymaking in its implementation of its obligations as a State Party to the UNFCCC. These are the same bases for the development of Philippine positions on the various issues negotiated under the UNFCCC process. An understanding of these basic principles would facilitate understanding of the Philippine positions on climate change issues at the national, regional and international levels. It is also hoped that this better understanding would lead to more participation in the development of these positions by all relevant sectors, government, as well as the members of the civil society. This could likewise result in a more informed and effective implementation of the obligations undertaken by the Philippines under the Convention.

The Balance of Responsibilities under the UNFCCC

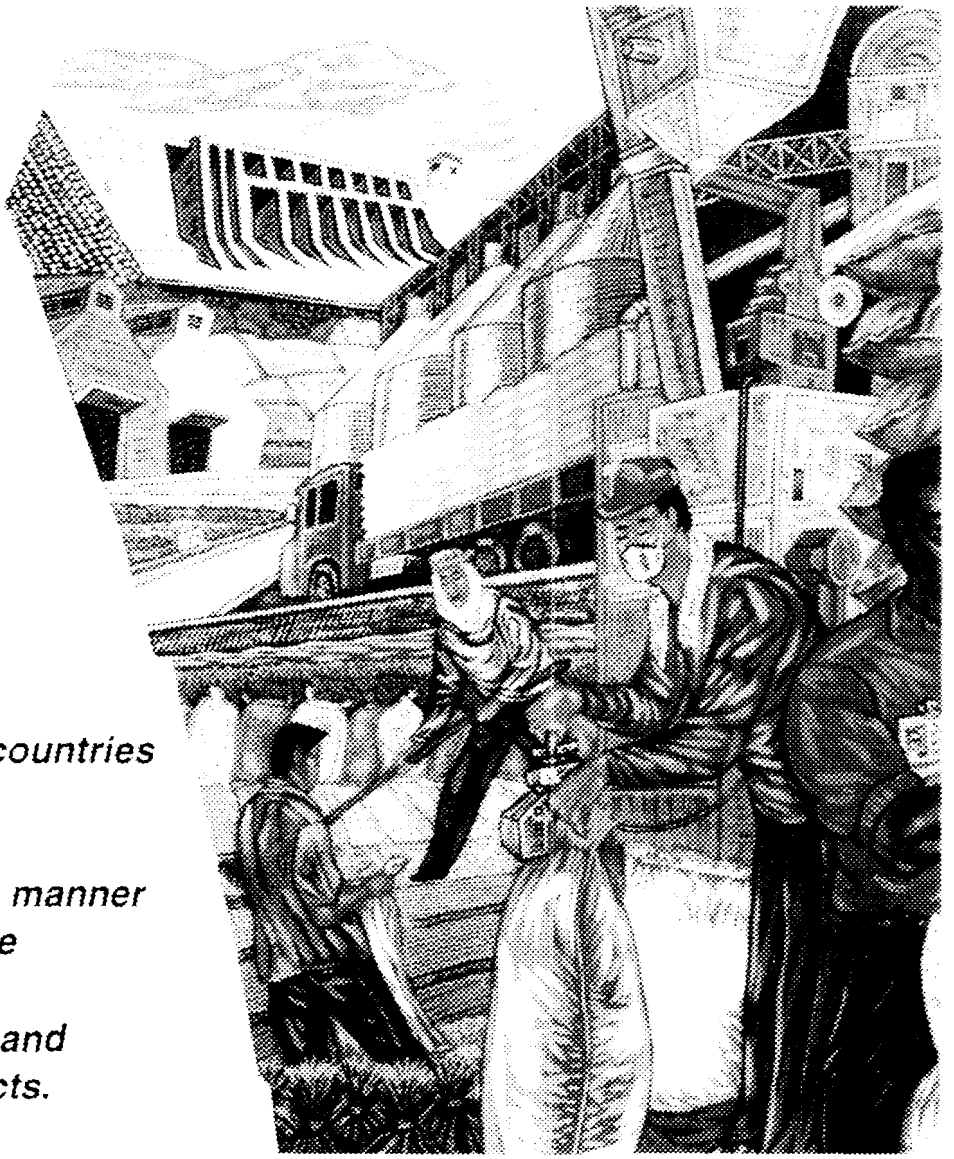
A careful balance of responsibilities of States Parties to the UNFCCC permeates the provisions of the Convention. This is based on the scientific assessment that "the largest share of historical and current global emissions of greenhouse gases (GHGs) has originated in developed countries" and that "the share of global emissions originating in developing countriess will grow to meet their social and development needs" [Preamble, paragraph 3]. This recognition is fundamental to the understanding of the Convention and the obligations of each State Party to the UNFCCC.

As a result of this, the Parties are divided into those countries listed in Annex I to the Convention (economically developed countries and countries with economies in transition), those listed in Annex II (developed countries), with the developing countries referred to as non-Annex I countries. The Philippines is a non-Annex I Party to the Convention.

The developed countries bear the main historical responsibility for the current accumulation of GHGs in the atmosphere, having achieved their level of economic development since the industrial revolution without due regard to its effects on the Earth's climate. Developed countries, therefore, gained an edge in technological progress and in financial resources. Developing countries, on the other hand, need to achieve development and will increase their GHG emissions in the process.

Developing countries are most vulnerable to the adverse effects of climate change, and having limited financial and technological capabilities, they might not be able to respond to these adverse effects. Hence, the main responsibility of the developed countries is to "modify [their] longer-term trends in anthropogenic emissions..." [Article 4.2-a] to mitigate climate change, and for developing countries to pursue their development in a sustainable manner and to undertake adaptation to climate change and its adverse effects.

The UNFCCC's objective [Article 2] reflects this balance of responsibilities. The ultimate objective is the "stabilization of greenhouse gas concentrations in the atmosphere", with



for developing countries to pursue their development in a sustainable manner and to undertake adaptation to climate change and its adverse effects.

the word "concentrations" referring to the accumulation of GHGs since the industrial revolution. The condition is that this should be achieved within a period long enough to allow the ecosystems to adapt, to ensure food security, and to "enable economic development to proceed in a sustainable manner".

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How this balance of responsibilities underlies the obligations of each State Party to the Convention will be shown in the discussion on selected issues under this Convention, and, in particular, in the chapter on the Kyoto Protocol and the CDM.

The Principle of Common but Differentiated Responsibilities

The principle of common but differentiated responsibilities is recognized as one of the basic guiding principles of sustainable development. Here, it is discussed within the context of climate change and its adverse effects.

The Preamble of the UNFCCC states, in paragraph 6, that international cooperation in climate change should be in accordance with the principle of common but differentiated responsibilities, but also taking into account "respective capabilities and their social and economic conditions". While climate change and its adverse effects are a global (common to all countries) concern [Preamble, paragraph 1], the responses that have to be made by each State Party and their respective responsibilities under the Convention would have to take into account the differences in their contribution to the present concentrations of GHGs in the atmosphere, their response capabilities and their specific situations.

Article 3 on Principles lists this principle as the first and also makes an important reference to "equity". Paragraph 1 of this Article states that, "Accordingly, the developed country Parties should take the lead in combating climate change and its adverse effects". It is important to note that the heading (*chapeau*) of Article 4 on Commitments under the Convention places all of these legally binding commitments under the principle of common but differentiated responsibilities. The Article then sets out the different responsibilities of each State Party at the national level and at the level of international cooperation.

The main obligations of all State Parties are laid out in the sub-articles of Article 4.1 of the Convention. The principle of common but differentiated responsibilities covers the implementation of all commitments.

Foremost among these obligations is the preparation of the national communications, the contents of which are determined through decisions of the Conference of the Parties, the plenary body of the Convention. The national communications consist mainly of a national inventory of anthropogenic emissions and a general description of steps taken or envisaged by each Party to implement the Convention. These communications are meant to provide information on the current state of the climate, the sources of emissions and possible sinks of all greenhouse gases.

The Convention subsidiary bodies then consider this information to determine the "overall aggregated effect" of steps taken by the Parties. The national communications aim to provide the Parties with a global picture of the climate and to determine whether the measures undertaken by the Parties assist in achieving the objective of the Convention or not.

The Philippines, as a non-Annex I State Party to the UNFCCC, is called upon to formulate programs containing measures to mitigate climate change and to facilitate adequate adaptation to it aside from the National Communications. The Philippine national program has been developed and integrated in the sustainable development plans of the country, in the climate change component of Philippine Agenda 21.

The Philippines is likewise active in the international effort to cooperate in adaptation, research, systematic observation and development of data archives, exchange of relevant scientific, technical, socio-economic and legal information related to climate change issues. One important aspect is cooperation in education, training and public awareness, which is the basis for achieving effective implementation of policies and measures on climate change.

Scientific Assessments as Bases for Policymaking

The impetus for the negotiation of a climate change convention came from an independent scientific and technical body, the IPCC. Having recognized that there is indeed a scientific basis for climate change, the experts realized that the only way for the international community to work together to address this environmental problem is to put this problem squarely into the political agenda of the States. In sustainable development conventions, there is no valid political discussion that is not based on scientific assessments and, in turn, there are no scientific assessments that can be meaningfully turned into concrete action without putting these in their socio-economic and political context.

The Ministerial Declaration of the Second World Climate Conference in 1989 clearly stated the principle of common but differentiated responsibilities of States in addressing the problem of climate change. It is significant to note that the Philippines was represented at this meeting by then Secretary of Science and Technology, Mr. Ceferino Follosco. A parallel process was then set up in which political negotiations were started, guided by the scientific assessments of the IPCC.

The UNFCCC continues to draw upon IPCC expertise, seeking at the same time to address the imbalance which continues to mark participation in the IPCC between experts from developed and developing countries. One important Philippine contribution to the IPCC was the setting up of a sub-working group on regional climate variability, now recognized as a valuable component in the assessment of global climate.

The Convention also provides for a Subsidiary Body for Scientific and Technological Advice (SBSTA), whose functions are determined by Article 9 and further decisions of the COP. The SBSTA, a multi-disciplinary body, deliberates on the scientific and technological aspects of the different issues in the Convention, putting these within the context of the political commitments that are undertaken.

It is essential that the development of Philippine positions on various issues of the Convention remain guided by the scientific assessments at the national level. Our policies and measures for mitigation and adaptation can

only be based on our capacity to undertake these measures given the scientific analyses specific to Philippine conditions. At the same time, it is also important for the Philippines to be involved in all the scientific and technical activities relevant to climate change at the international level so that specific Philippine circumstances may be taken into account in the adoption of any decision at the level of the Convention. In this manner, for example, the Philippines can assess the kind of technologies it would require to implement measures addressing climate change and its adverse effects.

Selected Issues in the UNFCCC: Philippine Policy Perspectives

National Communications

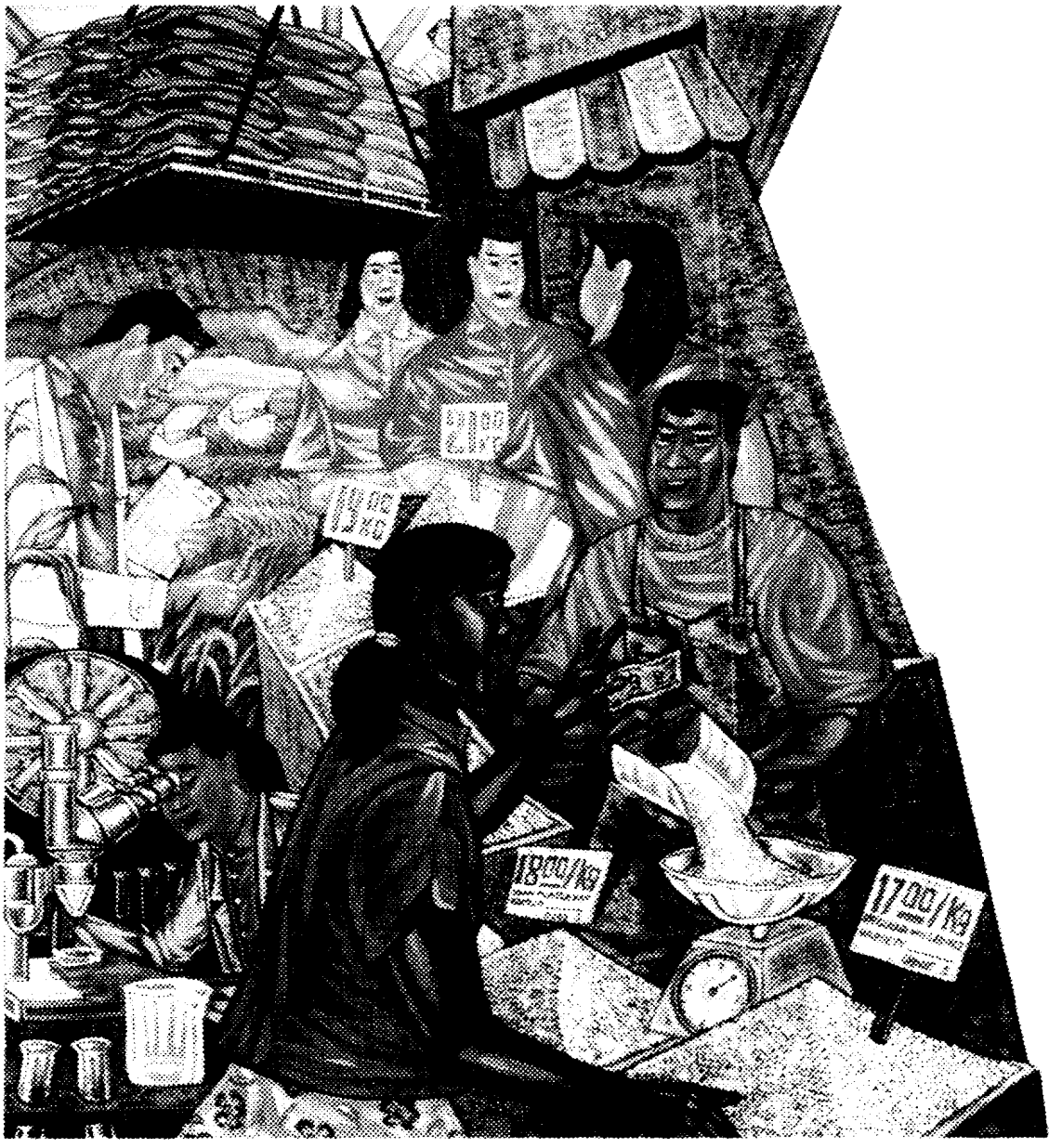
Philippine policymaking related to the national communications fully takes into account the principle of common but differentiated responsibilities.

In accordance with Article 4.3 of the Convention, the agreed full cost incurred in the preparation of the national communications of developing countries are to be met through new and additional financial resources provided by developed country Parties. This financial assistance is provided through an operating entity of the financial mechanism of the Convention, which is currently the GEF. The Philippines has availed itself of GEF assistance in the preparation of its national communications. As the preparation of the national communications is a continuing process, the provision of financial assistance would have to be made available not only for the initial but also for subsequent national communications.

Contents of the national communications of each Party to the Convention are provided in Article 12.1, and through subsequent decisions of the COP. To reflect the differentiated responsibilities under the Convention, additional requirements for inclusion in the national communications of developed country Parties are given in Articles 12.2 and 12.3. These articles specifically require a detailed description of policies and measures of developed country Parties in the implementation of their mitigation commitments. Developed countries are also obliged to

incorporate in their national communications details of measures undertaken to implement their commitments on the provision of new and additional financial resources, on transfer of technology, and on meeting the costs of adaptation for countries particularly vulnerable to the adverse effects of climate change.

There are different timetables for the submission of national communications of developed and developing countries. While reviews are required for the information submitted in the national communications of developed



countries, it is the overall aggregated effect of steps taken by all Parties, including developing country Parties, that is the objective of the consideration of their national communications. All these differences result from the application of the principle of common but differentiated responsibilities in the Convention.

Provision of New and Additional Financial Resources and Transfer of Technology

Two of the essential commitments of developed country Parties in the Convention are found in Articles 4.3 (on the provision of new and additional financial resources to developing countries) and 4.5 (on transfer of, or access to, environmentally sound technologies and know-how to developing countries). Once again, this is a reaffirmation of the principle of common but differentiated responsibilities. It is also a reflection of Chapters 33 and 34 of Agenda 21 agreed upon at the UN Conference on Environment and Development of 1992.

Without delving into the complexities of the implementation of these two commitments, it is important to underline the link of these commitments to those of developing countries as provided in Article 4.7, one of the most important articles of the Convention. The article states that the extent of the implementation of developing countries of their commitments under the Convention is dependent on the effective implementation of the developed countries' commitments related to financial resources and transfer of technology. In particular, it underlines that these must take fully into account "that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties".

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This provision reiterates the nature of the Convention as one for sustainable development – the full integration of environmental management with development planning. Financial resources and transfer of technology are not provided to serve mitigation needs of developed country Parties, but to achieve the ultimate objective of the Convention in a sustainable manner.

Capacity-Building

Capacity-building cuts across all the issues of the UNFCCC process. The discussion focuses on needs identified by developing countries and as interpreted by the developed countries. It is best to remain guided by the provisions of the Convention which states that there must be support for "the development and enhancement of endogenous capacities and technologies of developing countries" [Article 4.5] and of "improving (developing countries') endogenous capacities and capabilities" to participate in research and systematic observation activities [Article 5-c]. These two examples clearly illustrate that these capacities to be built must be those relevant to the needs of the developing countries, and not brought in from outside of these countries.

Capacity-building activities should not be used to facilitate market access in developing countries for developed country technologies, nor to advance the needs of developed countries for assistance in meeting their mitigation targets. Developing countries themselves must remain aware of these distortions in the activities undertaken for so-called capacity-building purposes.

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The Kyoto Protocol and the Clean Development Mechanism: Bases of Philippine Positions

The Kyoto Protocol to the UNFCCC was negotiated as a result of the first of a series of reviews on the adequacy of commitments of developed country Parties called for in Article 4.2 (d) of the Convention. The first review, conducted during the first meeting of the COP in Berlin, Germany, in 1995, concluded that the commitments of developed country Parties under the Convention are inadequate to meet the objective of the Convention. The Kyoto Protocol was then negotiated to set specific targets for emissions reductions of developed countries.

There are three articles in the Kyoto Protocol which are the contributions of the developing countries : Article 10, which is based on Article 4.1 of the Convention, reiterating the principle of common but differentiated responsibilities and sets out means through which existing commitments

under the Convention can continue to be implemented in support of the Protocol; Article 11, which is linked with the activities identified in Article 10 ; and Article 12, which is on the CDM.

It is worthwhile to recall that the CDM was put forward by the developing countries primarily in support for the creation of a clean development fund. It was the second part of a Brazilian proposal on a scientific measurement of contributions to global climate change which would take into account the historical responsibilities of States. Originally introduced as a penalty fund (for those developed countries which would not be able to meet their targets within specified periods under the Protocol), the Article defined instead an implementation mechanism (which would assist developed country Parties to meet their emissions reductions targets outside of their territories).

The CDM is one of three so-called mechanisms of the Kyoto Protocol, but the only one which involves the participation of developing country Parties. It is likewise important to keep in mind that the CDM, as put forward by the developing countries, is intended to assist the developed countries to meet their emissions reduction targets under the Kyoto Protocol. Any technology or financial transfer that would take place between a developing and developed country in projects undertaken under the CDM that reduces emissions would be credited to the developed country. These transfers are in no way to be deemed as the implementation of developed countries' commitments in terms of transfer of technology and financial resources as described in the section above. For this reason, the Philippines has taken the position that CDM projects are not to be financed through development assistance or through the financial mechanism of the Convention, nor should they be used as part of the implementation of technology transfer commitments of developed country Parties under the Convention.

Scientific assessments underlie the projects which are to be considered under the CDM, particularly in determining the baselines of the projects. The most important scientific assessment needed to guide policy positions, however, is one that will ensure the climate effectiveness of the CDM. This means that the use of the CDM by the developing countries

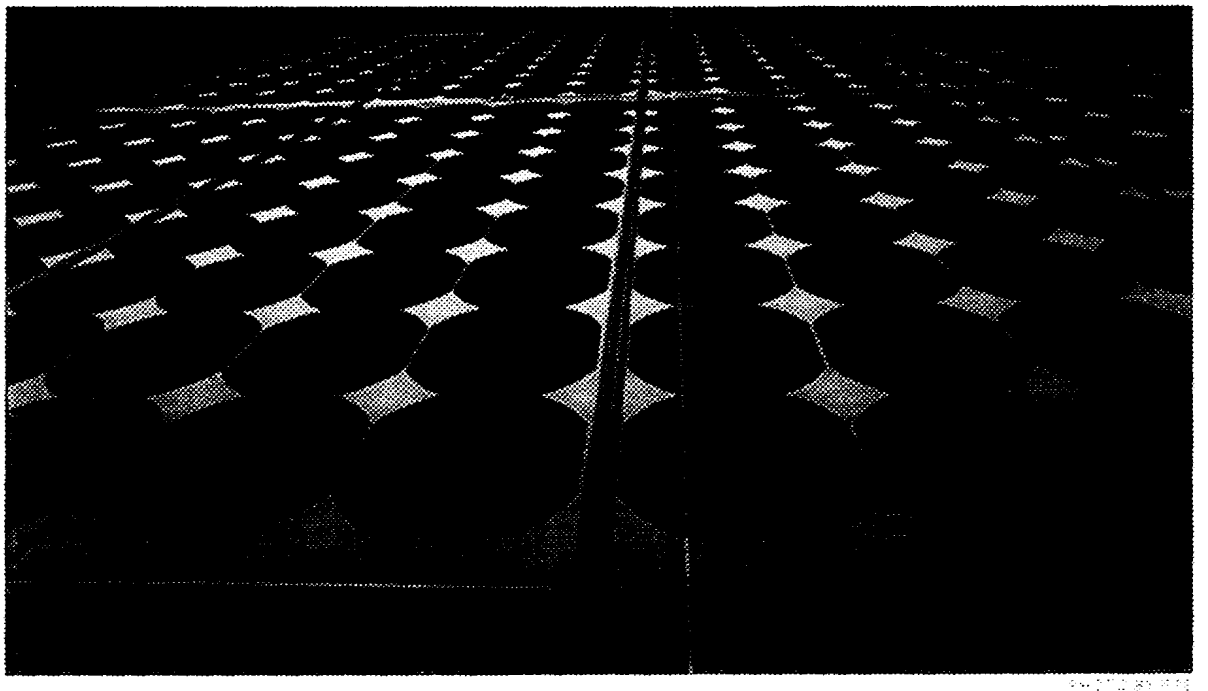
should assist them to achieve sustainable development and to contribute to the ultimate objective of the Convention [Article 12.2 of the Kyoto Protocol]. The CDM should not merely be an instrument to shift the burden of implementation of commitments from the developed countries to the developing countries.

The positions taken by the Philippines on the nature and function of this mechanism must ensure climate effectiveness, so that there are "real, measureable, long-term benefits related to the mitigation of climate change" in these projects [Article 12.5-b]. Good science must inform these policy choices.

The development of the Philippines' positions must always be consistent with the principles guiding the Convention. Considerations of equity remain primordial and scientific analysis must accompany policymaking at every step, to ensure that the Philippines can contribute to achieving the ultimate objective of the Convention.

Philippine Policies and Programs on New and Renewable Energy

*Reuben E. T. Quejas**



In response to the oil crisis in the 1970s, the government initiated a national program on the development of indigenous energy resources to achieve the country's energy self-sufficiency. Since then, the utilization and commercialization of new and renewable energy (NRE) sources and technologies have become one of the major strategies of the energy sector to attain energy self-reliance along with the protection of the environment.

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At present, the country's NRE Program aims to support the major thrust of the energy sector of attaining total electrification of the remote rural barangays in the country. The passage of the Clean Air Act of 1999 and the climate change issue further strengthened the government's commitment towards wide-scale utilization of NRE sources and technologies.

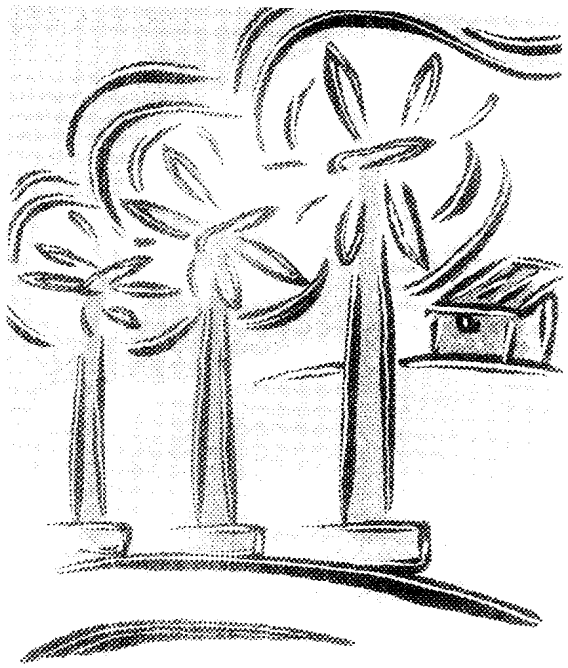
Present NRE Policies, Strategies and Programs

The Department of Energy (DOE) is mandated under Republic Act No. 7638 (RA 7638) to coordinate, supervise, control and prepare an integrated plan for all efforts, programs, projects and activities of the government relative to energy exploration, development and utilization. In executing its mandate, the Department firms up its long-term goal of energy-sufficiency, reliability and affordability within the context of environmental protection through the following efforts:

- formulation of clear policies and responsive plans and programs;
- intensive development of indigenous energy sources;
- effective coordination of downstream energy activities;
- provision of regional benefits to host communities;
- enhance private sector participation in energy projects; and
- close coordination and cooperation with other government agencies and private sector entities.

Specific to NRE, the DOE has embarked on the following major policy thrusts:

- provide right policy environment;
- nurture the NRE market;
- redefine the role of the government in the NRE sector



Right Policy Environment

The Department shall ensure that the overall NRE Program shall increase the contribution of NRE sources and technologies towards the country's energy self-sufficiency and support the overall poverty alleviation thrusts of the government, particularly in the remote rural areas where NRE systems are found to be viable. The DOE is committed to realize these objectives under the context of environmental protection and market globalization. Furthermore, the greater participation of the private sector shall be encouraged especially in the implementation and financing of various NRE projects and activities.

The NRE Market

The DOE also supports the establishment of various credit programs that will provide financial support to project developers and potential end-users in the NRE sector. Management and dissemination of information and training programs shall also be undertaken to promote the development of the NRE market in the country. Quality standards for commercially available NRE systems and products shall also be established and implemented to ensure consumer protection.

Government Roles in the NRE Market

The Department constantly reviews its NRE program to redefine roles in response to the various developments in the sector.

- Grant support to various government-initiated NRE projects must be assessed to ensure that blanket subsidies being provided to NRE end-users are justified according to their socio-economic conditions.

- There is a need to review the effectiveness of the centralized detailed planning approach within the NRE sector in order to see if a decentralized, community-level approach would be more appropriate and efficient in terms of project delivery.

- Perceived restrictive regulations in the form of detailed but sometime unnecessary requirements and circuitous procedures shall be revised to ensure immediate approval and implementation of NRE projects.

- There is a need to review the so-called "do everything" attitude of the government to ensure that all stakeholders and other interested parties can fully participate and contribute in the attainment of the overall goals of the program.

The DOE, through its Energy Utilization Management Bureau, oversees the NRE Program in coordination with other energy-related agencies including the National Power Corporation, the Philippine National Oil Company-Energy Research and Development Center, the National Electrification Administration, and the Department of Science and Technology and its attached agencies.

Status of NRE Utilization

NRE Contribution to the National Energy Mix

In 1973, indigenous energy contribution to the total energy mix accounted for about eight percent or 5.6 MMBOE, with NRE sources contributing a meager share of around three percent or 2.2 MMBOE.

To date, NRE sources continue to provide about 68.641 MMBOE (approx. 28 percent) in the overall primary energy mix of the country. Biomass energy provides the largest contribution among NRE sources, with about 69 MMBOE or about 99.9 percent. Other resources such as industrial waste, micro-hydro, solar and wind energy provide a meager share of around 0.06 MMBOE or 0.09 percent of the total NRE contribution.

Table 1. NRE Contribution by Resource, 1999

Resource	Contribution (MMBFOE)	Percent
Biomass	*68.58*	*99.911*
Bagasse	10.165	14.809
Charcoal	4.41	6.424
Coconut Residues	11.07	16.128
Rice Residues	4.342	6.326
Wood/woodwastes	38.331	55.843
Animal Wastes	0.017	0.025
Other Biomass	0.245	0.357
Others	*0.061*	*0.089*
Industrial Wastes	0.042	0.061
Micro-hydro	0.003	0.004
Solar	0.016	0.023
Wind	0.001	0.001
TOTAL	**68.641**	**100.000**

Source: DOE NRE Report (As of December, 1999)

Inventory of NRE Installations

As of 1999, a total of 47,030 NRE systems of various applications have already been installed nationwide, benefiting approximately 188,120 individuals (Table 2). Majority of the systems installed are biomass energy systems with 42,039 units, followed by solar energy systems at 4,457 units. Said installations were results of combined efforts by the government and the private sector in pursuing NRE projects. On the other hand, most biomass systems were actually traditional systems employed by the agro-industries, which are characterized as inefficient and require rehabilitation and retrofitting to improve their performance.

NRE Supply Potential

Statistics from various government agencies show an optimistic future for NRE. Biomass resources are expected to become available in larger quantities as the increasing population and food consumption per capita shall prompt higher agricultural crop production. As shown in Table 3, the aggregate biomass supply potential is estimated at about 254 MMBOE by year 2000 and shall exhibit a modest growth to about 314 MMBOE in 2010. Major contributors include wood/woodwastes, agriwastes (bagasse, coconut and rice residues), animal wastes and municipal solid wastes.

Table 2. Inventory of NRE Installations, 1999

SYSTEM	NO. OF UNITS	
BIOMASS	**42,039**	
Biogas System		653
Biomass-fired Boiler		201
Biomass-fired Dryer		16,185
Biomass-fired Oven/Furnace/Kiln		18,645
Biomass-fired Cookstove		4,816
Gasifier System		64
Other Biomass Systems		1,475
SOLAR	**4,457**	
Solar Dryer		68
Solar Water Heater		432
Solar Photovoltaic Systems		3,957
WIND	**377**	
Wind Pump		368
Wind Turbine Generator		9
MICRO-HYDRO	**68**	
Other NRE Systems	**89**	
TOTAL		**47,030**

Source: DOE NRE Report (As of December 1999)

Table 3. Biomass Supply Projections 2000-2010, (in million)

BIOMASS	2000	2002	2004	2006	2008	2010
Rice Residues	7.87	8.28	8.7	9.13	9.57	10.02
Coconut Residues	23.56	24.2	24.85	25.5	26.16	26.82
Bagasse	18.52	19.28	20.05	20.83	21.62	22.43
Wood/Woodwastes	86.22	89.18	92.08	94.93	97.71	100.43
Animal Wastes	12.35	12.59	12.85	13.1	13.37	13.64
Municipal Wastes	105.25	112.2	119.12	126.05	133.12	140.42
TOTAL	**253.76**	**265.73**	**277.65**	**289.53**	**301.54**	**313.76**

Source: Philippine Energy Plan 1999-2008

Being located just above the equator, the Philippines has a vast potential for various solar energy applications. The country's average daily insolation is around 5 kwh/m²/day. This indicates that solar energy is almost available everywhere in the country and can be utilized to provide electrification especially in remote rural areas where grid connection is not viable.

The Wind Energy Resource Atlas of the Philippines shows that the potential capacity for this energy resource is estimated to be about 70,000 MW. Region I has the largest wind resource potential while Regions VI, V and III, and the Cordillera Administrative Region also have good wind regimes either for on-grid or off-grid power production.

Meanwhile, there are about 28 MW of aggregate micro-hydro (less than 100 kW) power potential located in various areas of the country. Similarly, there are many mini-hydro (100 kW to 10 MW) sites in the country with an aggregate potential of about 1,132 MW.

The country's ocean resource area is 1,000 square kilometers, which is attributed mainly to its archipelagic nature. The potential theoretical capacity for this resource is estimated to be about 170,000 MW (Macawaris, 1998) using different types of ocean energy applications (ocean thermal, wave, tidal, current energy conversion systems). Although, there is very little information available on the potential of ocean energy, navigational experiences hypothesize that these systems are significant resource options.

The contribution of NRE sources to the total energy mix is projected to increase from around 72 MMBFOE in year 2000 to almost 95 MMBFOE in 2010, with an average annual growth rate of 2.74 percent during the planning period. Biomass fuels shall contribute 72 MMBFOE or 99.8 percent in year 2000 to 92.34 MMBFOE or 97.7 percent in 2010, thereby continuing its dominance in the NRE sector.

At the end of the planning horizon, it is estimated that the contribution of NRE for power application shall have a cumulative total capacity of 341 MW, with biomass contributing 156 MW, and solar, wind and ocean technologies aggregately accounting for a total of 185 MW.

Table 4. NRE Demand Projections, 2000-2010 (in MMBFOE)

RESOURCE	2000	2002	2004	2006	2008	2010
Hydro	0.014	0.017	0.02	0.024	0.027	0.031
Wind	0.011	0.134	0.134	0.224	0.981	0.931
Solar	0.089	0.139	0.208	0.381	0.511	0.658
Ocean	-	-	-	0.534	0.534	0.534
Biomass	72	75.776	80.121	84.042	88.07	92.345
Animal Waste	0.181	0.296	0.415	0.539	0.663	0.802
Municipal Solid Waste	-	-	0.445	0.445	0.445	0.534
Bagasse	10.672	11.235	11.814	12.408	13.018	13.646
Coconut Residues	11.568	12.148	12.757	13.396	14.065	14.766
Rice Residues	4.723	5.088	5.476	5.839	6.213	6.611
Industrial Waste	0.006	0.007	0.007	0.007	0.007	0.007
Fuelwood (Household)	35.766	37.285	38.807	40.275	41.731	43.2
Fuelwood (Industrial)	4.52	4.984	5.494	6.058	6.678	7.363
Charcoal	4.558	4.731	4.905	5.075	5.244	5.415
TOTAL	72.114	76.066	80.481	85.204	90.124	94.559

Source: Philippine Energy Plan, 1999-2008.

Table 5. Grid-based NRE Power Systems (in MW)

SOURCES	2000-2005	2006-2010	TOTAL
SOLAR, WIND, OCEAN	35	120	155
BIOMASS	161	25	186
TOTAL	196	145	341

Source: Philippine Energy Plan 1999-2008.

NRE Investment Oppurtunities

Solar Photovoltaics

About 3,957 systems of various photovoltaic (PV) applications are located in the country, with an equivalent capacity of 567 kWp. These installations are largely attributed to the initial efforts of the Philippine-German Solar Energy Program in the 1980s. To date, mostly mono- and poly-crystalline modules have been utilized. Amorphous silicon panels have generally been used in very small applications. A number of local firms in the country are now involved in system integration, design, installation and distribution of PV modules and products. Most of the products, especially PV panels, are imported from countries such as the US, Australia, Germany and Japan. There is also some local capability in the manufacturing of balance of systems and solar batteries.

Solar Home Systems

Currently, an estimated 3,455 solar home systems (SHS) have been installed in various locations in the country. Systems have been installed through private companies, local cooperatives (multi-purpose, agricultural, credit, etc.) as well as Rural Electric Cooperatives. The technical potential for SHS is difficult to define and will strongly vary with the system price offered. At present, about five million rural households have no access to electrical power and could, in principle, be electrified through SHS. However, given the on-going conventional electrification by grid extension and limited affordability and accessibility of remote rural households result in a commercial potential of only about 500,000 SHS.

PV Battery-Charging Stations

About 257 communal PV battery-charging stations have been installed in the country. This type of system appears to be most suitable for economically depressed areas since most rural people own a battery and have it recharged in the nearby town. One battery charger can provide sufficient power for a single fluorescent tube for two weeks before being recharged. Powering a small TV set by battery is even a more popular application in the rural areas.

PVs for Telecommunications

Photovoltaics have also been successfully used for back-to-back relay stations of telecom companies in the country. From the engineering's point of view, such relays are often situated at optimal locations where grid power is not readily available (e.g. mountain tops). The potential market for PVs for the telecommunication industry would amount to

an estimate of over 100 PV relay systems with a capacity of 3kWp, at least. About 119 systems with a total capacity of 94 kWp have been recorded so far.

PVs for Water Pumping

PV-powered drinking water pumping appears promising. The DOE and its cooperators have installed some 126 systems nationwide with a total capacity of 175 kWp. However, the economic feasibility of the drinking water project greatly varies depending on the local conditions (presence and depth of subsurface water table), on the willingness to pay for water, and other factors. PVs for irrigation purposes is still considered too costly.

Other Applications

Other PV applications found in the country include PV-powered vaccine refrigerators, PV-powered incubators (for hatching chicken and duck eggs), PV-powered streetlights, PV-powered lighthouses of the Philippine Coastguard and the newly commissioned 28-kWp centralized plant providing electricity to 200 households of Pangan-an Island, Cebu. These additional PV installations have an estimated aggregate capacity of about 45.2 kWp.

Solar Water Heaters

At present, there exist about 432 solar water heaters (SWH) for residential and industrial applications. SWH are mostly used for residential applications (bathing and household uses). Most of the SWH are imported from Australia.

Wind Energy Systems

Wind pumps

As of 1999, about 368 units of wind pumps were recorded throughout the country. Multi-bladed wind pumps have been in the country since the beginning of the century. They are mostly used for irrigation of agricultural farms and for domestic water supply. Currently, there are seven local manufacturers and suppliers fabricating and marketing wind pumps in various areas of the country.

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Wind Turbine Generators

A wind resource analysis and mapping study was conducted for the Philippine archipelago by the United States National Renewable Energy Laboratory (US-NREL) with the use of an automated wind resource mapping program. Results show that there are many areas of good-to-excellent wind resource for utility-scale applications and excellent wind resource areas for village power applications, particularly in the northern and central regions of the Philippines. Theoretical potential is estimated to be around 70,000 MW. However, additional studies are required to more accurately assess the wind power potential, considering factors such as the existing transmission grid and accessibility.

At present, there are about nine installed wind turbine systems in the country. One is the 10kW stand-alone system in the Northern Philippines serving 25 households.

There are only two known suppliers of small wind electric systems (a few hundred watts). For larger units, direct contact with foreign manufacturers is being done by interested users.

Biomass Energy Systems

Biomass technologies being utilized in the country range from the use of bagasse for cogeneration, rice/coconut husks dryers for crop drying, biomass gasifiers for mechanical and electrical applications, fuelwood and agri-wastes for oven, kiln, furnace, and cookstoves for cooking or heating purposes.

Fuelwood

Fuelwood is a major source of energy, particularly in the rural areas, through the use of cookstoves. Aside from being used as household fuels, wood and wood charcoal are also utilized in small-scale commercial activities (bakeries, restaurants, barbecue stalls, tobacco flue-curing, furniture making, among others). Current efforts are focused on the commercial dissemination of improved cookstoves to realize the potential savings from the supply base and the equivalent greenhouse gas emission reduction from fuelwood. The dendrothermal power program was not fully implemented due to management problems, supply or availability of wood, and peace and order instability, among others.

Bagasse

Sugarcane residue is used directly in sugar centrals as boiler fuel. There are about 39 operating sugar mills in the country, with an average production of 4,600 tons of canes per day. Bagasse roughly contributed about 10.16 MMBOE, mostly to the industrial sector or 3.6 percent to the total energy mix in 1998. A joint report of the UNDP and Word Bank has estimated that bagasse can produce as much as 60-90 MW of power that can be exported to the grid.

Rice hull

Total rice hull potential was estimated at 2.26 million metric tons in 1996. In some areas of the country, this residue is used as fuel in households and rural industries. It is also used as fuel for paddy and brick making. The same UNDP-WB report puts the exportable power of this resource at 40 MW. Several power projects in the past have shown the technical feasibility of the use of rice hull.

There are attempts to undertake grid-based power projects using this resource. The DOE provided partial accreditation to two large-scale rice hull-fired power projects, one of which is the 35-MW plant in Bulacan and another is a 25- to 35-MW plant in Nueva Ecija.

Coconut Residues (Husks/Shells/Fronds)

These residues are largely utilized as domestic and industrial fuels. Coco shells are converted into charcoal, which is primarily used for cooking, ironing and water heating. However, they are primarily processed into activated charcoal for export. As an industrial fuel, it is used for copra drying and in desiccating plants. Coco husks, on the other hand, are mainly used for copra drying and, to a lesser extent, as fuel for household cooking. Coco fronds are used for cooking fuel in households and drying in rural industries. The total potential of coco shell and coco husk in 1997 was 1.79 and four million metric tons, respectively. The Energy Sector Management Assistance Program study has also conservatively estimated that around 20 MW of power can be realized from coconut wastes and exported to the grid.

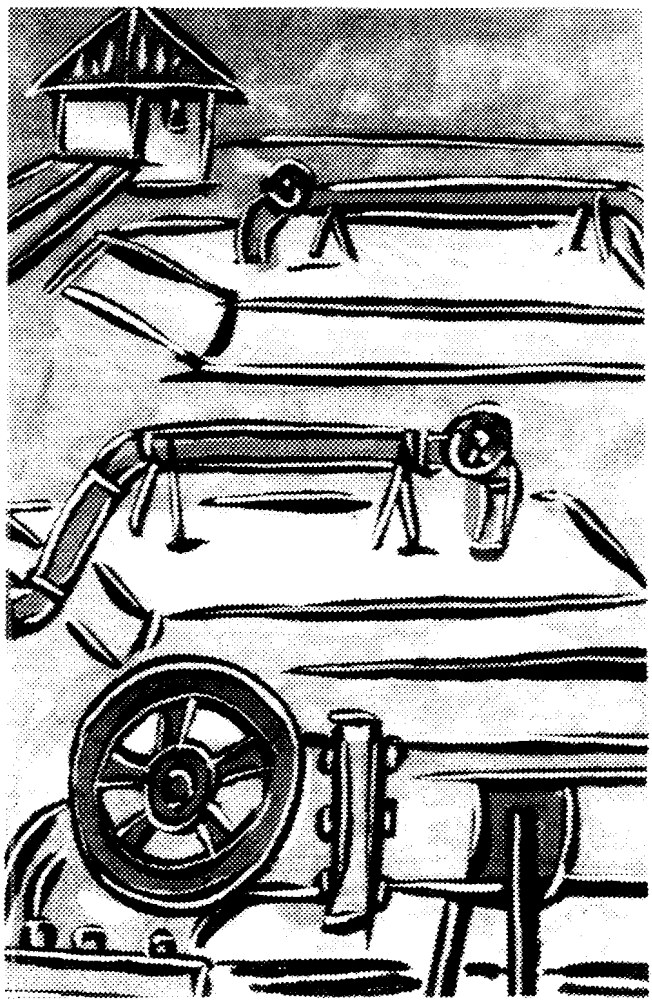
Animal Wastes

Currently, there are more than 653 operational biogas systems in the country, ranging from small- to large-scale systems. Most of these applications use wastes from poultry and livestock farms, and are seen more as a pollution-mitigating device. Environmental concerns are forcing hog farms to adopt biogas systems.

The technology is already in the commercial stage, and there are a total of nine biogas technology manufacturers and suppliers in the country. These manufacturers provide the necessary facility and service to biogas-system users. Services include sales and installation of turn-key plants, after-sales monitoring, and operation and maintenance services. Concrete digesters are being promoted for backyard to small-scale systems because of the availability of local and cheap materials.

Municipal Solid Wastes

A JICA-funded survey showed that in Metro Manila alone, wastes are being generated at an average of 0.431 kilograms per capita per day, indicating about 5,345 tons of garbage production. With the economic growth and increase in population, it is estimated that wastes generated in Metro Manila may double in the next 10 years. At present, there are two sanitary landfill sites and one open dumpsite in Metro Manila. However, because of the recent dumpsite tragedy, the continued use of these facilities is under consideration. Target disposal sites are encountering extreme opposition from residents and other sectors. Given these expected conditions, the development of waste-to-energy activities may not even be an option considering the implications of the recently enacted Clean Air Act.



Hydro Systems

Mini-hydro

In the Philippine Energy Plan, about 384 MW of mini-hydro power projects have been identified for implementation for the next 10 years (Table 5). The government has so far registered 37 mini-hydro plants located in various regions of the country, with a total installed capacity of about 74 MW and representing 6.5 percent of the total potential identified.

Table 6. Mini-Hydro Project, 2000-2008

Year	Name Of Project	Location	Capacity (Mw)	Annual Generation (Gwh)	Project Cost (Million Pesos)
2000	Bubunawan Falls	Bukidnon	7.00	37.60	265.20
2002	Lower Dugui	Catanduanes	2.50	12.00	184.50
2003	Taguibo River	Butuan City	7.24	36.15	234.16
	Upper Dugui	Catanduanes	6.90	28.00	509.22
	Batang-Batang	Palawan	7.00	30.00	401.80
2004	Odiongan 3	Gingoog City	10.00	69.20	656.10
	Pugu E	Agusan del Norte	6.80	33.10	343.46
2005	Cawayan 2	Sorsogon	2.50	12.00	66.08
	Bugtong Falls	Calbayog City	1.05	6.38	48.76
2006	Langogan	Puerto Princesa City	6.80	27.12	394.16
2007	Culaman River	Bukidnon	10.00	73.60	803.20
2008	Siaton	Negros Oriental	5.40	18.41	457.60
	TOTAL		**73.19**	**383.56**	**4,308.46**

Source: Philippine Energy Plan 1999-2008.

Micro-hydro Systems

As of end 1999, there were 68 units of micro-hydro systems installed, generating an aggregate capacity of 300 kW. Micro-hydro systems are justifiable for remote, decentralized power application. However, further activities that need to be undertaken shall include in-depth studies on the potential of micro-hydro systems, site identification, and an assessment of the socio-economic and environmental aspects.

Projects and Activities under the NRE Program

The following on-going and planned NRE projects and initiatives are being undertaken by the government and other key players in the NRE sector.

The O' Ilaw Program

Anchored on the commitment of President Estrada's administration to provide greater opportunities and benefits to the underprivileged, the GOP embarked on a program dubbed as "O Ilaw", which aims for the complete electrification of barangays by 2004. Under the program, energy will be a major prime pusher to spur economic growth in the countryside. This ambitious target will be achieved through the combined efforts and assistance of bilateral and multilateral institutions, the private sector, the LGUs and NGOs.

At present, 100 percent of the cities and municipalities are already energized. However, about 9,225 or 20 percent of our barangays still do not have access to electricity. Of these, about 50 to 75 percent can be connected to the grid, while the rest can be electrified using new and renewable technologies as an off-grid option.

The independent power producers (IPPS) will also be playing a major role in the program. Presently, about 1,700 barangays can be energized because they are located in provinces hosting power projects. The IPPS can donate or advance the electrification funds to construct distribution lines and may later reimburse the expenses from the DOE Fund, which is maintained pursuant to Energy Regulation 1-94.

Donor-Assisted Projects and Activities

In general, multilateral and bilateral funding assistance are currently being provided to the energy sector to assist the country in meeting its rural electrification goals and in developing a market-driven approach to the NRE projects and activities.

World Bank PHRD Grant on the Preparation of Rural Electrification Project

The on-going activities under this project include: 1) the conduct of a market assessment study on rural electrification to determine potential of NRE applications in unenergized barangays; 2) the conduct of a village-level resource assessment to determine potential off-grid electrification projects using NRE; 3) the study on the participation of the private sector in the rural electrification program; 4) the conduct of pre-investment or feasibility studies for off-grid rural electrification; and 5) the assessment of the roles of various agencies on rural electrification.

WB Pilot AID Project on Renewable Energy Application in the Island Grid

This is a pilot Activities Implemented Jointly project with the Swiss Government intended to put up a Hybrid system in Mindoro Island. The project is to be undertaken in three phases: preparation, implementation and monitoring. The project preparation phase has already been completed and two proposals have been submitted for possible Swiss funding in the implementation phase of the project.

UNDP-GEF Project Development Facility – Block B (PDF-B) Entitled "Capacity Building to Remove Barriers to Renewable Energy in the Philippines

The project is currently being executed by the DOE with the Institute of Climate, Energy and Environment (ICEE) as the implementor. The PDF-B Project aims to prepare a proposal to pursue a full GEF grant that will remove barriers to NRE commercial development and to co-finance pilot commercial NRE projects in the Philippines. Specific strategies will be designed to remove the following identified barriers: policy, information dissemination, public awareness, institutional strengthening, market strategies, delivery mechanism, standards and certification, financing mechanisms and donor coordination. The PDF-B Project is expected to be completed by the end of year 2000.

Financing Energy Services For Small Scale Energy Users (FINESSE) Project

The FINESSE Project, an on-going project of the UNDP, aims to develop and strengthen the technical capability of the Development Bank of Philippines in the evaluation and management of NRE projects. Furthermore, it aims to generate a pipeline of NRE projects for possible financing by the DBP itself.

Specifically, it shall enable the formulation of appropriate financing schemes in the form of loans under the Window III of DBP for NRE installations.

ADB Technical Assistance on Rural Electrification

The project aims to strengthen the institutional capability of the renewable energy sector to implement rural electrification projects. Specific activities that will be pursued under this project include the conduct of training programs, development of functional instructions and the establishment of a sustainable development program. The training program shall focus on the planning and design of off-grid rural electrification using NRE systems. The functional instructions component shall prepare the guidelines on the roles and functions of various government agencies and other key players in the implementation of off-grid rural electrification. The ADB has conducted the selection of project consultants and the project is expected to commence in the latter part of year 2000.

Major Bilateral Aids and Cooperation

Currently, there are about four major bilateral assistance projects involving actual NRE installations in various rural barangays in the country (Table 7). The first two are proposed projects under review and evaluation while the others are on-going. Said installations are expected to spur economic development in the areas concerned.

Table 7. *Major Bilateral Aids*

Name of Project	Cost	Funding Agency	Expected Outputs
1. Environmental Improvement for Economic Sustainability (EIES)	P410 Million	Netherlands Minister in Foreign Affairs	• Installation of 15,000 solar home systems in Region I, II and CAR
2. Photovoltaic Rural Electrification Service (PRES) Project in the Philippines	FRF 120 Million	French Protocol	• Electrification of various barangays in Regions V, VI & VII through the actual installation of about 7,750 PV systems for lighting, water pumping and other uses
3. Solar Power Technology Support Project (SPOTS)	P2.283 Billion	Spanish Aid	• Installation of solar energy systems in about 74 unelectrified and off-grid agrarian reform communities.
4. Municipal Solar Infrastructure Project (MSIP)	A$37.46 Million	AUSAid	• Provision of about 1,053 PV systems to power schools, health clinics, barangays halls and other rural infrastructures in about 359 barangays in the country.

Source: Various DOE Project Documents

There are also several projects currently being undertaken by the DOE in cooperation with bilateral donors. Most activities under these joint undertakings include exchange of information, exchange visits and other activities geared towards technology development. These bilateral donors were also viewed by the DOE as potential source of funds. Table 8 provides the list of projects currently being undertaken through bilateral cooperation.

Doe Projects and Activities

Affiliated Non-Conventional Energy Centers (ANECs)

The ANECs continue to provide support to the overall DOE and Barangay Electrification Programs. The centers act as project implementors in the field as well as technical and extension support to the DOE and its attached agencies in the overall electrification program.

Table 8. Projects Under Bilateral Cooperation

Cooperation	Scope of Cooperation	Status
1. RP – India	Solar PV manufacturing Geothermal energy	
2. RP – Hawaii	Biomass energy	• A report on potential cogeneration prospects from sugar mills in the Philippines is currently being developed
3. RP – China	NRE technology development	• Three NRE related proposals were submitted to the DFA for deliberation during the RP – China Joint Cooperation Meetings.
4. RP – EU	Rural electrification	• A proposal which aims to finance electrification of 200 off-grid barangays, was submitted to DFA for consideration.
5. RP – GTZ	PV standards and testing Wind Energy	• The GTZ did not prioritize the project for the year 2000.
6. RP – JICA	NRE /Diesel Hybrid Energy Systems	• A proposal for the utilization of diesel/ hybrid energy systems in various unelectrified off-grid barangays in the country

Source: DOE Project Documents (Various Files).

Management of Biomass and Solar Laboratories in the Philippines

The Biomass Laboratory in the University of the Philippines at Los Banos has made considerable progress in testing a rice hull-fed gasifier, a continuous-flow laboratory pyrolyzer and a simple gas clean-up unit. The Solar Laboratory in UP Diliman, on the other hand, continues to conduct technical studies on Solar Energy and provide technical assistance to solar PV end-users.

Renewable Energy Association of the Philippines (REAP)

REAP is a private organization of RE suppliers, manufacturers, distributors, service providers, project developers and consultancy groups. It has four affiliated local RE groups, which include the Philippine Solar Energy Society, the Wind Energy Association of the Philippines, the Biomass Energy Association of the Philippines and the Philippine Association of Small-Scale Hydro Developers in the Philippines.

The DOE continues to extend support to the REAP in its effort to promote and develop business opportunities in the RE sector. The DOE sees the vital role REAP is playing in coordinating the concerns and initiatives of the private sector. The DOE hopes the association will encourage greater private sector support to the rural electrification thrusts of the government and to the overall RE program.

National Anti-Poverty Commission (NAPC) – RE Collaboration

This cooperation under the government's overall Poverty Eradication Program aims to provide basic energy services using RE systems in several barangays. The focus is on the provision and generation of livelihood activities in the areas. A proposal on the scope of the collaboration is currently under review.

Relevant Laws and Proposed Bills on Renewable Energy Development

Existing Laws Relevant to the RE Sector

The Philippine government has developed several legislative measures envisioned to level the playing field for the renewable energy sector. This includes articulating policies favorable to renewable energy, removing perceived barriers to renewable energy development, providing a conducive market environment for RE development, and encouraging greater private sector investment and participation.

The Omnibus Investment Code (EO 226)

Executive Order (E.O.) 226, signed in 1987, gives both local and foreign investors complete information on all the incentives and incentive schemes they may avail of. Specifically, the Code enables the establishment of an annual Investment Priorities Plan, which provides a list of preferred areas for investment. The Plan covers critical industry sectors such as infrastructure development and modernization. Power generation activities, including renewable energy and cogeneration projects, fall under this category. Upon registration with the Board of Investments, project developers may avail of the several fiscal and financial incentives.

Executive Order 215 (As amended)

Executive Order 215, also signed in 1987, provides the legal framework for the private sector to operate power generation facilities. Energy Regulation No. 1-95 (ER 1-95), the implementing rules and regulations of the order, defines government procedure for the entry of independent power producers. Recently, DOE Circular No. 2000-03-004 revised ER 1-95.

Build-Operate-Transfer Law

The enactment of Republic Act 6957 (as amended by R.A. 7718) institutionalized various project-financing schemes that encourage the participation of both foreign and local investors in the country's infrastructure development program. In particular, Build-Operate-Own and Build-Operate-Transfer (BOT) schemes have been successful in financing and constructing additional power generation capacity. Under the BOT Law, firms are given incentives and all government infrastructure agencies including government-owned and -controlled corporations are authorized to award contracts under these schemes.

Mini-hydro Power Incentives Act (RA 7156)

Republic Act 7156 provides the legal framework for the development of mini-hydro projects in the country. It also provides appropriate incentives to ensure a reasonable rate of return for mini-hydro developers. The law also aims to facilitate hydro power development by eliminating overlapping jurisdiction of the many government agencies in various requirements by vesting in one agency the exclusive authority and responsibility to develop hydro power.

Executive Order No. 462 (As amended)

Executive Order 462, signed in 1997, aims to encourage private-sector participation in the exploration, development, utilization and commercialization of ocean, solar and wind (OSW) energy resources for power generation. Its implementing rules and regulations provide the necessary guidelines for the accreditation, review and approval of grid-connected OSW power project proposals by private proponents. Recently, EO No. 232 was signed by President Estrada amending E.O. 462 to make the OSW program more appealing to the private sector. The amended Rules removes some of the barriers the NRE industry perceives to be hampering private sector business.

Legislative Agenda Relevant to NRE Development

The following are the major legislative proposals that have direct impacts on the development of NRE projects in the country.

Omnibus Power Industry Bill

House Bill 8457, also known as the Electricity Industry Reform Bill, aims to restructure the electric power industry in the country to encourage greater private-sector participation in the power sector, and to achieve more stable and cheaper electricity rates in the long term. The bill proposes the privatization of the NPC and encourages the development and utilization of indigenous energy resources.

The NRE Bill

The DOE is also pushing for the enactment of the NRE Bill to accelerate NRE development, utilization and commercialization in the country. The Bill recognizes the vital role that NRE sources and technologies can play in providing adequate and sustainable energy services to remote rural barangays, and in attaining the environmental and social objectives of the energy sector. The salient features of the NRE bill include:

- Declaration of the State policy of giving preference to the development and utilization of NRE resources and technologies in view of its environmental and social desirability;
- Greater Private Sector Participation
- Encouragement of Renewable Energy Service Companies
- Provision of financial and fiscal incentives to NRE power producers and local manufacturers;
- Provision of a framework in the implementation of the NRE Program;
- Establishment of an NRE trust fund;
- Allowing hybrid installations for off-grid rural electrification; and
- Establishment of product standards and testing procedures for all NRE systems, equipment, products and services.

PHOTO BY G. NARTEA

Conclusion

The NRE Program has gone a long way since its inception in the late '70s. The present thrust of the program is to provide an additional option to attain the 100-percent electrification of the country's rural barangays. Major studies are currently being implemented to ensure that NRE activities would properly complement conventional electrification schemes.

Current activities are focused on the institutionalization of necessary policies as well as innovative financing and delivery mechanisms to accelerate NRE development and utilization in the country. The Program

recognizes the important roles of the private sector to finance and implement NRE projects and activities in the country. Efforts are also being done to level the playing field for NRE technologies against the traditionally favored conventional energy systems. Likewise, necessary information such as resource and market data and other related technical considerations are currently being generated and consolidated to make them more useful and accessible in developing NRE projects.

In the long term, NRE resources and technologies are seen to provide greater contribution in solving global environmental problems such as climate change and environmental degradation due to the use of fossil fuels. It provides a viable alternative to the increasing costs of petroleum and oil-based fuels that can translate to cheaper and more affordable power to rural households.

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Local Climate Action: Fine-tuning Local Mindsets

Pamela I. Gallares-Oppus *

PHOTO BY E.D. BALATAN

Food, shelter, employment, livelihood, health, access to clean water, waste management, roads — these are the first order of priorities that present-day local managers in the Philippines are compelled to address. Amidst all these issues, *is climate protection relevant in Philippine local governance?*

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Such question nags climate protection advocates that attempt to mainstream climate protection in developing countries. For a phenomenon whose impacts are projected to be felt decades hence, climate change remains to be a remote issue. Moreover, since developing countries' emissions are much lower than those of developed countries climate protection is believed to be a concern for the industrialized world.

But climate protection is relevant in Philippine local governance.

The Cities for Climate Protection Campaign™ (CCP) Campaign of ICLEI engages local governments worldwide to collectively reduce greenhouse gas (GHG) emissions to mitigate climate change. The Campaign abides by a five-milestone framework where quantifying and forecasting GHG emissions is the first. The CCP is implementing a USAID-assisted pilot project in the Philippines, involving the cities of Naga, Puerto Princesa, Tagbilaran, Cagayan de Oro and Cebu.

Local Impacts of Climate Change

"Why should local governments in developing countries such as the Philippines bother to reduce its emissions when more developed and industrialized countries produce more?"

Unfortunately, the impacts of climate change are not confined to developed countries where the bulk of GHG emissions are found. Studies indicate that cities in developing countries are more vulnerable to the effects of climate change because their "ability to adapt to change is already stretched to the limit" [ICLEI, 1995]. "Climate change will add to other stresses such as rapid urbanization, industrialization and economic development, which contribute to the unsustainable exploitation of natural resources, increased pollution, land degradation and other environmental problems" [ICLEI, 1997].

The vulnerability assessment conducted by PAGASA [PAGASA, 1999] posits that the Philippines, being an archipelagic country, would be highly vulnerable to the impacts of climate change. A 2° to 3°C temperature rise could double annual rainfall in some regions like Central Luzon, Southern Tagalog and all regions in the Visayas. This increased rainfall may aggravate soil erosion, especially in denuded watersheds. Heavier rainfall may also result in flooding due to increased runoff. In other

regions, like northern and eastern Mindanao, a decreased annual rainfall will affect the availability of water resources. Crops, industries and domestic consumption will compete for a reduced water supply. Increasing temperatures may also affect crop yields[1], and an accelerated sea level rise will affect coastal habitats [Perez et al., 1996].

All these negative environmental effects will take its toll on human health. The US EPA [1997] outlined the potential health impacts of global climate change. Among the significant health impacts that would most likely affect the Philippines are the following:

- Aggravated cardiovascular and respiratory diseases and allergies due to worsening air quality

- Increased cases of infectious diseases like malaria, dengue fever and intestinal illnesses

- Deaths and injuries from storms and floods, as well as intestinal illnesses resulting from the flooding of sewage treatment plants

- Increased malnutrition

Global Commitment to Local Climate Action

To respond to this issue, 154 local governments and the European Community signed the Climate Convention in June 1992 during the UN Conference on Environment and Development in Rio de Janeiro. The convention laid down some basic agreements [KLEE 1995]. Two of those relevant to the Philippines are the following:

- "Stabilize the concentration of greenhouse gases at a level that would prevent dangerous human interference with the climate system."

- "Take measures to limit anthropogenic emissions of CO_2 and to protect and enhance CO_2 sinks and reservoirs (forests)."

Local governments anywhere cannot do away with electricity, transport, waste and water distribution. Amidst the burning issues of climate change, how can local governments operate efficiently and effectively? More so, how will economic development proceed for developing countries like the Philippines?

Although unknown to many, local governments in the Philippines are already implementing programs and measures that are

protective of the climate. With the surge of western-oriented urbanization that demands more energy use, local governments may veer towards an energy-intensive growth rather than a climate-friendly yet business-as-usual growth. The following sections provide a snapshot of where climate actions stand in the Philippines.

Policies for Local Climate Action

"How remote is climate action from the Philippine local government's psyche?"

One milestone policy in Philippine democracy is the enactment of Republic Act 7160 or the Local Government Code of 1991. The Code devolves power and authority to local governments to respond to their constituents' needs. Basic climate action-friendly devolved functions include:

- Basic services delivery (e.g. shelter)
- Regulatory powers (e.g. issuing licenses to tricycles)
- Enhanced governmental and corporate powers (demand-side management)
- Improved national government-LGU relations
- Institutionalized LGU-NGO/private sector relations

Republic Act 7160 Sec.16 provides local government units with the power to promote the health and safety of their constituents, and enhance the right of the people to a balanced ecology [Pimentel, 1991]. Furthermore, RA 7160 Sec. 17 identifies and provides some environment and national

PHOTO BY Gil HARTEA

resources management functions specially accorded to cities and municipalities, to wit:

- Management and control of communal forests, implementation of community-based forestry projects, and establishment of tree parks, greenbelts and other similar forest development projects;

- Solid waste disposal system or environmental management system and services of facilities related to general hygiene and sanitation; and

- Implementing measures and enforcement of laws on pollution control, small-scale mining, mini-hydro electric projects.

The Guide to Local Environment Code Formulation [LogoDef, 1996] encourages climate protection under the rubric of Ambient Air Quality. Section 7, entitled "Reducing CO_2 Emissions", suggests the following broad actions:

- establish, replenish and maintain urban/municipal greeneries such as forests, tree parks and greenbelt areas which act as carbon sinks;

- implement restrictions on CO_2 emissions from stationary fossil fuel-powered facilities as prescribed by the DENR;

- propagate energy-saving measures such as daylight savings time; foster cooperative ventures in the use of power-generating machines; promote mass transport systems to encourage vehicle owners to leave their cars at home;

- strictly enforce the anti-smoke belching program;

- develop more efficient power generation systems, including hydraulic and geothermal energy.

Sections 8 to 11 of the Guide to Local Environment Code Formulation also provide for the reduction of other GHG emissions, the reduction of substances that deplete the ozone layer, the abatement of urban air pollution from motor vehicles, and the prevention of open burning.

With regard to deforestation, supporting policy provisions on the ban on slash-and-burn and the cutting of trees are described in Chapter 2 of the Guidebook [LogoDef, 1996].

Co-Benefits of Local Climate Action

Are local governments in the Philippines equipped towards climate action?

Policy-wise, yes. However, much is wanting in terms of actual performance. Therefore, outlining a few entry points for local climate action that are anchored on codal provisions, with occasional reference to actual programs and projects, may be worthwhile. The discussion is limited to immediately doable (meaning, no new local capital involved) emissions-reducing actions initiated by the government. This does not include either adaptation measures or new technologies that are capital-intensive (e.g. solar energy).

Access to Basic Services

Access to basic services and economic development is a primary local government concern that has resulted in and would still lead to the building of more road networks and the use of motorized transport. The lack of an efficient mass transport infrastructure within cities and across local governments, compounded by the lack of other available economic opportunities for the poorer

PHOTO BY DID BALATAN

communities, has served as an incentive for communities to engage in the transport business, resulting in overflow and congestion. A perfect example is the proliferation of tricycles in small and tourist-oriented cities, and the growing number of taxis, buses and jeepneys in medium-sized and larger cities. Here, the issue of affordability comes into play. Since majority of the local governments in the Philippines cannot afford cleaner engines to boost the transport sector, they have, for some time, resorted to importing cheaper, second-hand and pollutive transport units.

Even prior to the Clean Air Act of 1999, local governments (e.g. Cagayan de Oro) have attempted to address the issue of air pollution through emissions testing and apprehension. While the absence of an air quality monitoring equipment cannot attest to the improvement of air quality in the city, the act of regulating and apprehending drivers of pollutive vehicles is sufficient for anyone to appreciate that potential air pollutants emitted by engines are being minimized. Similar initiatives are being done in Puerto Princesa, Cebu City and Metro Manila. Smaller cities like Naga and Tagbilaran are already laying the groundwork for similar measures even without the Clean Air Act's Implementing Rules and Regulations.

Apart from emissions, the growing demand for access and mobility has led to the regulation and planning of road use and route access to mitigate traffic congestion. In larger cities like Manila, measures such as road-use scheduling (i.e. known as the color-coding scheme, truck bans in major highways during designated hours and the carless oval at the University of the Philippines during Sundays), 'pedestrianization' (Makati's networked walkways), putting up of biking paths (in Marikina), route assignments (banning of three-wheelers in major roads), high parking fees, and building mass transport systems are

incentives against individual car use. Smaller cities like Cagayan de Oro, Tagbilaran, Puerto Princesa and Butuan are gearing up for traffic rerouting schemes, which, if not carefully planned, may cause conflicts among the transport groups.

A remarkable but indirect traffic-related measure is Marikina's award-winning "Politika sa Bangketa" [LGA, 1997; Gallares-Oppus, 1999]. The mayor relocated ambulant vendors off the road to designated zones without sacrificing economic activities. This allowed the city government to regulate the informal sector and increase local government revenues, while clearing the streets for road vehicle users and pedestrians. This did not require Marikina to spend much on expanding its existing roads.

To further 'disabuse' local managers from equating access with excessive road-building and motorized transport use, the Integrated Rural Accessibility Planning (IRAP) Project [LGA, 1997] was adopted by a number of local governments. Here, access to basic services is premised on the people's needs and on the people's way of life, whereby service facilities are planned with and for communities. Contrary to its label, accessibility planning is applicable to the urban setting with communities actually defining travel patterns and access routes. As such, enhanced access among communities may result in time saved for travel, improved access to services, minimized investments on unnecessary infrastructure on the part of the local government, and reduced pollution.

There are a lot of other options for local governments and communities to choose from [STAPPA-ALAPCO, 1998]. Any or a combination of these measures would lead to reduced use of motor vehicles, time and financial savings, cleaner air and reduced GHG emissions.

Housing

Shelter provision is a devolved function, and it is a growing demand in light of the mushrooming rural migrants in urbanized areas. While it is a basic need, housing

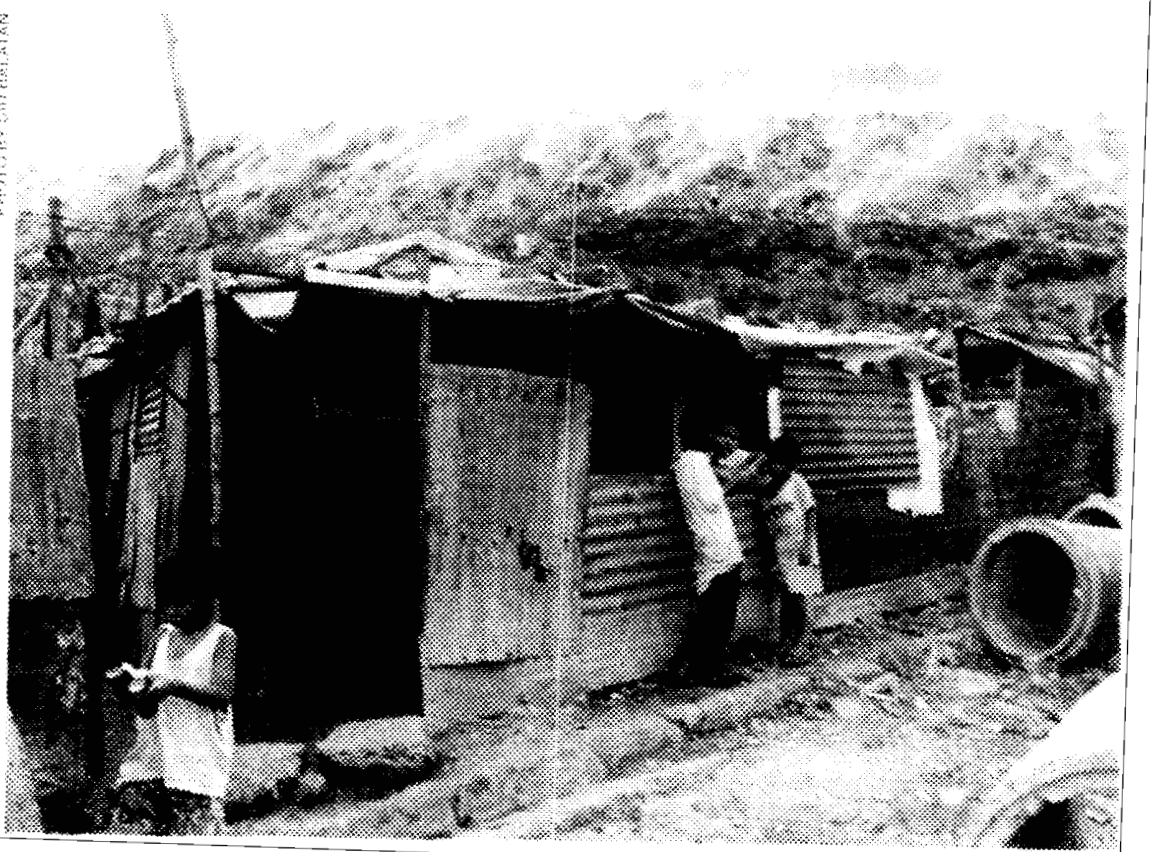


PHOTO BY GIO BALATAN

projects also have the potential to raise revenues and voters.

Housing projects consider a host of interdependent factors like access to economic opportunities, presence of basic utilities, livability, security and affordability. From the perspective of climate action, decision-makers grapple with factors like clearing forests and extracting raw materials for construction.

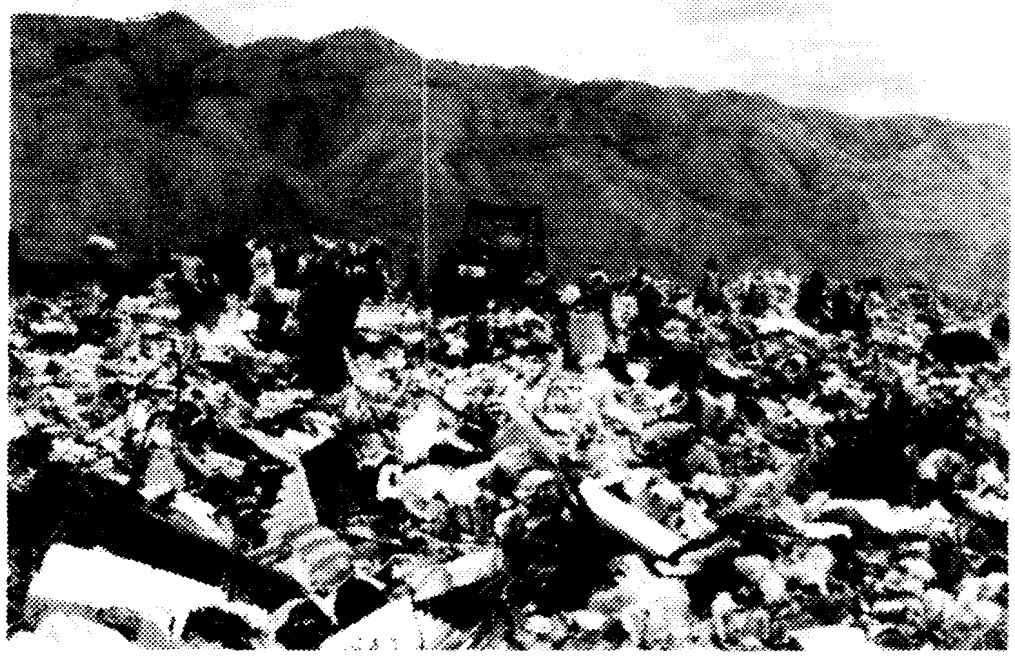


PHOTO BY GIL NARTEA

More basic and doable measures are building and area design. While all housing projects face budgetary constraints, building design can be improved to factor in climate-friendly components. Provisions for enhanced ventilation and illumination, choice of building materials that absorb heat less, spaces for rainwater catchment and composting are some design dimensions that will potentially reduce energy demand while improving domestic comfort and livability. The returns are financial savings and reduced GHG emissions from reduced energy demand. Puerto Princesa's ongoing "Green Homes, Green Communities" mass housing project proves that local governments can very well influence decisions towards building climate-friendly communities.

Watersheds and Forestry Development

Potable water supply is still a luxury even in highly urbanized local governments. Access to water becomes an added cost as households purchase bottled water and, in some areas, pay for water delivery services. Except for those local governments blessed with abundant fresh water sources, most local governments rely on ground water. The depletion of ground water, brought about by factors like unmonitored extraction, contamination from untreated sewage systems and unsanitary landfills, and deforestation, threatens local government coffers and the political stature needed to provide for its constituents, businesses, industries and agriculture.

Local governments have made efforts to preserve its watershed areas. Among the famous and successful tree-growing efforts are those in the cities of Puerto Princesa and Baguio. Puerto Princesa's Feast of the Forest has grown over a million trees in eight years with an 80-percent survival rate. Baguio City's "Saving the Busol Watershed", on the other hand, has also provided an avenue for civil society to continually monitor and ensure the survival of trees. Cebu City's nongovernment sector has bullishly advocated the preservation of its watershed areas.

Waste Disposal

One characteristic of urbanizing local governments is the growing volume of waste generated from a mix of sectors — household, business and industry. With the problems of space, foul smell, groundwater contamination and dangers from methane combustion in landfills, the issue of waste dumping confronts majority of local governments.

Based on documentation, Cebu City is the only local government that has an existing sanitary landfill. However, it is facing the danger of full waste occupancy.

Alternative mechanisms for waste management have been put up for those who cannot afford landfills, for example, Sta. Maria, Bulacan has constructed a waste material recovery center. Its key features are waste segregation and composting of biodegradable waste. Waste has been minimized and other recyclable materials have been used to generate livelihood [illegible 1996]. A similar initiative was undertaken in Pasig, Manila, through its "Pasig Environmental Enhancement Project".

The matrix below synthesizes the enabling conditions covering both policy and local actions, and the potential co-benefits from existing measures.

Enabling Policy	Entry Points	Actions/Refinement/Options	Co-Benefits
Local Government Code of 1991	Access to Basic Services	• Planning with the Users/Communities • Shift to nonmotorized transport • Shift to mass transport • Consistent engine tune-up/maintenance • Road-sharing or road-use scheduling • Regulating ambulant vendors	• Greater access with less travel demand • Physical fitness • Trips cuts • Financial savings from reduced fuel consumption • Decongestion • Lesser emissions • Cleaner air
	Housing	• Greening building designs • Providing green spaces • Implement waste segregation at source • Use of energy-efficiency appliances • Provision for rainwater catchment	• Financial savings from reduced energy bills • Improved domestic livability • Lesser demand for water pumping
	Watershed Management	• Ensure survival rate after planting	• Cooler air • Safety from storm and floods • Protected groundwater
	Waste Disposal	• Waste segregation, recycling and reuse • Composting • Establishing markets for recovered materials to encourage/sustain segregation efforts	• Income-generating opportunities • Cost recovery for waste management • Longer lifespan of landfills • Fuel saved from less frequent garbage collection

Integrating Climate Dimensions in Local Governance: Issues and Challenges

A run-down of climate action co-benefits reveals the importance of building the capacity of LGUs to engage in climate action. For developing countries, the list of co-benefits, and not CO_2 reduction, is sufficient leverage for local governments to refine its local development policies, plans and actions. With a basic enabling policy at the fore, local governments can already go ahead with fine-tuning existing policies, plans and actions.

While the Implementing Rules and Regulations of the Clean Air Act are still in deliberation, much can be achieved using the Local Government Code as the major enabling policy anchor. As demonstrated, key measures can already be introduced in the areas of housing, waste management, watershed management and forestry, and public access/transport.

With the assumption that policies are springboards for plans and actions, a rough checklist of questions may be considered in integrating climate action into existing and available local policies, to wit:

- Does the Comprehensive Land Use Plan balance housing/commercial and industrial use with green spaces/forests?

- Does the zoning plan favor multi-use of spaces for greater service accessibility and reduce travel demand?

- Does the Building Code integrate provisions for energy efficiency? Does it provide for pedestrian space?

- Does the Socialized Housing Design reduce energy demand and enhance domestic livability?

- Has the Local School Board integrated climate protection in its academic curriculum?

- Is there a rational basis (i.e., a passenger-demand ratio) in issuing franchise licenses to tricycles? Does an ordinance put a cap for franchises?

- Does a traffic and management board unit monitor and regulate the flow of traffic to avoid congestion?

- Is waste sorting and minimization encouraged?

- Does the local investment and energy board encourage demand-side management and energy efficiency especially among government-owned buildings?

While LGUs attempt to transform these questions into policies and actions in a participatory manner, the following more pressing political issues will also have to be confronted:

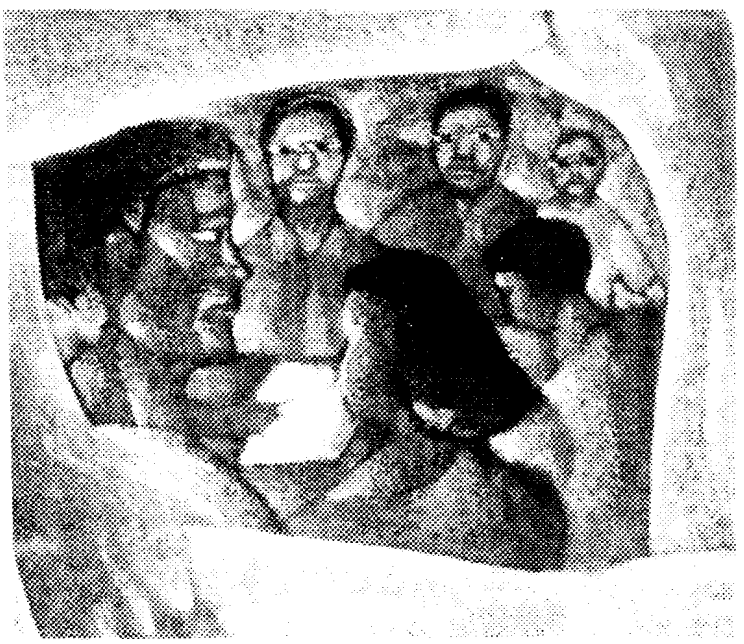
1. *Poverty and tricycle license regulation.* In smaller cities where income-generating opportunities are not as diverse as in the bigger cities, the issue of poverty prevails. How a local government could develop other creative opportunities for its poorer communities apart from transport would be the challenge.

2. *Capital availability and the use of energy-efficient appliances.* Affordability of more sound technologies is a burning issue not only among low-income families but also among low-income local governments. The challenge is showing how higher initial capital investments would redound to long-term savings. A greater challenge is accessing local financing windows that would provide win-win opportunities for the end-users and [illegible]

5. *Preserving green spaces vis-à-vis spaces for economic activities.* Urbanizing local governments are more often pro-industry and pro-business. The challenge is determining the local government's carrying capacity for expansion, which would not necessarily eliminate green spaces.

A Post-Script

Indeed, climate protection is not only about clipping GHG emissions from opulent sources. It is largely about reaping the socioeconomic and environmental profits from efficient and cost-effective local management. This requires fine-tuning parameters in policymaking, planning and implementation. Especially for small-sized local governments whose resources are mostly eaten up by personnel hiring and setting up basic service facilities, sound investments on energy-saving measures would generate financial savings from avoiding the pitfalls of western-oriented progress. These savings may also be rechanelled to other worthwhile programs, and not on wasteful spending on inefficient energy use. In the long-term, local investments on climate action, while a bit costly at the front-end, would potentially save the vulnerable poverty groups from socioeconomic and environmental disaster.



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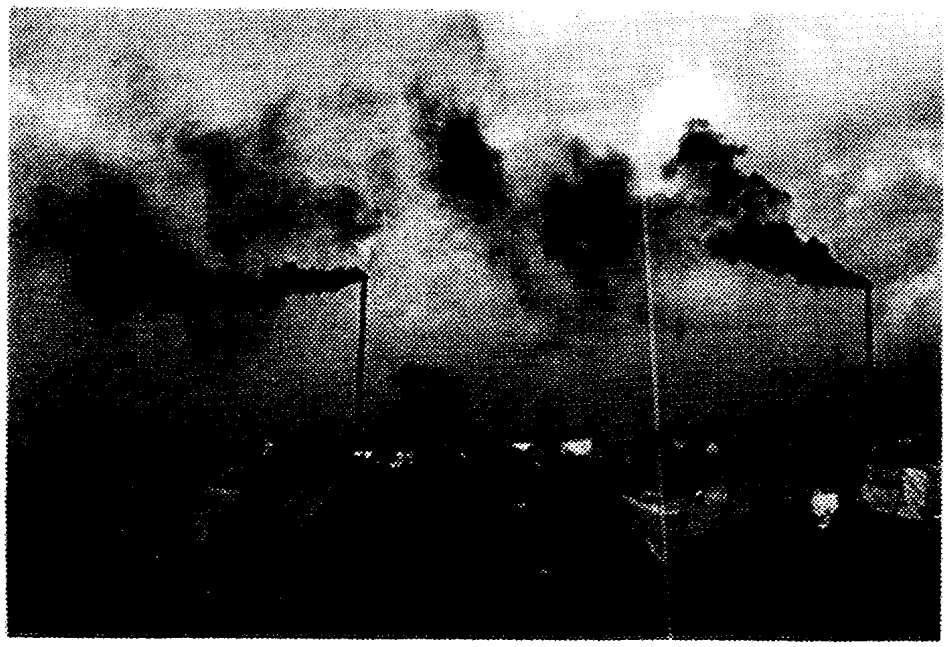
1 The Philippines' Initial National Communications on Climate Change. December 1999.
2 Its Zero-Waste/Ecological Waste Management project garnered a Galing Pook Award in 1995
3 Based on group discussions with the local implementors in the pilot sites of the Cities for Climate Protection Campaign in the Philippines. May to December 1999.

Counting Greenhouse Gases in Local Communities[1]

Gemma T. Narisma[*]



Efforts to address the issue of climate change cannot be left to the national government alone or to select agencies and institutions. Downscaling efforts are necessary in order to bring about effective change in mindsets and development policies in the nation.

Considering the potentially destructive impacts of climate change on future generations, it is everyone's responsibility to begin taking steps and to find ways to effectively address this issue. This essay aims to provide a method of accounting for greenhouse gas (GHG) emissions in order to better understand and formulate effective GHG avoidance measures. By providing these tools and capabilities, it is hoped that local communities will contribute to the global effort of protecting our climate.

* Climate Studies Division, Manila Observatory

Greenhouse Gas Inventory Methodology

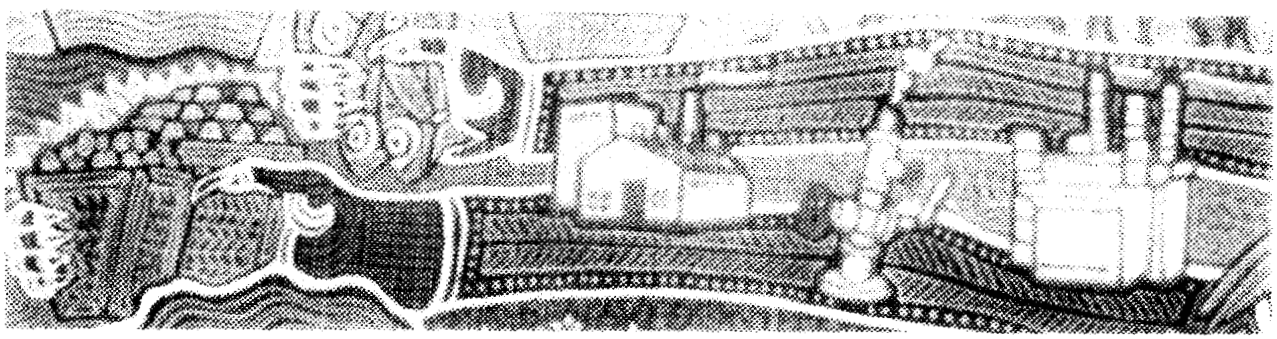
As far as avoidance of further GHG emissions into the atmosphere is concerned, the only viable solution at present is either the reduction of emissions from the sources themselves or the conservation/enhancement of sinks that will remove or sequester GHGs from the atmosphere. Sources and sinks of GHGs associated with human or anthropogenic activities can be classified according to five basic sectors: energy, industrial processes, agriculture, waste, and land use change and forestry. All five sectors emit the major GHGs: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halocarbons such as CFCs, substitutes such as PFCs and HFCs, and sulfur hexafluoride (SF_6). The last three gases are usually associated with industrial production. For a local inventory, the first three gases mentioned (CO_2, CH_4 and N_2O) are of primary concern since these comprise the bulk of anthropogenic GHG emissions in the Philippines.

The fundamental equation used in inventory calculations is elementary:

$$E = A \times EF$$

where E is the emissions (in kg or tons), A the activity data which indicates the activity that is responsible for the emission (e.g. liters of gasoline, or kWh or electricity, or tons of cement, etc.), and EF is the emission factor associated with the particular activity (e.g. kg CO_2 per liter of gasoline, kg CO_2 per kWh of electricity, etc.).

In the following sections, the values and procedures for calculating emissions from the five basic GHG source sectors are described.

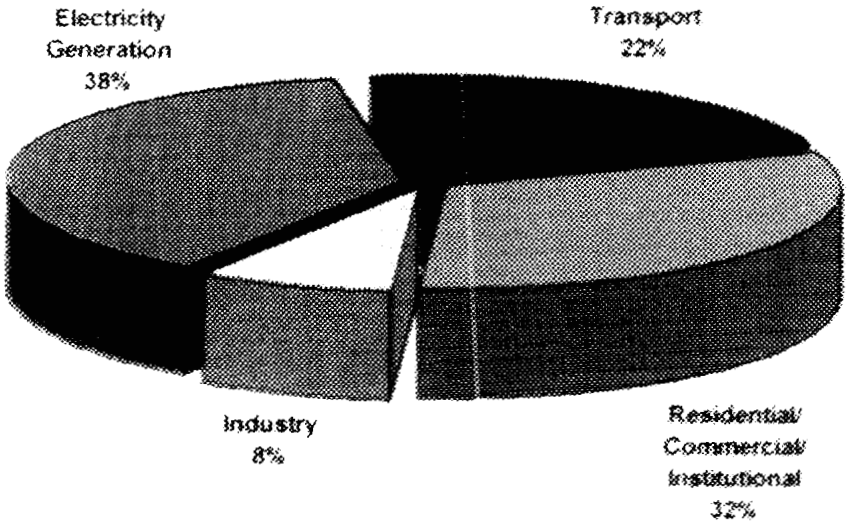


Philippine CO_2 emissions from energy mainly come from three subsectors: a) electric power consumption, b) transport, and c) residential and commercial use of fuel such as liquefied petroleum gas (LPG), kerosene, diesel and gasoline. The emissions from these subsectors can be traced to the combustion of fossil fuels such as coal and oil.

The combustion of fuel types and their derivatives release significant amounts of CO_2 into the atmosphere. In 1990, global CO_2 emissions from fossil fuel combustion reached 22 billion tons and Figure 1 shows that most of the emissions come from the three subsectors mentioned above (IPCC, 1996).

In the Philippines, the use of fossil fuels in 1994 released about 50 million tons of CO_2, thus comprising

Figure 1. 1990 Global CO_2 emissions from fuel combustion

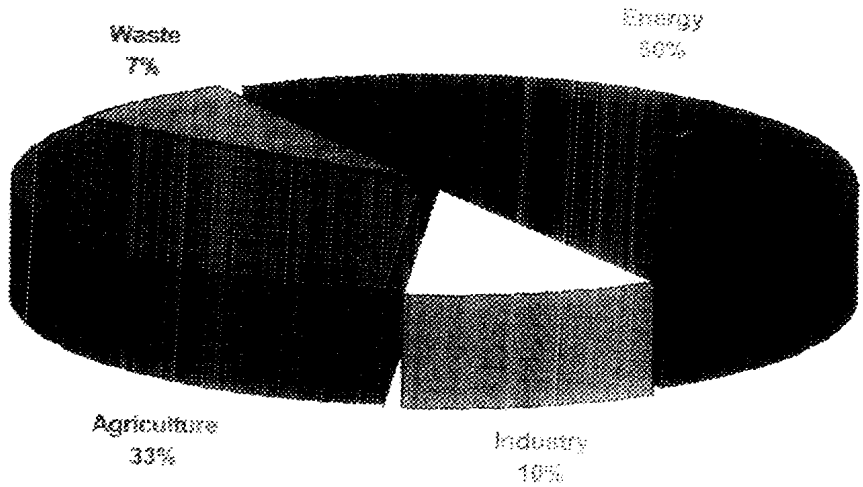


Source: IPCC, 1996

nearly half of the national total of GHG emissions [Villarin et al., 1999]. This is shown in Figure 2.

It is clear on both global and local scales that the energy sector is the most significant source of CO_2 emissions in the atmosphere. It is also the most difficult sector to control in

Figure 2. 1994 GHG emissions from four non-LUCF sectors of energy, agriculture, industry and waste



terms of emissions due to our heavy dependence on its readily available products and services.

Emissions from residential/commercial fuel consumption, electricity consumption and transport have to be monitored separately in order to arrive at amounts that will be useful for local emissions avoidance strategies. The following steps outline the inventory of GHG from these three subsectors of local energy.

Residential/Commercial Fuel Consumption

The usual processes that consume fossil-based fuels are cooking, gas lighting and power generator operations. The fuel types used in these processes are mainly gasoline, kerosene, diesel and LPG. The following steps outline how to compute the equivalent amount of CO_2 emitted by these processes:

1. Determine the amount of fuel (in liters) used in each process.

Table 1. Emission factors for gasoline, diesel, LPG, and kerosene fuels

Fuel Type	EF (kg CO_2/liter)
Gasoline	2.27
Diesel	2.63
LPG	0.42
Kerosene	2.40

Source: IPCC, 1997

2 Each type of fuel has a corresponding emission factor (EF) which gives the equivalent amount of CO_2 emitted per liter of fuel consumed, as listed in Table 1.

3 Then for each process, multiply the amount of fuel consumed with the respective emission factor (according to fuel type) to obtain the amount of CO_2 emitted in kilograms.

Electricity Consumption

The actual use of electrical devices emits gas only indirectly, through the electricity that comes from fossil fuel-based power plants. Users of electrical appliances are therefore indirectly responsible for CO_2 emissions associated with their electrical consumption. The following steps compute the equivalent amount of CO_2 produced in electricity consumption:

1 Determine the amount of electricity consumed in a particular time frame (in kWh or MWh). This can be done using a sectoral (or bottom-up) approach in which emissions from consuming sectors such as residential, commercial, industrial, street lighting, and the like, are accounted for. If it is not necessary to distinguish among consuming sectors, a top-down approach can be employed, in which the overall total power consumption is the only activity datum needed. This number is usually given in kilowatt-hours, or 1000 watt-hours.

2 Determine the power generation system that supplies the electricity, e.g. diesel generator, coal-fired power plant, or hydroelectric power, etc.

3 Each fuel type used in these power generation systems has an equivalent EF as listed in Table 2. A cursory examination of these EF values shows that coal-based power releases more carbon than diesel or natural gas.

4 Multiply the amount of electricity consumed by the appropriate EF to arrive at the equivalent amount of CO_2 emitted (in kilograms).

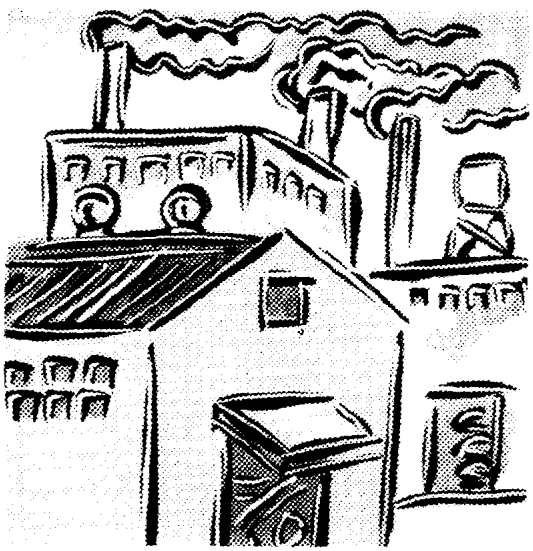


Table 2. *Emission factors for the different fuel types used in power plants.*

Fuel Type	EF (kg CO_2/kWh)
Coal	0.940
Oil	0.798
Diesel	0.764
Natural gas	0.581
Hydro*	0.000
Geothermal*	0.000

Source: IPCC, 1997

* Hydroelectric and geothermal power systems are assumed to produce insignificant amounts of CO_2.

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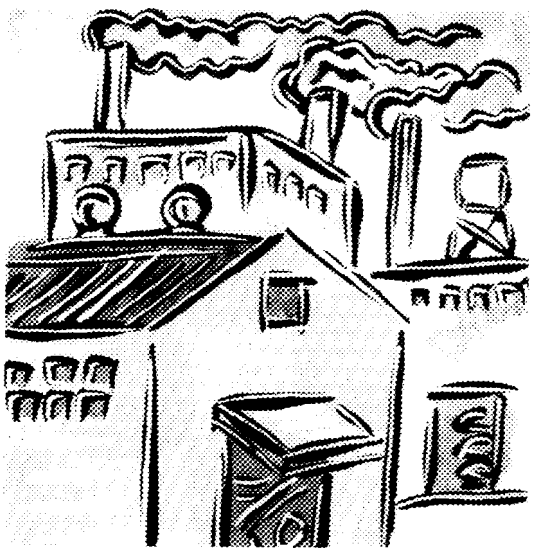

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Source: IPCC, 1997

* Hydroelectric and geothermal power systems are assumed to produce insignificant amounts of CO_2.

Table 4. Emission factors per fuel type in the transport sector.

Fuel Type	EF ($kgCO_2$/liter)
Premium and Unleaded Gasoline	2.27
Diesel	2.63
Kerosene	2.40
Regular	2.23

Source: IPCC, 1997

Table 5. Emission factors for different types of vehicles

Vehicle Type	EF ($kgCO_2$/VKT)
Gasoline	
Cars	0.506
Utility Vehicles	0.579
Trucks	1.32
Buses	1.32
Motorcycles/ Tricycles	0.266
Diesel	
Cars	0.319
Utility Vehicles	0.415
Trucks	1.097
Buses	1.097

Source: IPCC, 1997

Combustion processes in transport, which convert fuel chemical energy into mechanical energy, directly release CO_2 into the atmosphere. The amount of CO_2 emitted depends on the type of vehicle and the type of fuel used by the vehicle. Two approaches can be employed to compute the equivalent amount of CO_2 emitted by the transport sector. In the first approach, CO_2 emissions are calculated from the total fuel consumed by the vehicles, while in the second, emissions are determined from the total distance traveled by the vehicles.

First approach: Fuel consumption per vehicle

1. Determine fuel consumed (in liters). If this is unavailable, other related parameters such as fuel expenses can be used to infer fuel consumption.

2. For each fuel type, select the appropriate emission factor listed in Table 4.

3. Multiply the amount of fuel consumed by the appropriate emission factor to arrive at the equivalent amount of CO_2 emitted.

Second approach: Vehicle distance traveled

1. Estimate the average number of kilometers traveled by each type of vehicle in the community.

2. Multiply this number of kilometers with the total number of vehicles to get the Vehicle-Kilometers Traveled (VKT). Do this for each type of vehicle in the community.

3. Select the appropriate EF based on the type of vehicle and type of fuel used, as listed in Table 5.

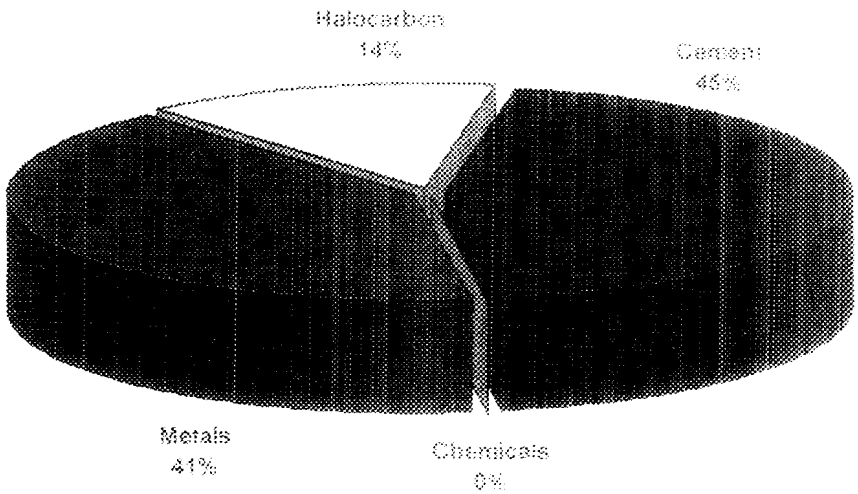
4. Multiply the VKT by the corresponding EF to arrive at the equivalent amount of CO_2 emitted.

These default values indicate that on a per-vehicle per-kilometer-traveled basis, trucks and buses are the greatest sources of CO_2 emissions. On a per (ending)-capita basis, however, this may no longer be true.

Industry

In 1994, the industry sector was responsible for almost 11 percent of the total equivalent CO_2 emissions in the Philippines. Figure 3 shows that 86 percent of these emissions comes from the cement and metal manufacturing industries [Villarin et al., 1999]. Because of their dominance, these two major industries are the only subsectors considered in the local inventory.

Figure 3. 1994 Philippine GHG Emissions from the Industry Sector.



GHG emissions from industry come from the manufacturing process of raw materials and do not include emissions from electricity consumption, which are already considered under the energy sector. Calculating CO_2 emissions is fairly straightforward:

1. Obtain the amount of material (steel or cement) produced (usually given in tons). To facilitate conversion, 1 bag of cement is approximately 0.04 tons.

2. Each ton of cement or steel produced has a corresponding emission factor listed in Table 6.

3. Multiply the amount of material produced by its corresponding emission factor.

Table 6. Emission factors for cement and steel production

Production Material (t)	EF (tCO_2/t of material produced)
Cement	0.5
Steel	1.6

Source: Revised 1996 IPCC Guidelines

Equivalent CO_2 emissions from the agriculture sector were about 33 percent of the national total in 1994. In this sector, rice cultivation and domestic livestock management are two major sources that should be included in any local community inventory. Figure 4 shows that these two subsectors comprise about 72 percent of the national CO_2 emissions total in 1994.

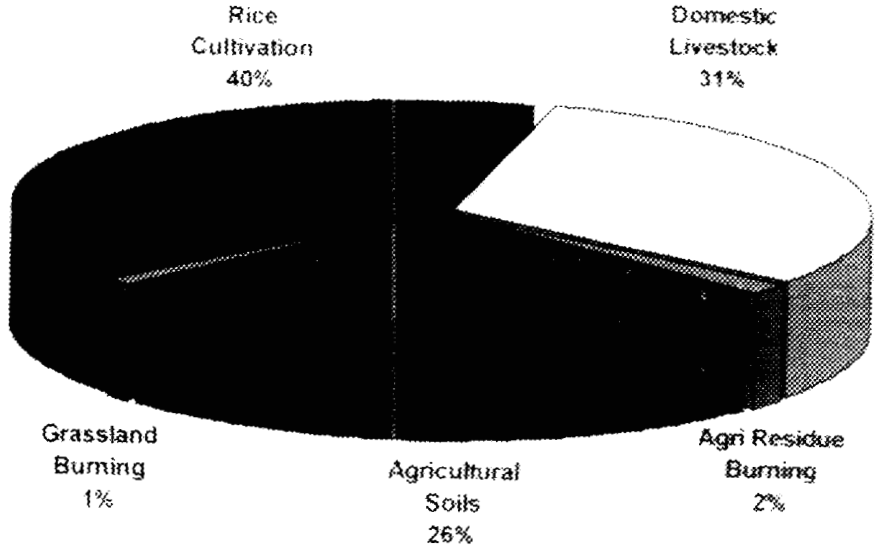
Anaerobic decomposition of organic matter in flooded ricefields together with domestic livestock manure management and enteric fermentation produce CH_4. The following steps outline a simple method of computing CH_4 emissions from these two subsectors.

Methane emissions from flooded ricefields

The amount of CH_4 emitted by anaerobic decomposition of organic matter in flooded ricefields depends on the way these ricefields are watered, either by irrigation or by natural rainfall. Irrigated ricefields tend to support more anaerobic decomposition and thus produce more CH_4. To compute emissions:

1. Consider the size of the ricefields in hectares and the watering method employed.

Figure 4. 1994 Philippine GHG emissions from the agriculture sector



2 Select the appropriate emission factor, as listed in Table 7.

3 Multiply the number of hectares of ricefields by the corresponding emission factor to get the amount of CH_4 emitted.

4 Since this result is for CH_4, it is important to convert this to an equivalent amount in uniform CO_2 units. This is to enable the addition and comparison of all emissions in the inventory according to an equivalent unit of CO_2. This is done by applying the so-called cwr of CH_4, which is 21 (i.e. a molecule of CH_4 is equivalent to 21 molecules of CO_2 in terms of capacity to warm the earth). In our example, then, multiply the amount of CH_4 emitted by the cwr (21) of CH_4 to get the equivalent amount of CO_2 emitted.

Methane emissions from domestic livestock management.

The amount of CH_4 produced in domestic livestock management depends on the type of livestock and the number of heads managed per year. To compute for CH_4 emissions in domestic livestock, two processes are considered: enteric fermentation and manure management. The methodologies used for both processes are basically similar to each other except for the values of their emission factors.

Enteric Fermentation

1 Determine the average number of heads of a particular livestock type per year.

Table 7. CH_4 emissions factors for flooded rice fields

Watering Method	EF ($kgCH_4$/hectare)
Irrigation	262
Rainfall	45

Source: International Rice Research Institute, 1994

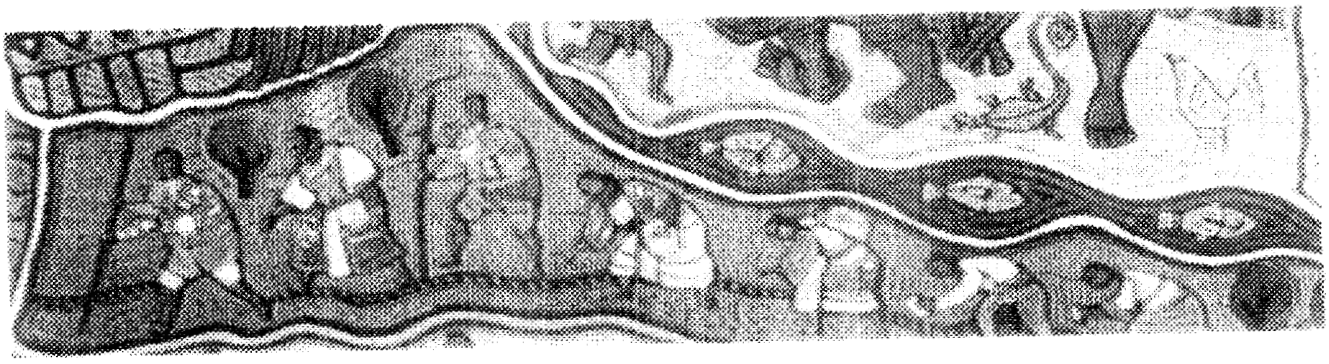


Table 8. CH_4 emission factors for domestic livestock enteric fermentation

Livestock Type	EF ($kgCH_4$/head/year)
Dairy Cattle	56
Buffalo	55
Non-Dairy Cattle	44
Horse	18
Sheep	8
Goat	5
Pig	1.5
Chicken	not estimated

Source: IPCC, 1997

2 Refer to Table 8 for the corresponding methane emission factor.

3 Multiply the average number of heads of a particular livestock per year by the corresponding emission factor.

4 Multiply the result by methane's GWP (21) to get the equivalent amount of CO_2 emitted.

5 Follow the same procedure for all other types of livestock and add these results to get the total emissions from enteric fermentation.

Manure Management

The procedure here is essentially the same as that of the previous section. Only Table 9, which lists the CH_4 emission factors associated with various types of livestock, is different.

Table 9. CH_4 emission factors for domestic livestock manure management

Livestock Type	EF ($kgCH_4$/head/year)
Dairy Cattle	27.00
Pig	7.00
Buffalo	3.00
Horse	2.18
Non-Dairy Cattle	2.00
Goat	0.22
Sheep	0.21
Chicken	0.023

Source: IPCC, 1997

Waste

The primary GHGs released by the waste sector are CH_4 and N_2O. Figure 5 shows that in the 1994 GHG inventory, majority of the emissions (about 60 percent) in the waste sector comes from solid waste. The other 40 percent of the pie is shared almost equally by the other subsectors, namely industrial wastewater, municipal wastewater and human sewage.

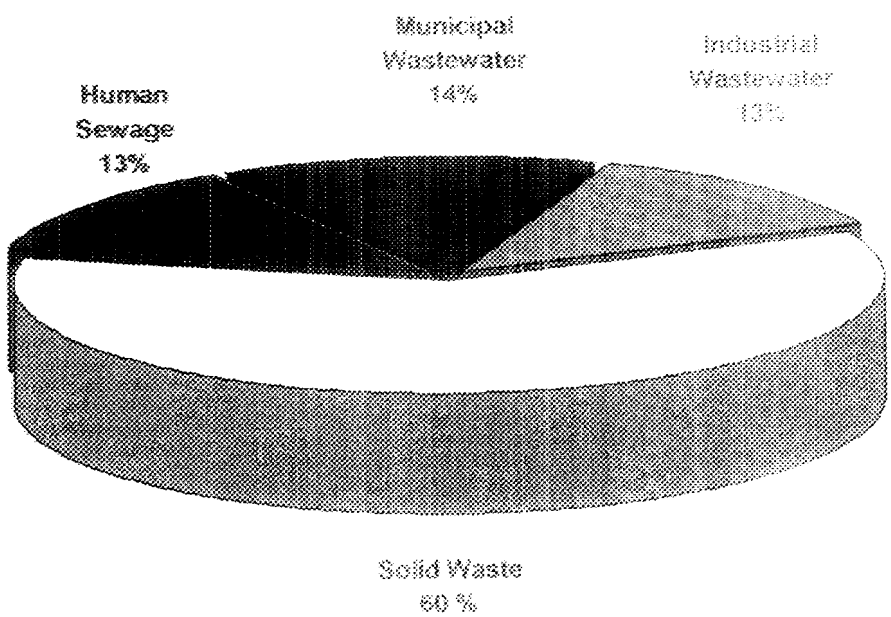
As an initial effort, a local community inventory can begin by focusing on emissions associated only with solid waste. The steps are as follows:

1. Obtain the total annual MSW in tons disposed to Solid Waste Disposal Sites (where 1 ton = 1000 kg).

2. Multiply this amount by the emission factor 0.045 ton CH_4/ton MSW to get the equivalent amount of CH_4 emitted.

3. Multiply the result by methane's GWP (21) to get the equivalent amount of CO_2 emitted.

Figure 5. 1994 Philippine GHG emissions from the waste sector.



Land Use Change and Forestry Sector

The LUCF plays a crucial and significant role in determining GHG emissions because it can either be a net sink or source of GHGs. As a sink, for example, biomass growth of our forests can sequester CO_2 from the atmosphere and thus lower the net amount of total emissions. Table 10 lists the amount of CO_2 that can be potentially taken up or sequestered per hectare of land for the different types of forest.

Forest harvest for commercial and fuelwood purposes, however, leads to biomass loss, which can offset the sequestration potential of the forest and reduce its role as a sink. Moreover, deforestation and land use change release CO_2 into the atmosphere via on-and-off site burning and biomass decay processes.

Table 10. CO_2 sequestration rate of different Philippine biomass types

Biomass Type*	Annual CO_2 Uptake Rate ($kg\ CO_2/ha/yr$)
Forest	
Dipterocarp, Old Growth	5,500
Dipterocarp, Residual	8,199
Pine, Closed	5,500
Pine, Open	5,500
Submarginal	5,500
Mossy	5,500
Mangrove	5,500
Tree Plantation	14,685
Agroforestry	9,900
Brushland	1,833
Grassland	0

*Source: (Lasco, ++-)

In 1994, the **net** amount of CO_2 sequestered by the LUCF was only 126 kilotons of CO_2, as shown in Figure 6. This was computed after considering both the carbon sequestered by our forest biomass and the carbon emitted from forest land use change and conversion.

There are still uncertainties in the calculations and more in-depth local research is needed to fully understand the crucial impact of LUCF on GHG emissions. Thus, emissions from forest land use change and conversion are not calculated here because of uncertainties in the fate of deforested biomass and biomass densities prior to and after land conversion. However, to illustrate the carbon-saving capability of the LUCF sector, a first order approximation of the potential CO_2 uptake of our local forests can be obtained by following these steps:

1. Determine the type of forest and its land area.

2. Multiply this value by the appropriate CO_2 uptake rate of this particular forest biomass type, as listed in Table 10.

Figure 6. 1994 Philippine LUCF emissions and sinks in the LUCF sector

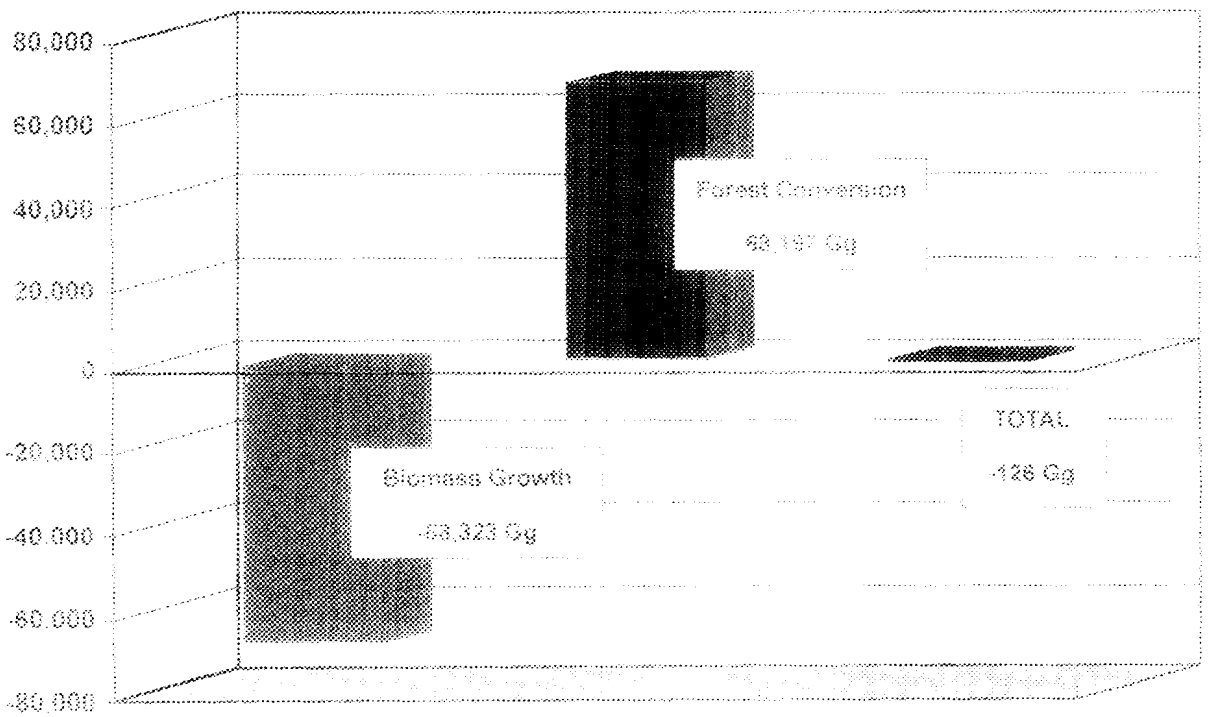


PHOTO BY PPE

Conclusion

An inventory of local CO_2 emissions is only the first step in addressing the issue of climate change. Although important in itself, this has to be followed by concrete strategies aimed at implementing effective emissions-avoidance measures. These carbon-saving measures may have to start on a small scale and move into more extensive and sustainable practices: from individual to household to barangay to municipality and so on. Eventually, the national government and the international community will have to engage one another for such climate protection schemes to have any impact at all. For local communities, CO_2 avoidance strategies can already be formulated without drastic changes in their current policies.

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1 Abridged version of "Greenhouse Gases from Local Communities: An Inventory Manual", Narisma G.T., A.V. Villa-Real, J.I. Villarin, 2000

The Urban Modification of Climate in Metro Manila

*M. A. Estoque and M. Sta. Maria**

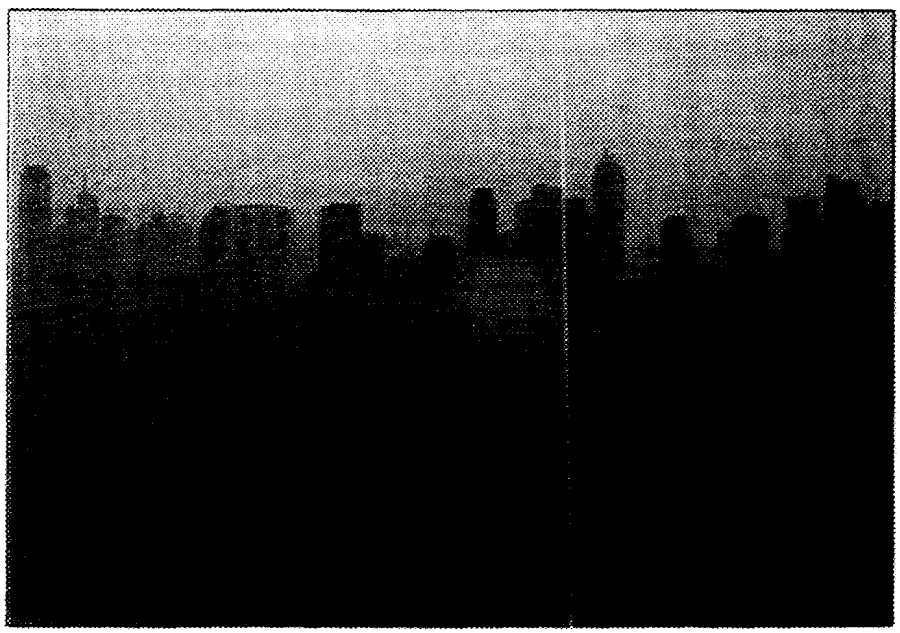


Photo by PPG

Observational studies have shown that the climate of a city or an urban area is significantly different from that of the surrounding rural areas. The differences are due to four factors. First, urbanization changes the thermal properties of the Earth's surface. Areas of concrete, asphalt and other building materials replace vegetation, resulting in higher surface temperature. Second, buildings and other structures in urban areas are wind obstacles, altering the general air flow patterns and generating air turbulence. Third, urbanization changes the moisture conditions at the Earth's surface. The relatively moist vegetated surface of the original rural area is replaced by a dry surface. Very little evaporation occurs from the surface, which results in a drier and warmer surface air over the city. Fourth, the urbanized area emits heat and pollutants into the atmosphere.

* Urban and Regional Climate Modeling Group, Manila Observatory

As a consequence of the above-mentioned factors, the urban area becomes warmer than the surrounding rural areas and the so-called urban heat island develops. The urban heat island is best developed when the prevailing winds are light and the skies are clear. During such conditions, the urban-rural temperature difference may reach values as much as 10°C. However, the average difference for all types of prevailing weather conditions is much smaller, with an average of about one to two degrees [Detwiller, 1979]. As a city grows in size, the temperature contrast between the city and the surrounding rural areas increases. Several investigators have found an average increase of about 1°C per one hundred years.

Previous investigators have also found increases in rainfall. These increases are due to several factors, the most important of which is the temperature increase associated with the urban heat island. Another factor is the increase in air friction associated with the increase in roughness of the Earth's surface in the city due to buildings and other structures. These two factors generate upward motions in the urban area and in the immediate vicinity. Under favorable conditions, the upward motions result in condensation of water into clouds and rainfall. Another factor which could contribute to the generation of rain is the release of cloud condensation nuclei into the atmosphere by industrial and other sources in the city. This factor is important primarily in inland urban areas.

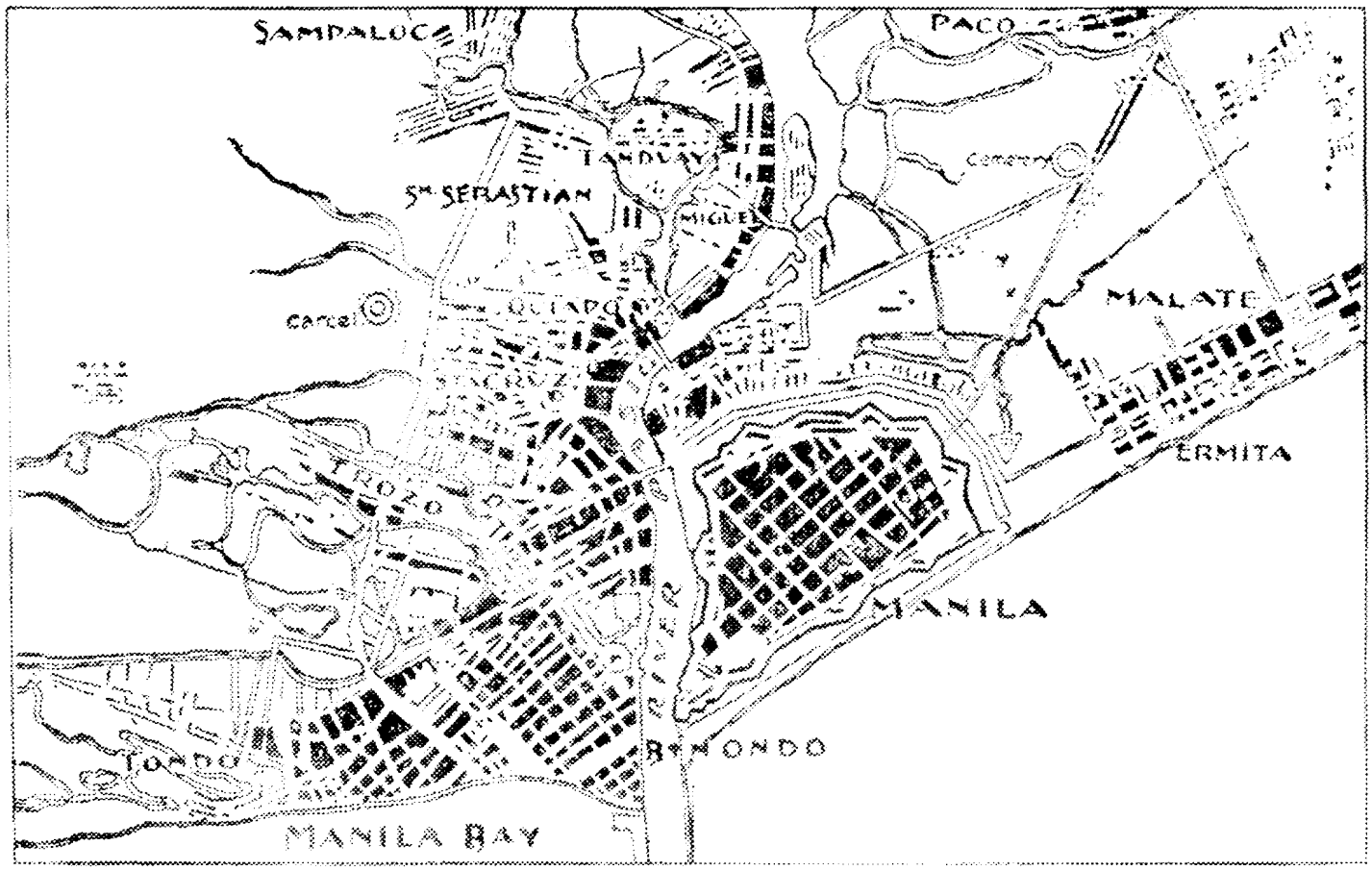
Many studies have been made in order to detect the effect of urbanization on rainfall. The detection is very difficult because rainfall is highly variable, both in space and in time. Nevertheless, urban-generated rainfall has been indicated in several past studies. For example, urban rainfall trends in Tulsa (Oklahoma) showed a gradual increase in summer rainfall of about 10 percent in five decades [Landsberg, 1956]. During this increase, the urban area rew from an Indian village of a few hundred inhabitants to a city of several hundred thousands of inhabitants. Subsequent studies [Changnon, 1970] showed an increase of five percent in annual rainfall due to urbanization in both Chicago and Urbana.

The most intensive study which has been conducted in order to determine the effect of urbanization on rainfall has been done in the St. Louis area in Missouri under the

METROMEX Project (Huff and Vogel, 1978). The results of the study show that the maximum urban effect occurs northeast of the city of St. Louis (about 30 km from downtown), outside the main urbanized area. This maximum (about 30-percent increase) is found during the summer when the prevailing wind blows toward the northeast. This location of the maximum is downwind of the city in relation to the prevailing wind. In contrast, the urban effect is negligible upwind of the city toward the southwest. Over the city itself, the increase in rainfall is only about 10 percent. The urban effect of rainfall is mostly due to the intensification of ongoing storms as they move across the warm urbanized area of the city. The greatest intensity is reached after the storms have crossed the city into the northeast rural areas.

In this report, we describe the results of a study to determine the effect of the urbanization of Metro Manila on temperature and rainfall. The growth of the urban area associated with Metro Manila is indicated in Figs. 1, 2 and 3.

Figure 1. The city of Manila in 1872 [The Story of the Philippines and Our New Possessions, Halstead, 1898]



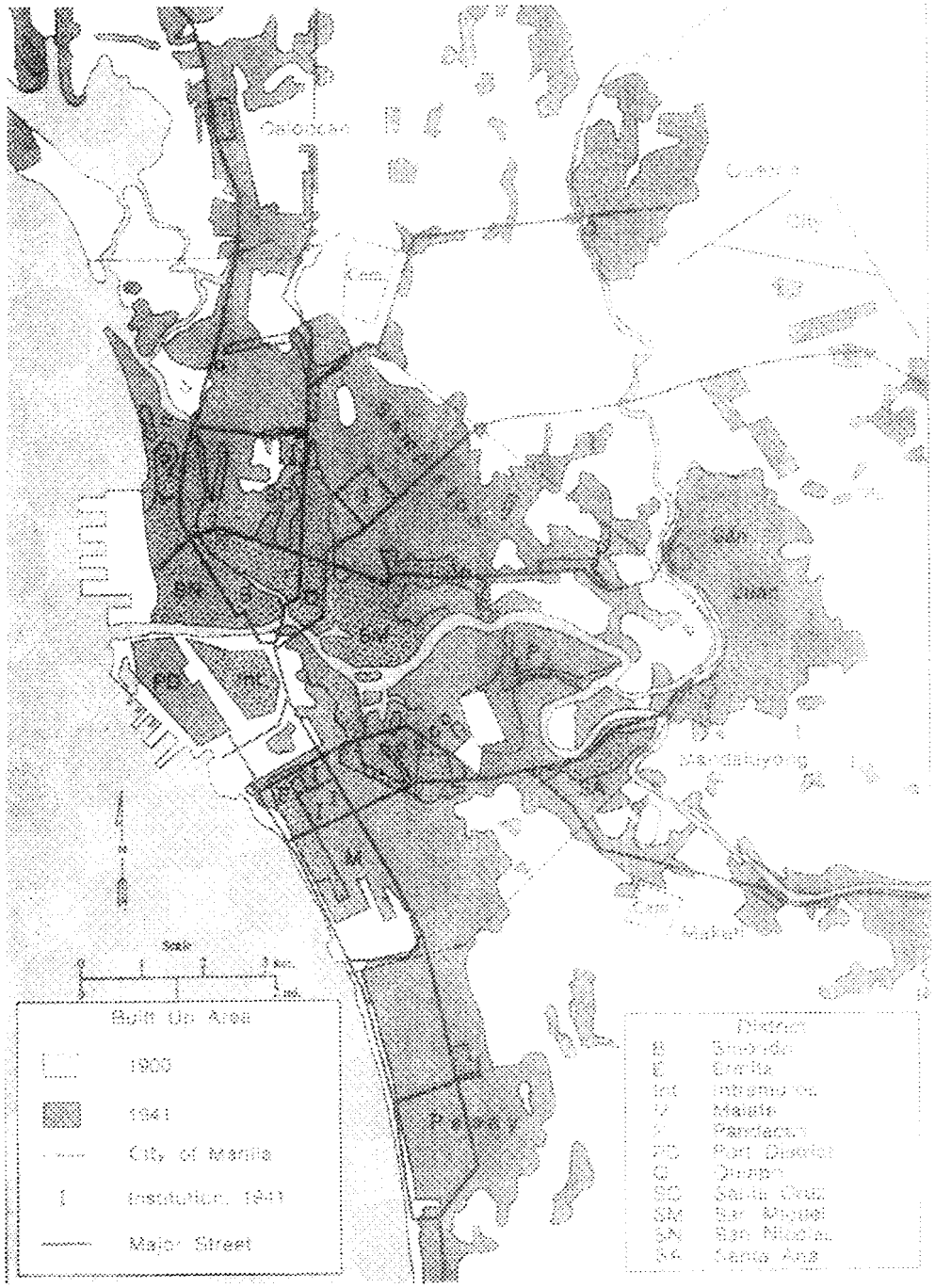
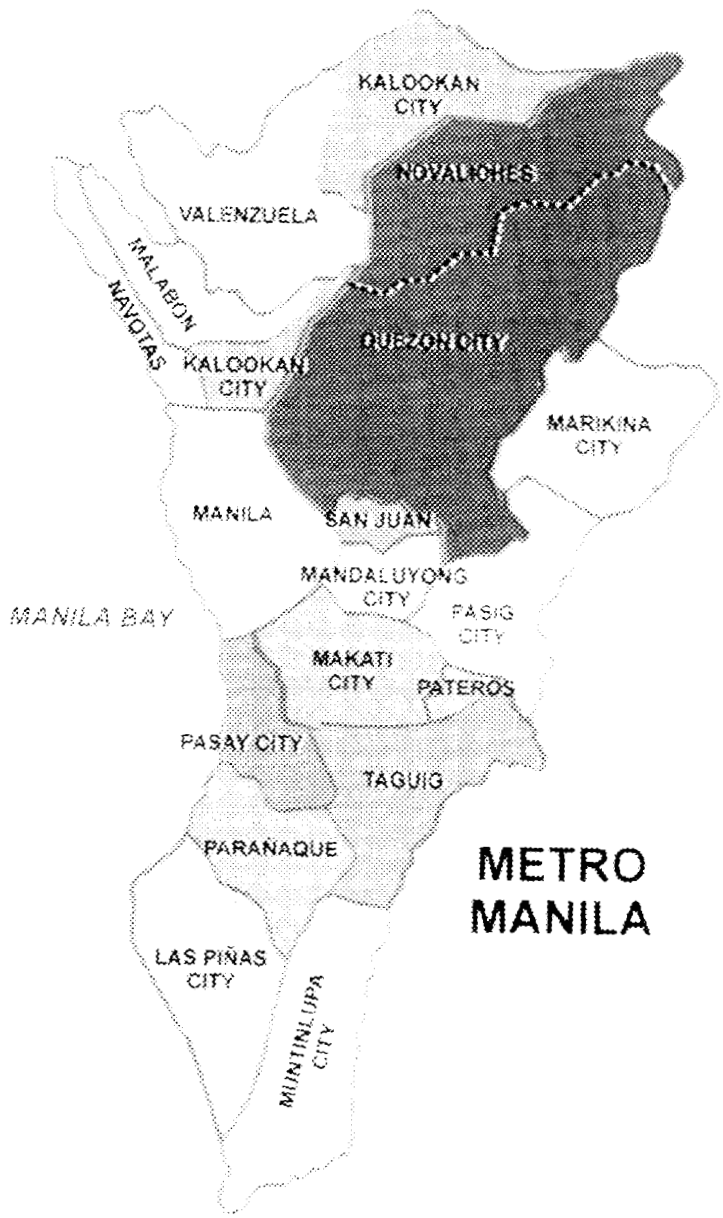


Figure 2. Metropolitan Manila, 1900-1941 [Doeppers 1984].

Fig. 1 indicates that the urban area in 1872 covers an area of only about 5 square kilometers. Metro Manila in 1941 is in Fig. 2 and is roughly 50 sq. km. The present urbanized area of the city is shown in Fig. 3. The urbanized area is about 700 square kilometers, representing more than one hundred times the size of the 1872 area. It is interesting to note that the Manila Observatory started making observations at the Padre Faura station in 1865, several years earlier than the map in Fig. 1. Fig. 1 indicates that the station may be considered as practically a rural area at that time. The observations continued up to the end of the Japanese

Figure 3. Metropolitan Manila in the present [Hear Enterprise Co., 1996].



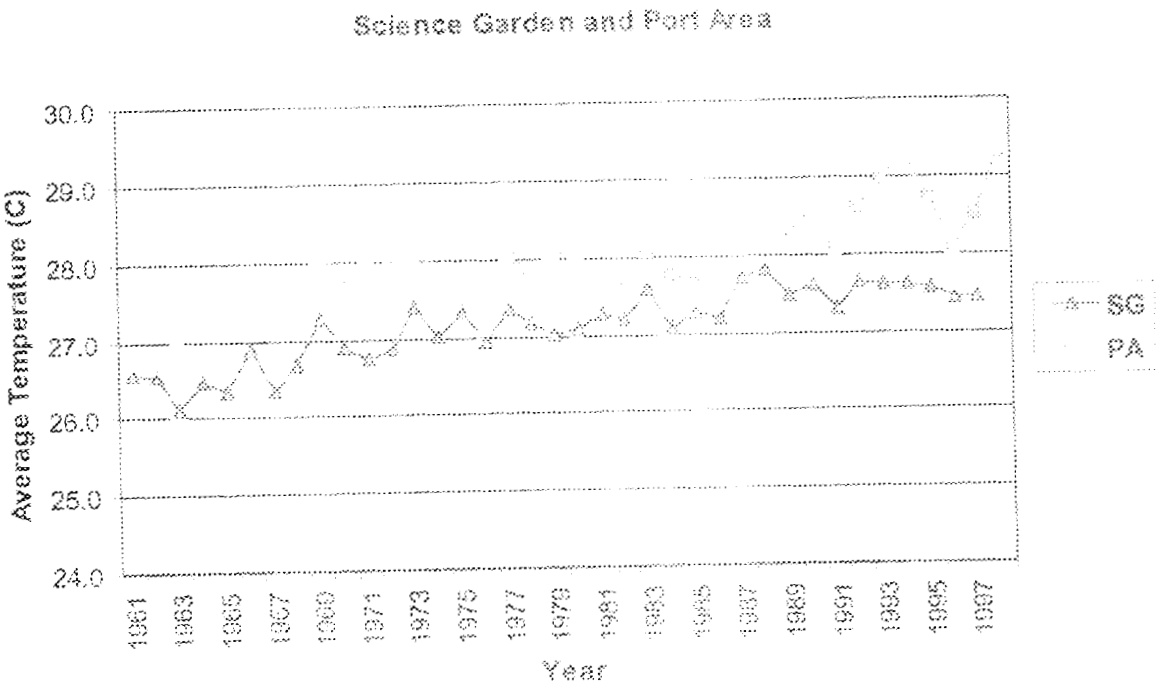
occupation. The station was destroyed during the Battle of Manila in 1945. Subsequently, two weather stations (Port Area and Science Garden) were established. The locations of these stations are shown on Fig. 3.

The primary temperature and rainfall data used are the observations at the two stations: Port Area and Science Garden. The Port Area is a coastal station, as shown in Fig. 3. Science Garden, on the other hand, is an inland station in the urbanized area about 10 km northeast of the Port Area. Data are available for the period 1961 to 1997.

Urbanization Effects on Temperature

As an introduction, we show the general characteristics of temperature variations with the aid of a plot of the time series of monthly temperatures in Fig. 4. Note that there is a significant rising trend in the temperature at both stations. This aspect will be discussed in more detail later. Note also that, on the average, the Port Area is warmer than the Science Garden. This is surprising on the basis that the Port Area is located at the edge of the urban area while the

Figure 4. Average annual temperature for the years, 1961 - 1997.



Science Garden is within the urban area. The explanation is found in Fig. 5, which shows the monthly variations of the average maximum and average minimum temperatures. Looking at the curve for maximum temperature, one sees that the Science Garden is approximately 1°C warmer on the average than the Port Area during the daytime. In contrast, the minimum temperatures are 2°C colder at nighttime. The net effect makes the Science Garden colder during an entire 24-hour period. The warmer temperatures in the Science Garden during the daytime are due to the urban heat island effect. During the night, however, radiation makes the temperatures colder than those at the Port Area where temperatures are moderated by the relatively warm sea surface.

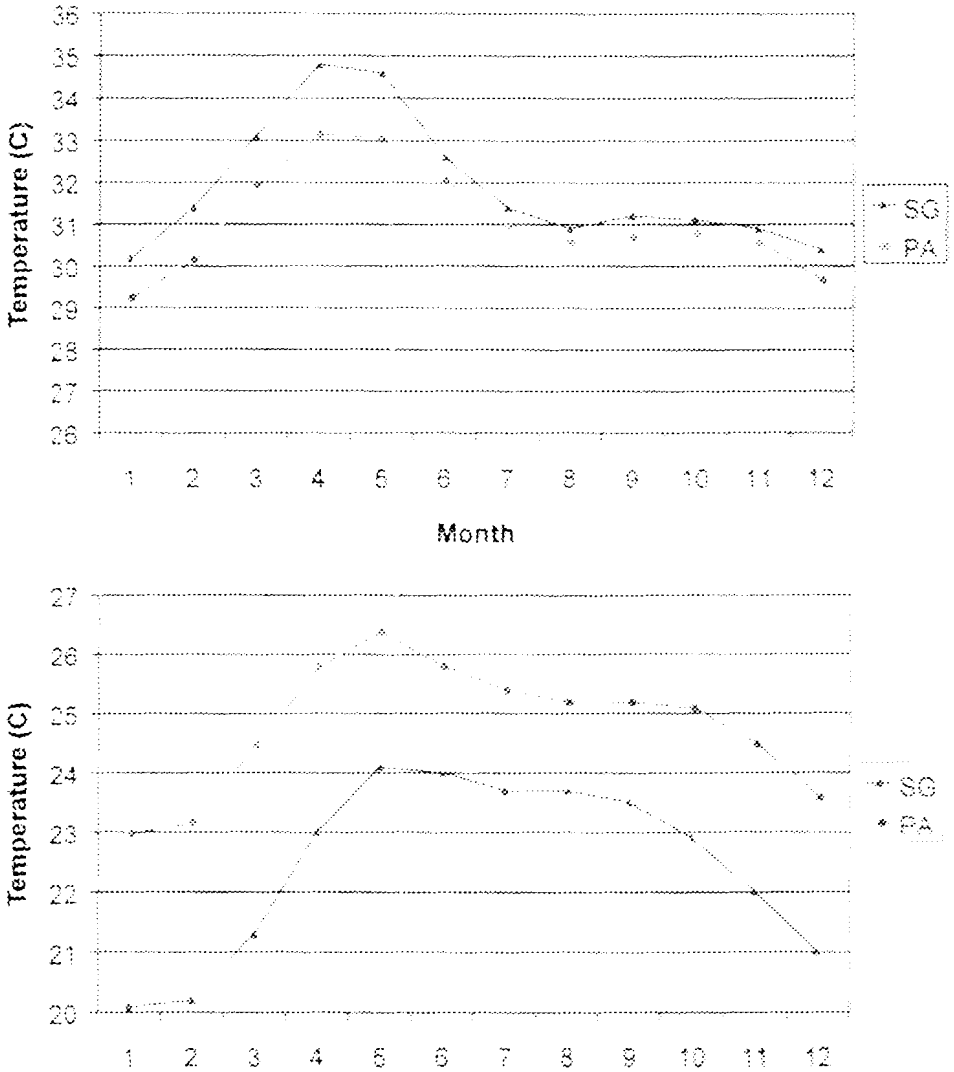


Figure 5. *(a) Maximum and (b) minimum average monthly temperatures for Science Garden (SG) and Port Area (PA) stations.*

In Fig. 4, we noted an increasing temperature trend for both the Port Area and the Science Garden observations. In order to show the trend, we have computed decadal averages of the temperatures during the period, 1961 to 1997. Note that due to the lack of data, the last average corresponds only to a seven-year averaging period, 1991 to 1997. The results of these computations are shown in Fig. 6. One sees that there is an increase of about 1°C at both stations during the 35-year period, 1961 to 1997. The rate of warming is equivalent to about 3°C in 100 years. This rate is approximately 10 times that of the estimated average rate of warming for the entire globe.

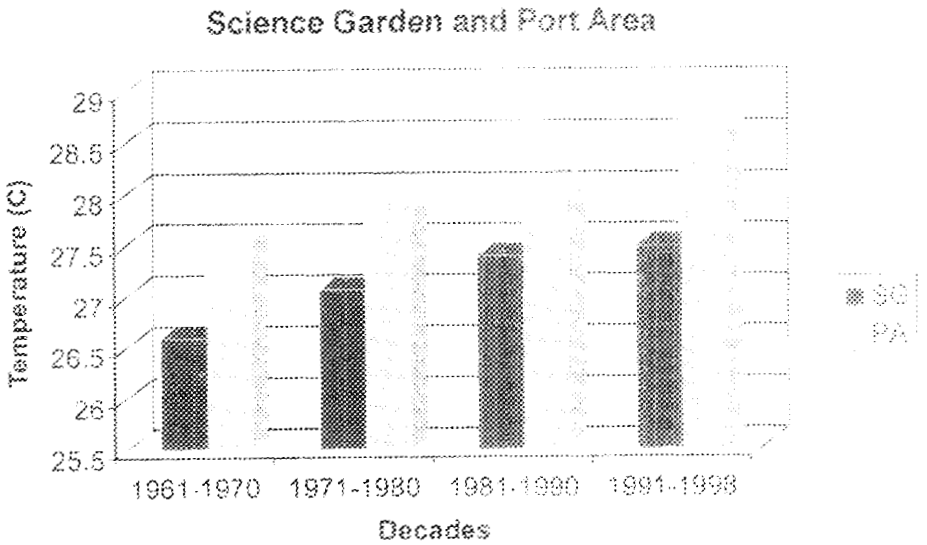
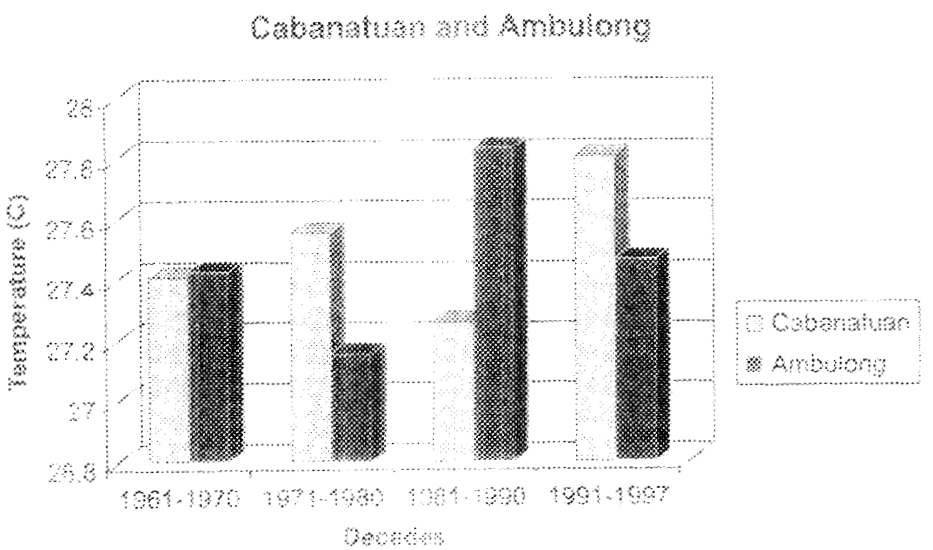


Figure 6. Decadal temperature averages for the two stations in Metro Manila.

We now compare the trend at the above urban stations with that of corresponding rural stations. For comparison, we use the analysis of corresponding temperature observations during the same period for the two rural stations available: Cabanatuan, Nueva Ecija and Ambulong, Batangas. Cabanatuan is located about 100 km north of Metro Manila while Ambulong is located at about 50 km south of Metro Manila. The results of the analysis are shown in Fig. 7. Note that there are no systematic temperature trends at the two rural stations. On the basis of the lack of trend at the two rural stations, we can conclude that the warming trend at both the Port Area and the Science Garden is due to the urbanization of the Metro Manila area.

Figure 7. Decadal temperature averages for two rural stations.



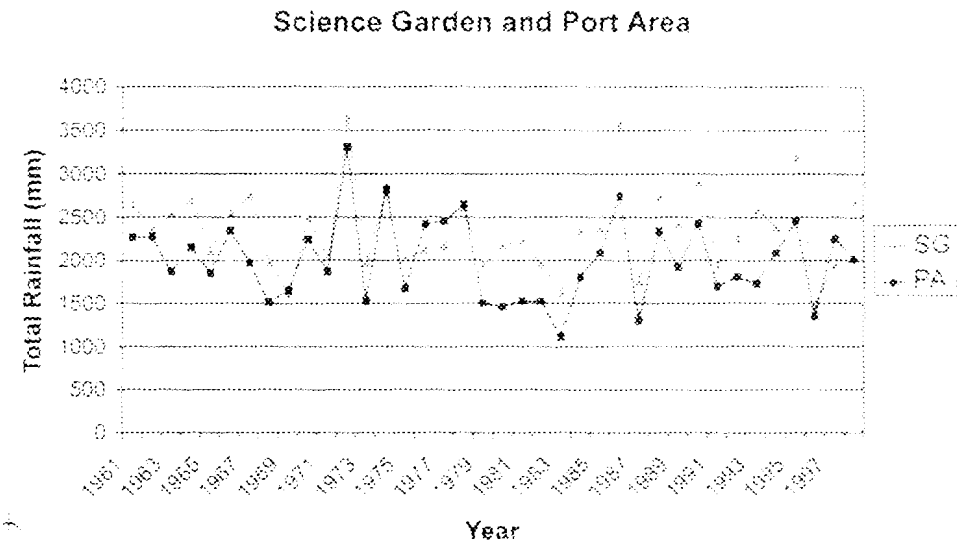


Figure 8. Total yearly rainfall for the years, 1961-1997

Urban Effects on Rainfall

The general characteristics of the time variations of rainfall for the Port Area and the Science Garden may be seen in Fig. 8. We see extremely large variations in rainfall in contrast with the smoother variations of temperature in Fig. 4. Note, for example, the large variations during the period, 1971 to 1973. Starting with a value of about 2000 mm in 1971, the rainfall jumps to a value of about 3500 mm in the next year, a change of about 75 percent in one year. This is followed by a return to approximately the same value in 1973. It is remarkable that the rainfall at both stations exhibit similar time variations throughout the entire period of observations. One notes that, on the average, the Science Garden has more rainfall than Port Area. This is shown more clearly in Fig. 9, which shows the decadal averages of rainfall, corresponding to the time series. The total rainfall at the Science Garden is greater than that of the Port Area by about 10 percent.

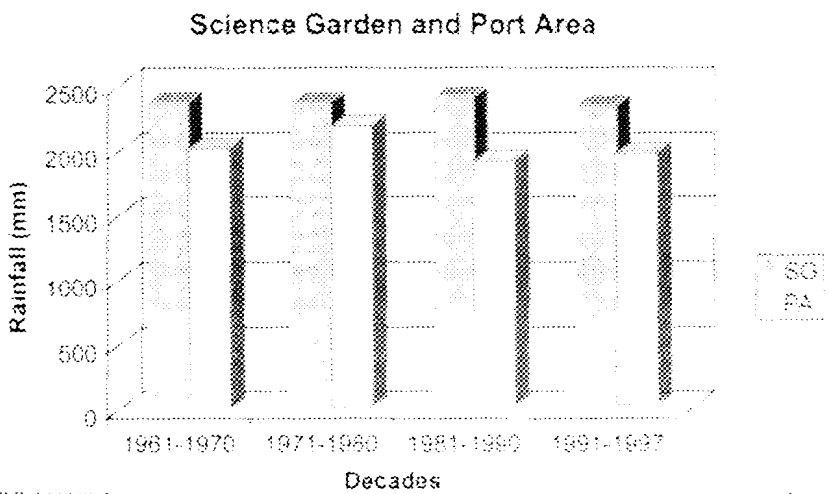
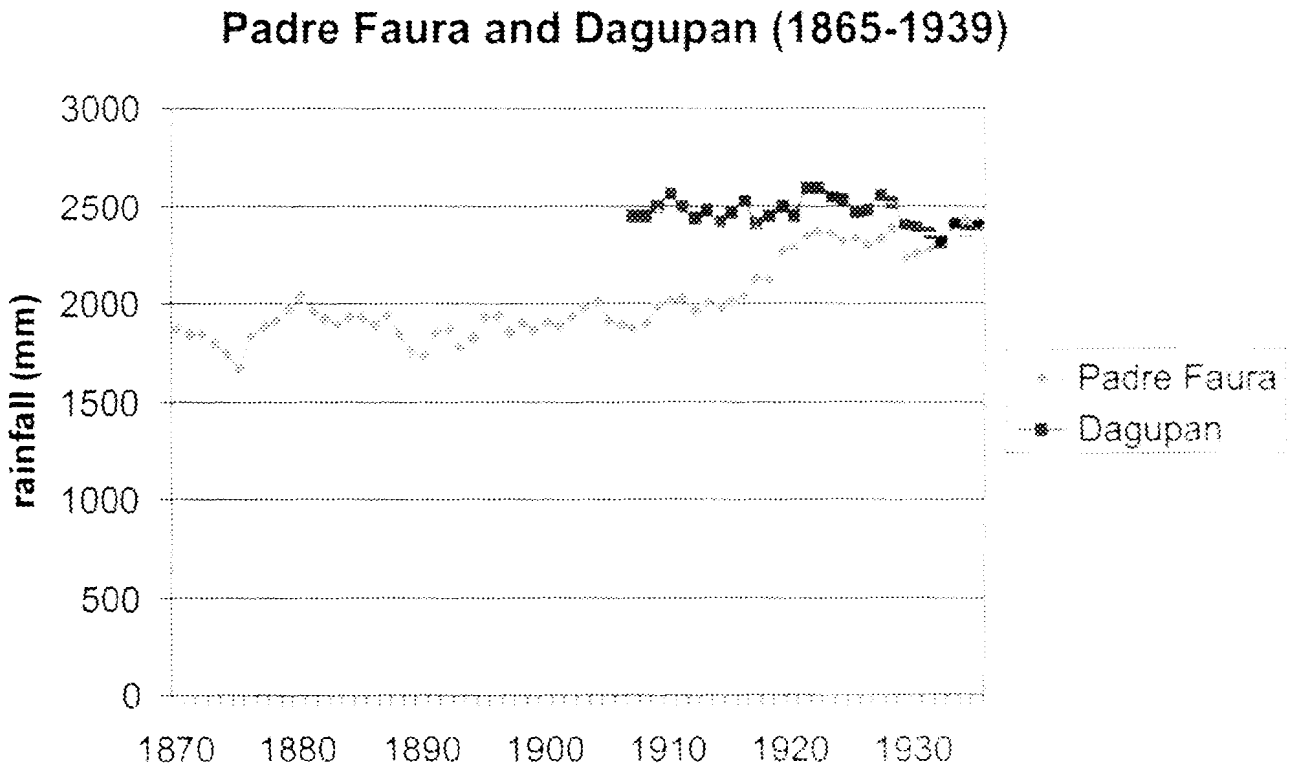


Figure 9. Decadal rainfall averages for the Metro Manila stations.

In order to account for the greater amount of rainfall at the Science Garden, we use the same argument used to explain the urban effect in St. Louis City on rainfall (Changnon et al., 1976). One might recall that the effect is manifested by a rainfall maximum located northeast of the city. This location is on the leeside of the city, on the basis of the prevailing winds which blow from southwest to northeast. While the winds traverse the urban heat island associated with the city, the surface air is heated and convective showers are initiated. The showers intensify as they continue drifting with the wind toward the northeast. Thus, a rainfall maximum occurs to the leeside or northeast of the city. In contrast, rainfall is minimum to the windward side, which is outside the urbanized area. An analogous situation occurs in the Metro Manila area during the summer when the prevailing flow is generally from the southwest. The Port Area (see map in Fig. 1) is located at the western edge of the urbanized area, or the windward side. On the other hand, the Science Garden is toward the leeside relative to the Port Area but still inside the urban area. Following the reasoning used for St. Louis, one can account for the greater rainfall observed at the Science Garden compared to that at the Port Area. In fact, one would expect the same rainfall tendency even if urbanization did not occurred. This is due to the effect of the sea breeze which would normally occur due to the temperature contrast between the sea and the rural area. However, this contrast would be less than the corresponding contrast at present between the sea and the urbanized area. Therefore, the purely sea breeze effect on rainfall would be considerably less than the urbanization effect.

Before leaving this section, we discuss briefly the intriguing trends in the rainfall observed at the Padre Faura station during the period from 1865 to 1940. During this period, the urbanized area of Metro Manila increased considerably. The time series of rainfall for this period is shown in fig. 10. One can see that there is definitely an increasing trend in rainfall. The greatest rate of increase occurs near the second half of the period. For comparison, we show on the same diagram the time series for Dagupan - rainfall data is available only for the later part of the period. Dagupan is a rural station of the same rainfall type as Padre Faura. Since Dagupan shows no corresponding increase, can we attribute this increase in rainfall at Padre Faura to urbanization? This question would be an interesting problem for future study.

Figure 10. Rainfall variations at Padre Faura (Manila) and at Dagupan.



Socio-economic Implications of Urban Climate Change

The growth of Metro Manila urban area, a tropical city, has been a major threat to the environment. In tropical regions, the development of urban areas pose special problems due to the general absence of strong prevailing winds which tend to ventilate cities. In this connection, we note that there are now about 30 urban areas in the tropics with a population of more than 5 million. In almost all of these areas, haphazard urbanization has created serious environmental problems. This is most serious in connection with the proliferation of squatter areas in cities. Many of these environmental problems are minimized by the proper siting and designing of urban areas. These can be done so that they incorporate the results of observational studies such as the one we have described here. In addition, they can also incorporate the results of the theoretical simulation studies which we are presently undertaking at the Manila Observatory.

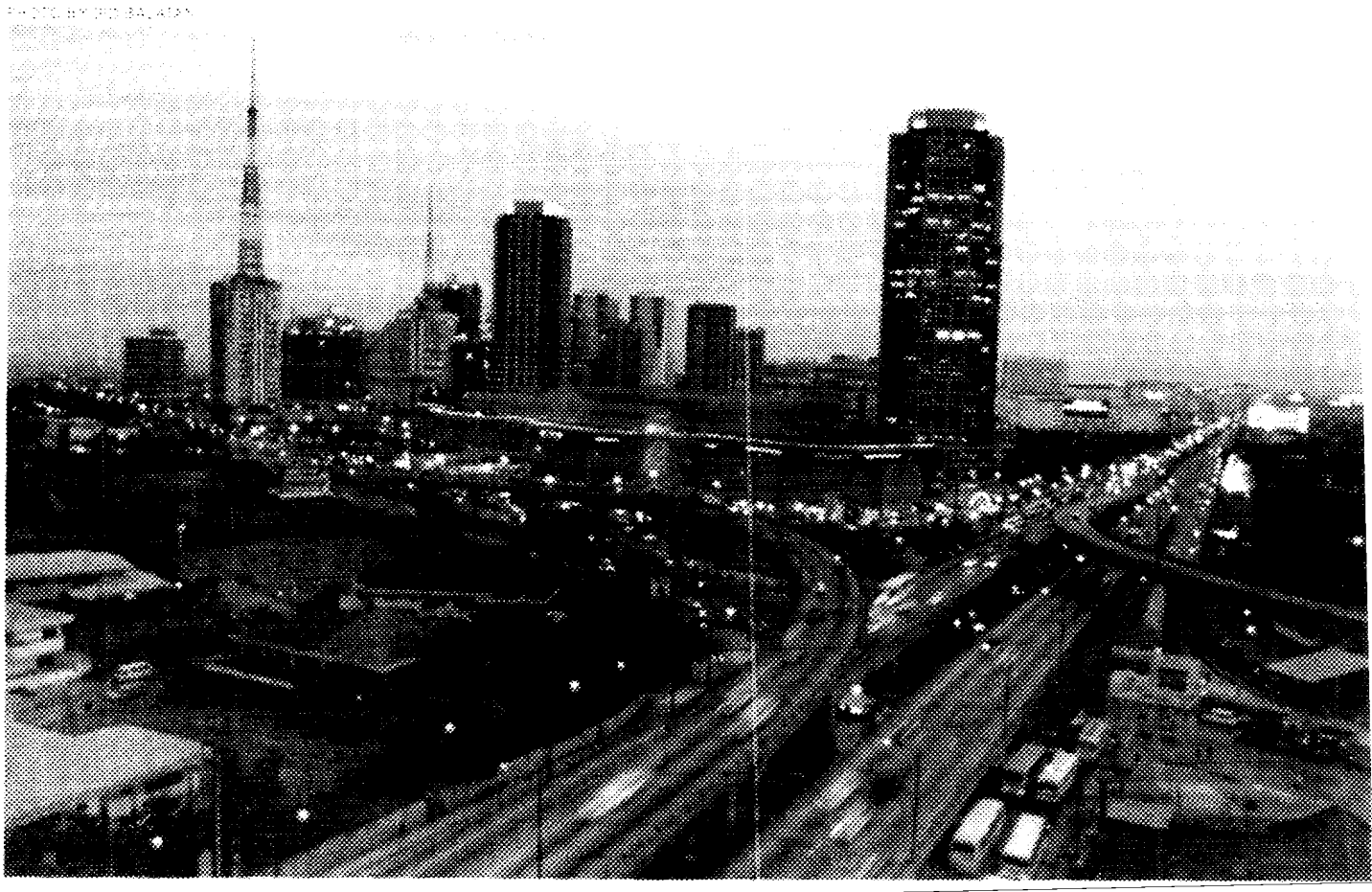
Our present studies indicate that there has been a gradual increase in temperatures associated with the growth of Metro Manila. During the last 20 years, the average increase is about one degree. This increase corresponds to all types of weather conditions. Under adverse conditions (weak winds together with clear skies in the summer), we estimate that the city temperatures in the afternoons could be as much as 10 degrees warmer than those of the neighboring rural areas. The excessively high temperatures will result in increased morbidity and loss of productivity, especially in the poor districts of the city.

In the case of rainfall, our study indicates only a slight effect of urbanization on Metro Manila. This is consistent with the results of previous studies which show that the effects occur primarily outside the urban area, along the downwind direction according to the prevailing wind. Accordingly, urban Metro Manila would generate rainfall over regions north of the city during the southwest monsoon season. Therefore, no adverse results will occur over the city due to rainfall. On the other hand, the rainfall effect could be beneficial in terms of additional rain over the regions north of the city.

In brief, one may conclude that the primary adverse effect of urbanization of Metro Manila on the environment is the increase in temperature inside the city. This is in addition to the more serious effect associated with air pollution. These effects can be minimized by the proper planning of urban areas. Our studies indicate that such planning should incorporate information from climatological investigations of the effects of urbanization. For example, the effects can be minimized by an appropriate orientation of the site and shape of urban areas relative to the prevailing winds. A more thorough study of these effects can be determined by computer simulations based on fluid dynamical models.

Summary and Conclusions

This report presents a study of the effects of urbanization on the climate of Metro Manila. The climatic elements considered are temperature and rainfall. Observational data from two stations in the urbanized area (Port Area and Science Garden) are used. These are supplemented by observations from rural areas. The analysis of temperature shows a definite warming trend of about the same amount at both stations. The increase is equivalent to a warming of about 3°C per one hundred years.



The analysis of rainfall at the Port Area and the Science Garden indicates an increase in rainfall in the urbanized area. But, due to the lack of data, it is not possible to determine precisely the real extent and the magnitude of the effect of urbanization on rainfall. It is suggested that this effect be investigated by using an urban climate model.

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LUCF in the Philippines: CC Impacts and Mitigation Potential

Rodel D. Lasco and Florencia B. Pulhin[1]

Evidences gathered so far have shown that climate change is indeed happening. The Earth's surface temperature this century is as warm or warmer than any century since at least 1400 AD [Nicholls et al., 1996]. By the year 2100, the average surface temperature is projected to increase by 1° to 3.5° C while sea level is expected to rise by 15 to 95 cm.

The Earth's atmosphere is composed of greenhouse gases (GHGs), such as carbon dioxide (CO_2), methane (NH_4), nitrous oxides (N_2O) and chlorofluorocarbons (CFCs), that absorb thermal radiation emitted by the Earth's surface. If more GHGs are emitted into the atmosphere they absorb more heat which, in turn, could lead to a change in the world's climate.

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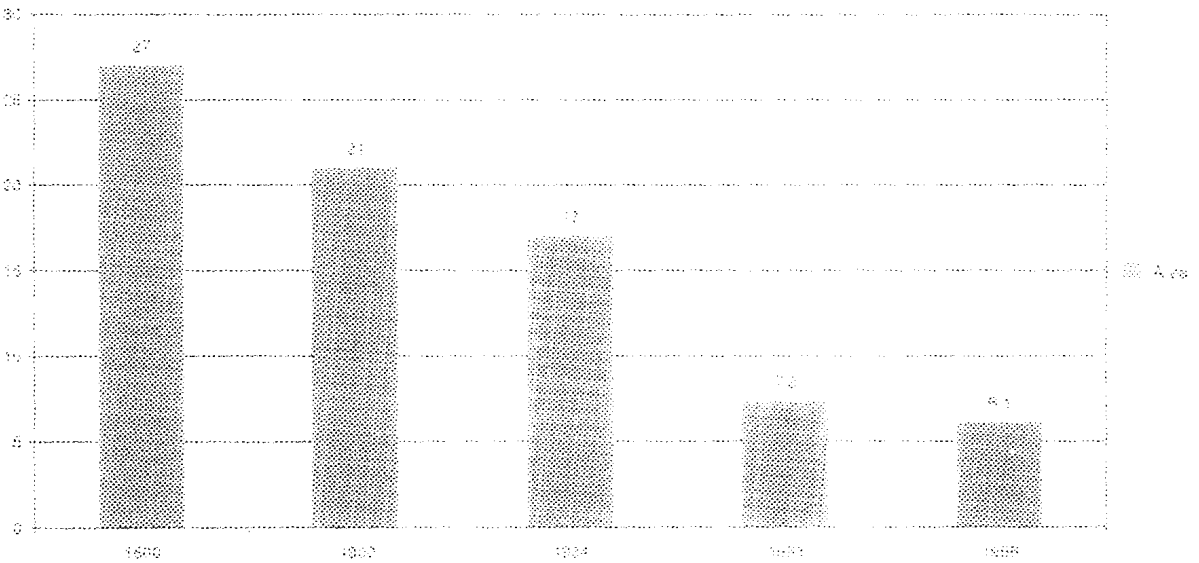
Among the sets, CO_2 is the most abundant and is responsible for more than half the radiative forcing associated with the greenhouse effect [Watson et al., 2000; Schimmell et al., 1995]. Scientists have pointed out that the global carbon cycle may be out of balance. Proof: the atmospheric CO_2 levels are 25 percent higher compared to the time before the industrial revolution. This rise has been rightly attributed to anthropogenic (man-made) causes, primarily fossil fuel combustion and, to a lesser degree, such activities as agriculture and deforestation.

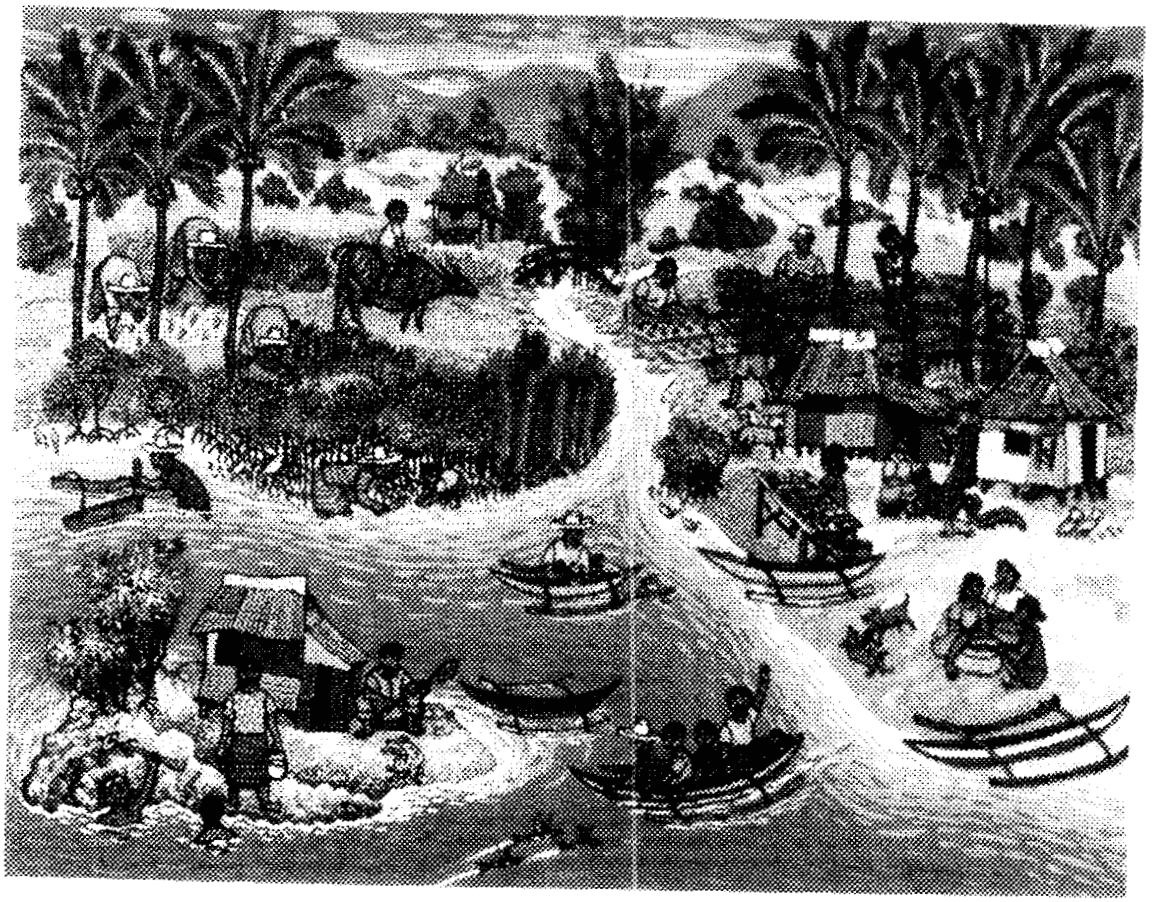
Forest ecosystems play an important role in the climate change problem because they can both be sources and sinks of atmospheric CO_2. They can be managed to assimilate CO_2 via photosynthesis, and store carbon in biomass and in soil [Watson et al., 2000; Brown, 1998; Brown et al., 1996; Trexler and Haugen, 1994]. Great attention is focused on tropical forestry to offset carbon emission due to its cost-effectiveness, high potential rates of carbon uptake, and associated environmental and social benefits [Brown et al., 2000; Moura-Costa, 1996; Myers 1996]. Tropical forests have the biggest long-term potential to sequester atmospheric CO_2 (80 percent of the world's forests total) by protecting forested lands, reforestation, slowing down deforestation and agroforestry [Brown et al., 1996]. However, at present, the world's tropical forests are estimated to be a net source of 1.6 Gt of carbon per year primarily because of deforestation, harvesting and forest degradation [Watson et al., 2000]. At least 20 percent of all atmospheric CO_2 emissions are from tropical deforestation.

Historical Land Use Change and CO_2 Emission

When the Spanish colonizers first set foot in the Philippines in 1521, 90 percent of the country was covered with lush tropical rainforest (ca. 27 million ha out of 30 million total land area) (Fig. 1). By the year 1900, there were still 70 percent or 21 million ha of forest cover [Garrity et al., 1993; Liu et al., 1993]. However, by 1996 there were only 6.1 million ha (20 percent) of forest remaining [Ibid., 1997]. Thus, in this century alone, the Philippines lost 14.9 million ha of tropical forests.

Figure 1. Forest land area in the Philippines from 1500-1996





In terms of carbon loss due to forest destruction, it is estimated that Philippine forests released about 4.1 Gt (1 Gt = 10^9 tons) of carbon into the atmosphere since the 1500s. Of this amount, 70 percent (2.9 Gt) were released this century. This is based on the premise that all the carbon in the forest biomass was released as CO_2 into the atmosphere. In reality, some of this carbon is still stored in long-lasting wood products such as furniture and old houses. The above estimate of carbon loss does not include carbon in understorey vegetation, litter and soil. This unaccounted portion could amount to 25 percent of above-ground biomass [Brown et al., 1996].

The global annual carbon emission from fossil fuel combustion and land use changes in the 1980s have been reported at 7.1 Gt per year [Schimmel et al., 1996]. Thus, the total carbon emitted by Philippine forests in more than 450 years is equal to 58 percent of global carbon emissions in one year alone.

Carbon Stocks and Rate of Carbon Sequestration

There are six major land cover categories of forest lands in the Philippines: protection forests (old-growth forests and other protected forests), second-growth forests, brushlands, grasslands, tree plantations and agroforestry farms. We have previously attempted to quantify the potential of these categories to store and sequester carbon [Lasco, 1998; Lasco and Pulhin, 1998]. More recently, we have revised these estimates based on initial data from our field studies in the country. However, these estimates were mainly based on values generated from other tropical countries, default values, or expert judgment.

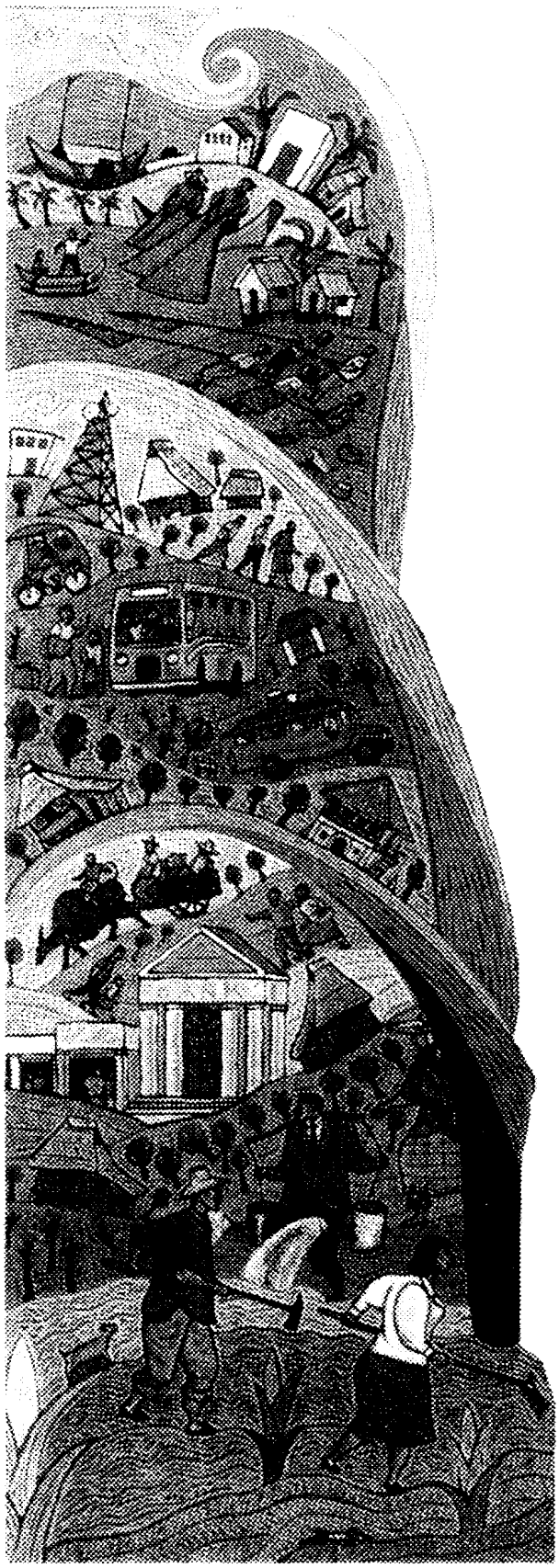
Table 1. Carbon content, biomass density and biomass accumulation data for LUCF in the Philippines

Forest Land Use	Carbon content of Biomass (%)	Total Above-ground Biomass (t/ha)	Rate of above-ground biomass change (t/ha/yr)	Source of Data
Protection forest Old-growth forest Mossy forest Pine Submarginal	44.7 (Visayas)	OGF 446 in Visayas All others 50% of OGF.	2.1 in Visayas	Lasco et al., (1999)
Second-growth forest (SGF)	43 (Luzon)	279 in Luzon 282 in Mindanao (Mean = 271)	7.01 in Luzon 9.2 in Mindanao (Mean = 8.5)	Lasco et al. (1999) Kawahara et al. (1981)
Brushlands	46.3 for wood (Visayas)	66 in Visayas	3.4 in Visayas	Lasco et al. (1999)
Grasslands	44.5 (Visayas)	28 in Visayas	0 (been use regularly burned)	Lasco et al. (1999)
Tree plantations	46 (Luzon) Visayas: 39.2 for mahogany wood 43.3 for Gmelina wood 45.0 for mangium wood (Mean= 43.1)	In Visayas: Swietenia macrophylla: 87 G. arborea: 180 A. mangium: 246 In Mindanao: G. arborea: 100 Paraserianthes falcataria: 92, 102 and 36 S. macrophylla: 261 (Mean = 138)	In Visayas S. macrophylla: 8.4 G. arborea: 18.8 A. mangium: 41.0 In Mindanao P. falcataria: 8.0 and 9.8 G. arborea: 10.8 (Mean = 15.9)	Lasco et al. (1999) Lasco et al. (1994) Kawahara et al. (1981)
Agroforestry	46 Gliricidia sepium-based alley cropping(Luzon) 46 Gmelina arborea and cacao multistorey system (Luzon)	Multistorey system (Luzon):206 Alley cropping (Luzon): 33 Fallow system (Visayas): 32 (Mean = 112)	Improved fallow (Visayas): 5.0	Lasco et al. (1996a b) Kungu (1994)

Since then, a new set of data on biomass, biomass accumulation and carbon content of Philippine forests has been obtained. We use these new data to make a new estimate of the potential of these land cover types to store and sequester carbon.

Protection forests (2.7 million ha) comprise the remaining natural forests, which include old-growth Dipterocarp forests, mossy forests, pine forests, mangrove and submarginal forests. Logging has been totally banned in these forest types since 1992 because of their biodiversity and cultural values. Total carbon stocks in these forests is estimated at 346 Mt while carbon sequestration is at 1.6 Mt/yr.

There is an estimated 2.7 million ha of second-growth forests in the Philippines as of 1997. The policy of the government since 1992 has been to rely on these forests as the main source of wood. Logging in natural forests is allowed only in second-growth Dipterocarp forests. We calculated that the Philippine second-growth production forests



store 318 Mt carbon. In terms of carbon sequestration, second-growth forests are able to sequester 7.6 Mt C/yr excluding understorey vegetation, soil and litter.

In 1997, there were 2.2 million ha of brushland areas in the Philippines, with less than 20 percent canopy cover. These are essentially remnants of tropical forests that were progressively degraded by excessive tree-cutting. The main vegetation cover in these areas are relic trees, shrubs and grasses. Given adequate protection, these areas are expected to regenerate back to mature tropical forests. It is estimated that these brushlands store 66 Mt carbon, and they sequester 9.5 Mt C/yr which is higher than the previous estimate (6.4 Tg C/yr [Lasco and Pulhin, 1998]). This is because our new estimate is based on actual data while previous estimates were based on literature.

There are 1.2 million has of grasslands in the Philippines, resulting from deforestation and land cultivation and degradation. Total carbon storage of grassland areas is estimated to be 16 Mt carbon. The rate of carbon sequestration is conservatively assumed to be zero because grasslands are regularly burned. Experiences in the Philippines and in other countries in Southeast Asia show that if protected, these grasslands will likely regenerate back to tropical forests since the latter is the native vegetation of the area [Friday et al., 1999; Samson, 1986]. While at present grasslands do not contribute much to carbon sequestration, they have the potential to do so.

The main government strategy to rehabilitate these degraded areas is through reforestation and tree plantation establishment. Typically, fast-growing species such as *Gmelina arborea*, *Acacia* spp. and *Eucalyptus* spp. are used. It is calculated that the existing tree plantations in the Philippines store 33 Mt carbon and sequester 2.4 Mt C/yr.

It is estimated that there are 6.5 million has. of agroforestry farms in the Philippines. This area includes both forest tree-based farms as well as coconut plantations (which are typically intercropped) and fruit orchards. There are data now available on the carbon storage of various agroforestry systems in the Philippines but only one source for carbon sequestration. Total carbon storage for agroforestry farms is estimated at 327 Mt carbon, while carbon sequestration is 17.5 Mt C/yr.

On the basis of the above calculations, the total carbon in the biomass of all Philippine forest land cover types is equal to 1107 Gt. Not included in these calculations are carbon contained in understorey vegetation, litter and soil. If these comprise 25 percent of the total aboveground biomass [Brown et al., 1996], then the total carbon in the forest ecosystem could reach about 1384 Mt.

Table 2. Carbon stocks and rate of carbon sequestration of forest land cover types in the Philippines

Land use Type	Area (106 ha)	Carbon storage (t/ha)	Total C in Biomass (106 t)	C sequestration rate (t/ha/yr)	Total C sequestration (106 t/yr)
Protection Forest	2.66		344.0		1.62
OGF	0.8	199.36	159.49	0.94	0.75
Mossy	1.04	99.68	103.67	0.47	0.49
Pine	0.23	99.68	22.93	0.47	0.11
Mangrove	0.11	99.68	10.96	0.47	0.05
Sub-marginal	0.48	99.68	47.85	0.47	0.23
Second-growth forest	2.73	116.53	318.13	2.8	7.63
Brushlands	2.23	29.45	65.66	4.26	9.5
Grasslands	1.2	12.91	15.49	0	0
Tree Plantations	0.6	50.91	35.95	6.85	4.11
Agroforestry	6.48	50.4	326.59	2.7	17.5
Total	15.0		1106.71		40.36

Source: Land Use, TMB (1998); Lasco and Pulhin (1999)

Annual carbon sequestration amounted to 40 Mt C/yr. However, it is estimated that Philippine forests release 0.3 and 11.1 Mt C/yr because of wood harvest and deforestation, respectively [Lasco, 1998]. Thus, the net carbon sequestration is 28.6 Mt C/yr.

The methods used in estimating the rate of carbon sequestration here are different from the IPCC approach used in the national GHG inventory. Thus, the values generated in this study are not intended for IPCC national inventories. Rather, it is designed to provide an alternative way of looking at the carbon budget of the country's forest lands. One difference of our approach is that only changes in biomass are considered. This is because this is the only carbon pool where there are actual Philippine data. In addition, our estimate is confined to carbon only (thus CO_2) while the GHG inventory considered other GHGs as well (i.e. CH_4, N_2O, NO_x and CO).

The following are the similarities and differences between our estimate and the GHG inventory as contained in the Philippines' Initial National Communication on Climate Change [2000]:

Source	Mt CO_2 or CO_2 equivalent	
	2000 National Communication	This paper
Biomass growth	111	147 (40 x 3.67) 11 (0.3 x 3.67)
Harvests	42	Does not include fuelwood harvests.
On site and off site burning	36	41 (Deforestation loss)
Decay	33	0 (Not estimated because of lack of country data)
Net Absorption	< 1 (0.126)	105

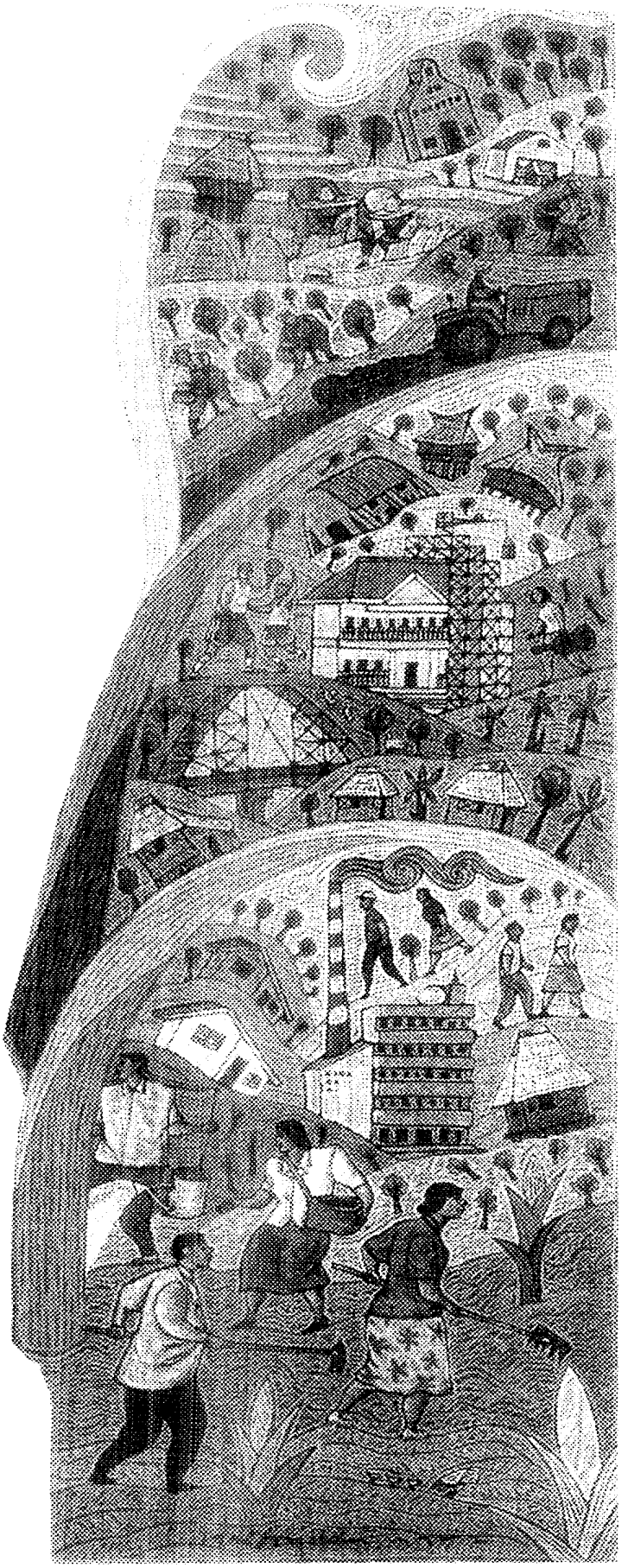
It is reported that the total Philippine CO_2 emissions from fossil fuel and land-use change are equivalent to 101 Mt C/yr [Philippines' Initial National Communication on Climate Change, 2000]. Based on our calculations, forest lands may be able to sequester about an equivalent amount of CO_2 per year. In contrast, the LUCF sector has an almost negligible net CO_2 absorption in the 2000 Initial National Communication.

The LUCF sector can turn from source to sink or vice-versa depending on the data used. This puts into question the reliability of the results of national inventories in developing countries in which LUCF is a significant sector and which rely heavily on default values. Consequently, making firm reduction commitments under the UNFCCC may be difficult for developing countries because of the large uncertainty in the baseline carbon budget (Lasco and Pulhin, 2000).

Opportunities and Threats under the Kyoto Protocol

In 1997, during the Third COP, the Kyoto Protocol was drafted, and this was the first international agreement that places legally binding limits on GHG emissions from developed countries (UNFCCC, 1997). The Protocol provides flexible mechanisms to meet carbon reduction obligations. The most relevant to developing countries is the CDM found in Article 12 of the Kyoto Protocol. Essentially, the CDM allows Annex 1 (developed) countries to meet their carbon reduction quota via activities in developing countries. One of the issues yet to be resolved is whether LUCF projects are eligible under the CDM.

In many forums, it has been clearly stated that the Philippines is against including "sinks" in CDM. ***Thus, this paper does not presume that LUCF projects will be part of the suite of options that will be***



available should the Philippines decide to join the CDM. The sole purpose of this section is to discuss the potential opportunities and threats presented by the LUCF sector should it be included in the CDM. The technical issues related to LUCF projects will not be discussed here. They are adequately analyzed in the recent IPCC special report on LULUCF [Watson et al., 2000].

The CDM provides a way for developing countries to be more actively involved in the mitigation of GHG in the atmosphere, short of actual reduction commitments. But perhaps more importantly, in the short term, developing countries stand to benefit from the CDM through investment inflow and technology transfer that will support their respective sustainable development agenda [Frumhoff et al., 1998]. In general, what will happen is that developed countries or their private corporations, needing to satisfy their carbon reduction requirements as provided in the Kyoto Protocol, could finance projects in developing countries designed to conserve or sequester carbon. Alternatively, one emerging scenario is for developing countries to offer carbon credits for sale to interested Annex-I parties under a market-driven carbon trading scheme. For some projects, developing countries in the tropics offer comparative advantages. This is especially true for LUCF projects which are usually more cost-effective in tropical countries.

A carbon offset (C-offset) project is designed to remove from and/or prevent the release of carbon dioxide into the atmosphere in order to balance CO_2 emissions taking place elsewhere [Moura-Costa, 1996]. The intent

and incremental effect criteria are considered vital for valid C-offset projects. Simply renaming existing projects as C-offsets is not acceptable if there is no added carbon sequestered. For example, an existing reforestation project could not be automatically considered a C-offset project (although it does sequester carbon) unless it can be proven that with additional investment, the existing reforestation project will have a marked increase in carbon sequestration. Similarly, if a forest area that is in danger of destruction is protected primarily to prevent carbon release , then it is a valid C-offset since carbon would have been released without the project.

Potential Co-Benefits of LULUCF Projects

For the Philippines, LULUCF projects offer many advantages under the CDM. These benefits are discussed below.

(1) Ecological and social co-benefits

For an Annex I country, the main benefit of the CDM is that it offers a flexible and cost-effective way to meet its obligations under the Kyoto Protocol. However, for a developing country, the more immediate attraction of LULUCF projects is the many co-benefits they generate, which are consistent with its sustainable development goals.

In the Philippines, deforestation and forest land degradation is one of the leading environmental and social problems. There are anywhere from 2 to 9 million has. of denuded and degraded upland areas that need immediate rehabilitation [Lasco and Pulhin, 2000]. At the present rate of reforestation (ca. 100,000 ha/yr), it will take more than 100 years to fully rehabilitate these areas.

Many protected areas (at least 2.7M ha) have also been legally proclaimed to conserve the remaining biodiversity resources of the country. However, many of these are merely protected on paper. Resources are needed to adequately manage these areas.

It is clear that the government does not have adequate resources to effectively address the environmental and socio-economic problems in forest land areas, even with the current level of foreign support. There is, therefore, a need to generate support from elsewhere to speed up rehabilitation and development in the uplands.

The CDM offers a unique opportunity as a source of financing and technology to rehabilitate and conserve Philippine forest resources. LULUCF projects such as conservation of protected areas and the establishment of tree plantations have many positive social and environmental impacts aside from their ability to reduce carbon in the atmosphere.

(2) Participation in CDM promotes long-term Philippine environmental security

The Philippines, as an archipelagic country composed of numerous small islands, is very vulnerable to the impacts of climate change. Sea-level rise as a result of the rise in global temperatures will submerge low-lying coastal areas where many of the major urban areas are located [Perez, 1997]. It is, therefore, a major environmental security issue for the country.

By participating in activities that mitigate GHGs in the atmosphere, the Philippines will in fact be acting on its own long-term interest. While some may argue that the climate change problem is a "bogey man", it is better to be on the safe side because of the potential magnitude of its impacts. In any case, many CDM projects are "no regrets" measures in that whether climate change materializes or not, the country will benefit from them.

(3) Meeting obligations under the Biological Diversity Convention

The Philippines is one of the biodiversity hotspots in the world. A key strategy in the conservation of biodiversity is the delineation and proclamation of protected areas. Aside from the UNFCC, the Philippines is also a signatory to the Biological Diversity Convention.

LUCF projects offer another opportunity to meet the goals of both conventions. As implied earlier, forestry conservation and rehabilitation projects could directly lead to greater biodiversity conservation. To cite a simple example, a C-offset project that aims to reduce the deforestation rate in a protected area (carbon emission avoidance), if successful, will also promote the conservation of biodiversity in the particular area.

Potential LUCF CDM Projects in the Philippines

There are numerous possible CDM projects in the LUCF sector. On the basis of Philippine conditions, the projects discussed below are likely to be suitable.

(1) Reforestation and tree plantation establishment

Perhaps the simplest type of project that could easily meet the requirements of a C-offset project is the reforestation of or tree plantation establishment in a denuded area. The baseline scenario can be established in many upland areas in the Philippines, which have been historically unable to recover due to a grass-fire-grass cycle. The carbon sequestered could also be readily quantified as a function of the biomass accumulation of trees over time.

(2) Conservation of protected areas

Projects that aim to conserve existing carbon stocks in protected areas in the Philippines by slowing down deforestation and degradation could also qualify as CDM projects. One possible difficulty is showing that under a baseline scenario, such forests are indeed under pressure. In addition, it must be shown that preserving a tract of forest does not lead to increased cutting in adjacent stands, thereby negating the carbon benefits of the project (leakage issue). In terms of carbon credits, this type of project could yield the highest carbon per unit cost.

(3) Improved silvicultural and harvesting practices

Any activity that increases the biomass of forest stands theoretically also increases the amount of carbon fixed. Thus, silvicultural practices such as fertilization and timber stand improvement could have positive effects. Harvesting practices that lessen damage could also reduce carbon emissions from decaying plant parts. For example, in a C-offset project in Sabah, Malaysia, it has been shown that reduced-impact logging practices led to increased carbon sequestration [Putz and Pinard, 1993].

(4) Agroforestry and community forestry

In the Philippines, community or social forestry projects typically promote a shift to agroforestry practices from unsustainable farming practices. The increased planting of trees and the use of soil conservation techniques help reduce carbon emissions into the atmosphere. The computation of carbon benefits is pretty straightforward. However, there may be higher risks associated with working with individual farmers (e.g. farmers may decide to cut trees sooner than planned).

(5) Dendrothermal power plants

The use of tree biomass to produce energy has been explored in the Philippines during the 1970s using *Leucaena leucocephala*. The project did not prosper mainly because of management problems rather than technical ones. By substituting fossil fuels with renewable biomass, there is less carbon released into the atmosphere. The technology is already available for this type of project but the cost-effectiveness is still uncertain.

There are certainly many other possibilities aside from the above. For instance, it has been discussed whether policy reform projects should also be considered. While policies have definitely far-reaching impacts on the carbon budget of a country or region, its value-added impacts are harder to isolate and quantify.

Threats of CDM to Philippine Forestry

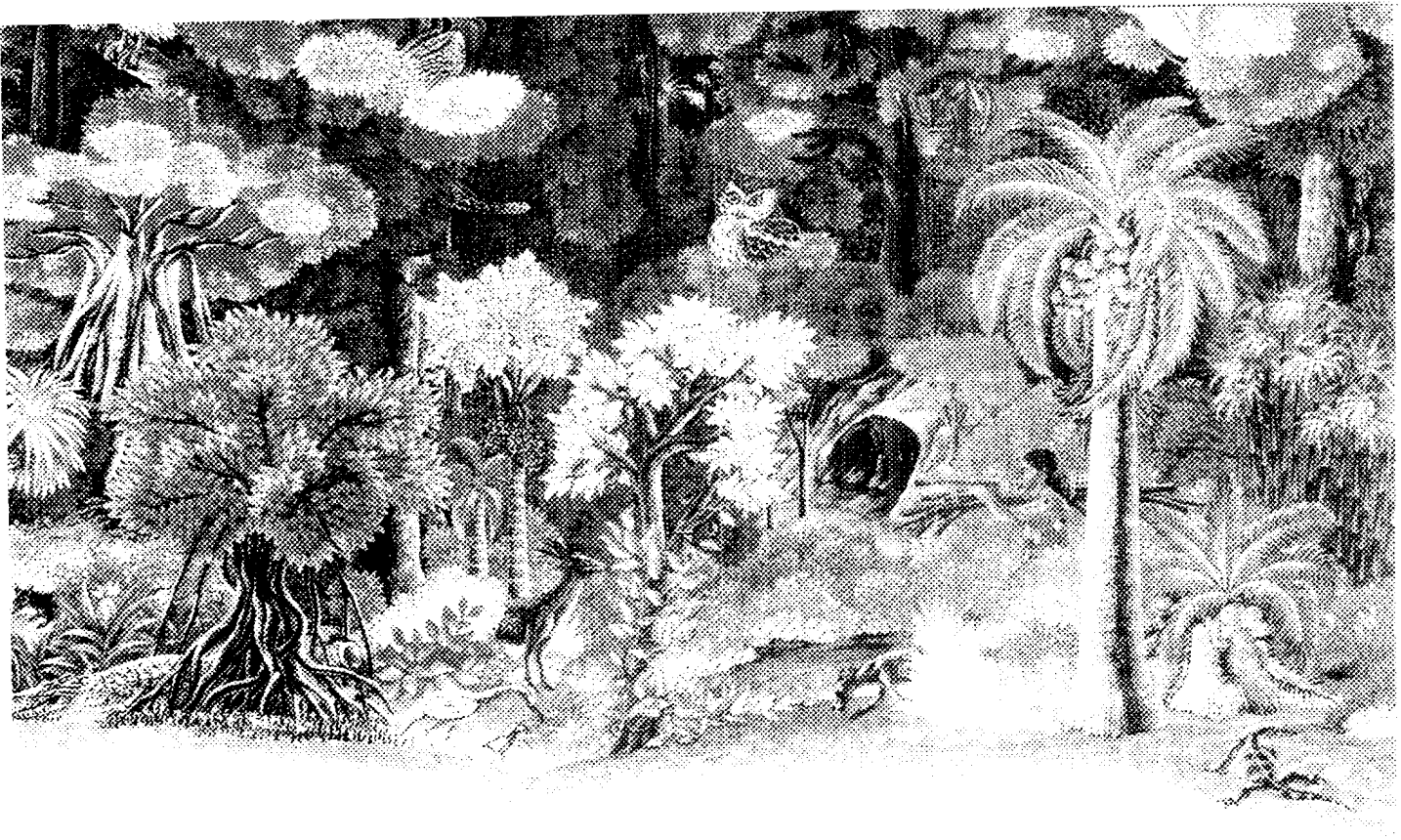
Participation in the CDM, particularly through LULUCF projects, is not without risks and problems for a developing country like the Philippines.

(1) Overemphasis on plantation forests using exotic over indigenous species

One of the most commonly stated fears is that CDM projects will be biased towards fast-growing exotic species grown as monocultures [Brown, 1998]. Worse is the danger of converting natural forests into tree plantations. Certainly, the Philippines must guard against such possibilities.

(2) Lack of technical expertise

Developed countries have a relatively large pool of experts both in the development regulatory agencies and research institutions that understand the technical issues involved in the CDM, as is self-evident in meetings such as those under the auspices of the UN. However, the situation is the total opposite in developing countries. Even within research and academic institutions, there are very few that have a good understanding of the technical issues involved. The result is that potential host countries such as the



Philippines may not be able to formulate adequate guidelines and safeguards to ensure that national sustainable development goals are met by CDM projects.

(3) Failure to capture co-benefits

Related to the previous point, there is a possibility that developing countries will not be able to fully capture the co-benefits from CDM projects and will therefore be merely exploited. Aside from lack of technical readiness, other potential causes of this are:

- lack of integrated area planning in sites where CDM projects will be located
- graft and corruption
- inadequate implementation guidelines
- lack of local community participation

(4) Loss of opportunity to develop forests for national development

Forests lands that will be used for CDM projects will not be available for other uses since it is necessary to keep the carbon "locked-up" for a long period of time. There are concerns that this will deprive developing countries the use of those lands to pursue their development goals. However, this will not happen if host countries ensure that CDM projects are compatible with the national land-use plan. For example, projects in denuded grassland areas are ideal candidates because the national interest for those areas is to really keep them under long-term forest cover.

In the final analysis, the inclusion of CDM projects in the CDM may be decided by political considerations rather than scientific veracity.

Addressing the issue of climate change requires the involvement of all sectors of society. Researchers and development workers in the NGO sector could contribute by promoting forest conservation and rehabilitation of degraded areas.

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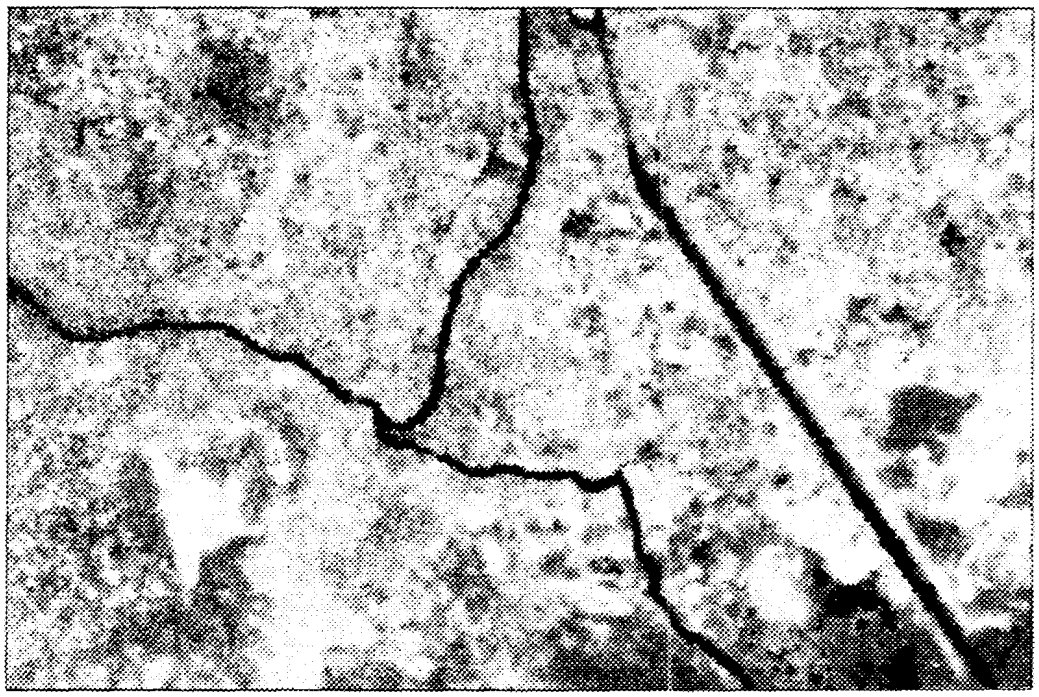
Remote Sensing/GIS for CC Impacts and Mitigation Studies

May Celine T.M. Vicente, Efren C. Ty, Jr., Melanie F.B. Dychinco, Gerald A. Galgana and Sidky M. Macatangay[*]



Remote sensing is the science of obtaining information from a distance, without actual contact with the object being observed. A simple example is photography, where light is recorded on photographic film. Satellite images are used to supplement surveying, geologic and soil mapping, crop monitoring and land use/land cover mapping.

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This paper presents another application of remote sensing, that is, as a tool for greenhouse gas mitigation and climate change adaptation. Greenhouse gases, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and chlorofluorocarbons (CFCs) are responsible for maintaining the Earth's constant temperature by trapping heat and reflecting it back to Earth. However, human-induced activities, such as burning fossil fuels (coal, oil, gas), deforestation and energy consumption contribute to an unnatural increase in GHGs. The net effect is an increase in global temperature, which has been linked to extreme climatic events, sea level rise, damage to produce and property, incidences of flooding and drought.

In developing countries, land use and changes in land use (e.g. deforestation) are linked to GHG emissions. Each specific land use class has its own emission or sequestration level. These are based on human activities, vegetation cover, or the simple interaction of certain substances within the area. Some classes, such as vegetation, absorb more CO_2 than they produce and are called sinks while others, such as highly populated areas, have a positive CO_2 emission, thus called sources. The decrease in vegetative cover, due to land conversion, increases the CO_2 content in the air. As trees are cut down and more roads and buildings are built – more CO_2 is emitted.

Therefore, land use classes and changes in these have both positive and negative impacts, in terms of GHG levels. These changes are due to

Table 1. Causes or Events and Impacts Associated with Land Use Change

Change In Land Use	Causes/Events	Impacts
Bare Soil/Open Space/ Vegetation to Residential/ Commercial	• subdivisions • encroachment of squatters • zoning	• increase in GHG emissions, particularly in the energy, waste and transportation sectors • decrease in vegetation • increase in population • displacement of flora and fauna
Water to Soil	• sedimentation • reclamation	
Residential to Commercial	• increase in large-scale capital investments • infrastructure development (i.e. construction of malls, and other commercial buildings)	• high increase in GHG emissions, particularly in the energy, waste and transportation sectors • decrease in open spaces • displacement of population • increase in infrastructure
Commercial to Residential	• decrease in large-scale capital investments • re-zoning	• decongestion of road networks • moderate decrease in GHG emissions
Bare Soil/Open Space to Vegetation	• construction of parks	• potential GHG sink
Low/Medium Density Residential to High Density Residential	• degradation of the city core into slums	• increase in population • high increase in GHG emissions, particularly in the waste, energy and transportation sector

certain natural and human-made events within an area. Table 1 lists some of the issues and impacts arising from some such changes.

Considering the trade-offs between land use and land cover classes, policymakers can therefore manage the emission of GHGs through proper land use and land cover allocation as well as regulation. GHG emissions caused by spatial change can be offset by a corresponding land use and land cover change in another site. If, for example, a certain area within the city is converted to a commercial zone, the additional GHGs emitted can be offset by converting another area into a land use or land cover with comparatively less emissions.

It is evident that GHG mitigation is local in nature, whereas the issue of climate change is global. For developing countries such as the Philippines, the present concern is not mitigation. The Philippines only accounts for 0.3 percent of the world's GHG emission, based on 1997 figures [CDIAC, 2000a], and any local reduction will not have any significant impact in global GHG emissions. It is almost certain, however, that the impacts of climate change will be experienced for the next 100 years, even while considering mitigation options. The local response, therefore, goes beyond mitigation and into vulnerability assessment for adaptation. Adaptation, however, does not preclude the need for mitigation by large GHG emitters.

The issue of global warming also has socio-economic implications and trade-offs. Some countries are more vulnerable to climate change due to their low growth rates, rapid increase in population, and ecological degradation [IPCC, 1997]. Locally, each land use and land cover class can be used to assess levels of vulnerability to climate change.

The detection of land use and land use changes through remote sensing thus becomes important because of two reasons: (1) land use and land cover classes can indicate the amount of GHG emissions, and are key to emissions reduction, and (2) each specific land use and land cover is a factor in judging vulnerability to climate change. This information, supported by matrices of existing and future land use

Figure 1. *SPOT XS Satellite Images of Southeast Metro Manila, 1988 and 1997*

South-Eastern Metro Manila in 1988

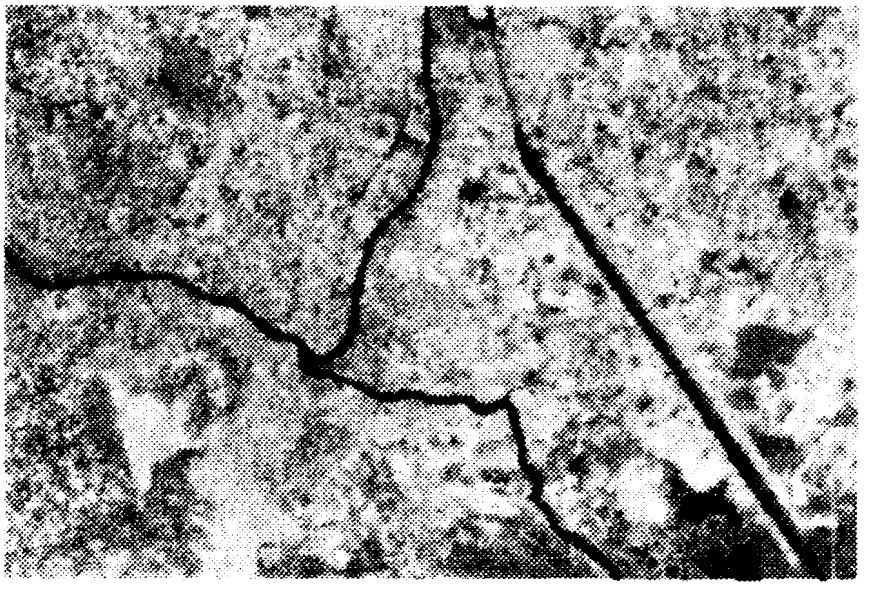
allocations, will aid policymakers in addressing CO_2 mitigation and climate change adaptation as integral parts of urban and rural planning towards sustainable development.

Methodology

As a demonstration of land use change detection applying remote sensing, the region of Southeast Metro Manila was selected. This region covers parts of San Juan, Pasig, Taguig, Mandaluyong, Pateros, Quezon City and the surrounding municipalities of Taytay and Cainta in the province of Rizal. SPOT XS satellite images were used for the detection of land use change in the area.

Spectral Characteristics of Land Use Classes

The spectral signature and morphology representative of each land use class type are presented here. These facilitate semi-automated photo interpretation. The technical term, spectral signature, in the case of SPOT imageries, refers to the way an object reflects solar energy while morphology refers to the form and pattern of the object of detection. Each land use class inherently possesses a distinct spectral signature and morphology. The image samples are then associated with a specific land use class. Land use classes were verified through ground truthing undertaken from October to December 1999.



South-Eastern Metro Manila in 1997

Change Detection

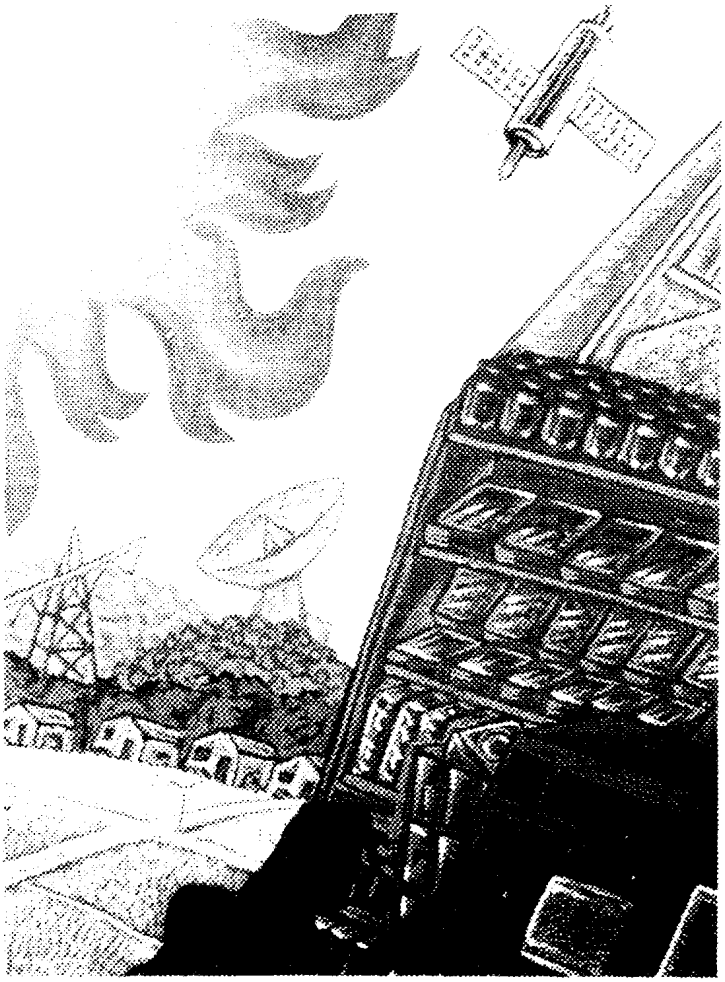
When applying RS to detect land use changes in a particular area, spatial and spectral resolution and quality of imageries must be given due consideration. These inherent characteristics of satellite imageries influence the detectability of phenomena under study.

Image classification methodologies, such as the International Standards Organization's (ISO) unsupervised and supervised classification algorithms may be used if the land use is spectrally homogeneous, such as for natural phenomena. However, there is often a mixture of natural features in so-called artificial classes in the urban setting. Therefore, spectral methods of classification have to be complemented with pattern recognition and extraction. Thus, it is recommended that to generate estimations of GHG associated with urban areas, satellite image processing should be composed of two parts: (1) to extract natural phenomena and (2) to detect man-made features of the urban environment.

Using the algorithm developed by Vicente, et al. (1987)[1], land use in 1988 and in 1997 were logically combined. This is to produce a matrix of values that represent different kinds of change, as follows :

1988 / 1997	Cloud Shadow	Water	Clouds	Vegetation	Bare Soil	Commercial	High Residential	Medium Residential	Open Space	Low Residential
Cloud Shadow	1	2	3	4	5	6	7	8	9	10
Water	11	12	13	14	15	16	17	18	19	20
Clouds	21	22	23	24	25	26	27	28	29	30
Vegetation	31	32	33	34	35	36	37	38	39	40
Bare Soil	41	42	43	44	45	46	47	48	49	50
Commercial	51	52	53	54	55	56	57	58	59	60
High Residential	61	62	63	64	65	66	67	68	69	70
Medium Residential	71	72	73	74	75	76	77	78	79	80
Open Space	81	82	83	84	85	86	87	88	89	90
Low Residential	91	92	93	94	95	96	97	98	99	100

From this table, it is easy to assign a corresponding numerical and color code to a specific change. For example, a value of 74 would indicate a pixel change from vegetation to medium-density residential use.



One advantage of this method is that we can accurately track the subsequent changes from baseline values, that is, from a base year. However, the number of objects to keep track of increases geometrically as the number of classes increases. Also, some changes are logically impossible or have a slight chance of happening.

Results and Discussion

Based on the results of the classification in 1988, about 390 ha, or 33 percent of the total study area, was residential. In 1997, residential areas increased about 548 ha, or 46 percent of the total study area. The increase is noted for both low-density and high-density residential areas. Simply put, a sizeable amount of population migrated from the surrounding provinces and or nearby municipalities or cities into the region, or a probable rapid increase in the population of the region under study.

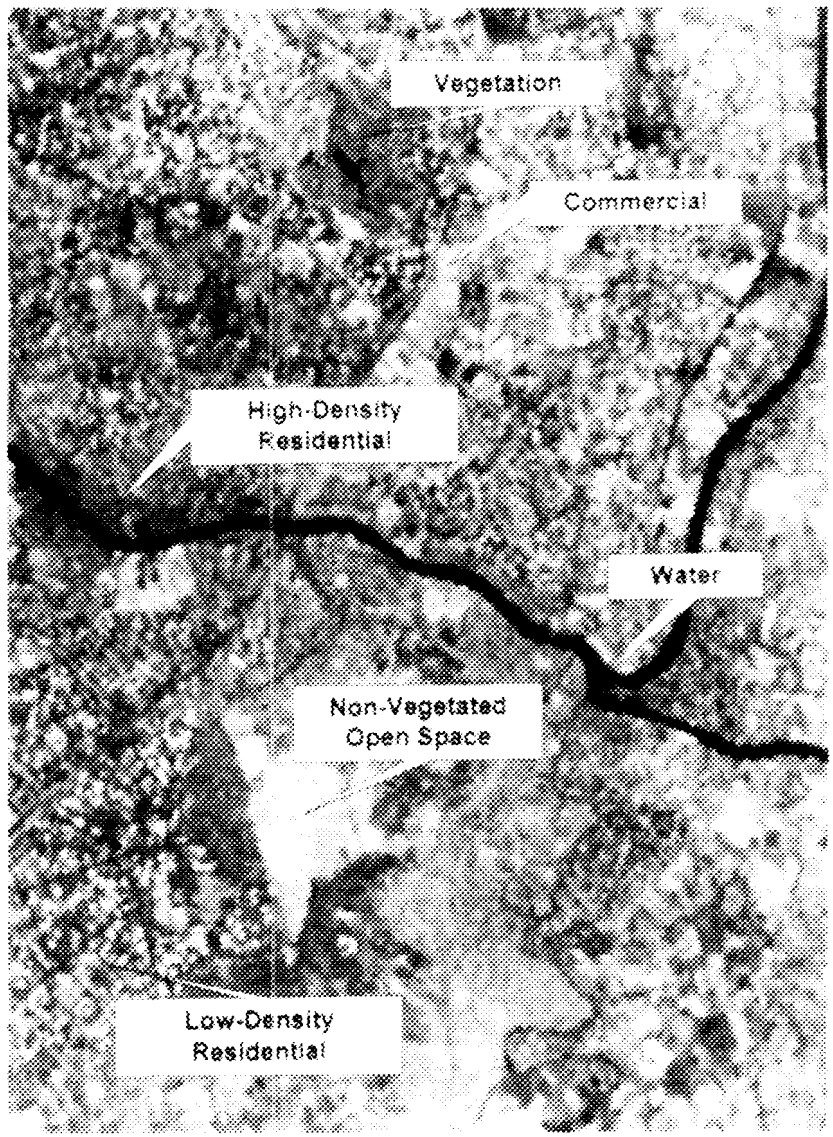
A case in point is the area along the Manggahan Floodway (covered by 300-meter offsets from the waterway on both sides). It was noted that in 1988, there were only about 14 ha of high-density residential land. This was located on the eastern bank of the waterway, while there was none on the western side. Most of the area was still vegetated then. In 1997, settlements ballooned to about 160 ha of high-density residential land that expanded to the western bank of the floodway.

The 41 percent increase in settlements within the southeastern part of the metropolis can be correlated with events that occurred between 1988 and 1997. The development of the CALABARZON (Cavite, Laguna, Batangas, Rizal, Quezon) area near southern Metro Manila as the new investment hub of Luzon, and the completion of the circumferential road (C5) connecting to the South Super Highway opened up the cities and municipalities of this area to migrants. The growth and increase of settlements along the Manggahan Floodway may also be correlated to the increase in capital investments due to the expansion of economic activities in Pasig City.

The increase in residential areas resulted in a decrease in vegetation and open spaces. From 1988 to 1997, it was observed that the areas covered by vegetation decreased by 10 percent, from 252 ha to 224 ha. Bare soil areas decreased by 65 percent, from 214 ha to 78 ha. Non-vegetated open spaces, however, increased by 41 percent, from 131 ha to 185 ha. Possible reasons for this include construction work, as in the case of Fort Bonifacio.

There is a notable increase in large-scale capital investments, as shown by the doubling of commercial areas from 62 ha in 1988 to 126 ha in 1997. Due to limitations of the image classification algorithm, industrial land use is also grouped under this category.

Most of the land use changes involved the conversion of vegetation, bare soil or open space to residential classes. This encompassed about 180 ha. Some residential classes (about 42 ha) were converted into commercial uses. Curiously, about 61 ha of either bare soil or open space classes were converted into vegetation. Most of these changes cited occurred in the southeastern part of the map, where the area was mostly riceland. Other places where land use and land cover change occurred include urban fringes.



Conclusion

The use of satellite images clearly identified areas that have been converted to other uses and their corresponding vulnerabilities to specific effects of climate change. Comparison between land uses in 1988 and 1997 showed the encroachment of people in cities and municipalities near the Manggahan Floodway. The sudden increase in population, and settlements within business centers made the area more vulnerable to

health hazards. These hazards are due to congestion and the different levels and concentration of emissions from land use classes.

Values of CO_2 emission per square meter by land use and land cover types can be used to approximate emissions from an area. It can be demonstrated that increases in certain land use types, such as residential, commercial and industrial area result in additional GHG emissions.

Definite figures for population density per hectare for high-density areas can be used as factors in deriving the total population in these slum settlements. Analyses by logically relating population distribution maps and elevation may be undertaken to determine the population vulnerable to adverse environmental conditions such as rise in water level or flooding.

The understanding of the impacts of climate change on developing countries such as the Philippines may help in guiding policymakers in planning mitigation and adaptation strategies. In Metro Manila alone, coastal municipalities and squatter settlements found in Malabon, Navotas and Valenzuela are highly vulnerable to flooding. The effects due to climate change may raise the proneness to flooding even more. This has a direct impact on infrastructures and economic activities in the area in the form of reducing productivity of the low-lying areas and causing massive migration to higher land.

Rapid evacuation could add to the problem of congestion. Unplanned expansion of settlements and other land uses that involve economic activities may even contribute to greater damage. Lesser open spaces may trigger health hazards, degradation of land and ecosystems, and the further depletion of natural resources.

It is thus important to consider climatic events vis-a-vis comprehensive land use plans and the national physical framework plans of the government. In doing so, we must ease the impacts of climate change and prepare the different sectors for their roles in adaptation.

The use of vulnerability maps, regular monitoring of flood and drought events, and of other activities will allow us to adapt in a timely and effective manner.

GHG emission maps derived from RS-GIS will also aid us in targetting those sectors for which mitigation will indeed lead to significant carbon savings.

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Abbreviations

ADB	Asian Development Bank
AFTA	Asean Free Trade Area
AIDS	Acquired Immuno-Deficiency Syndrome
AIJ	Activities Implemented Jointly
ALGAS	Asia Least-Cost Greenhouse Gas Abatement Strategy
APEC	Asia-Pacific Economic Conference
BAS	Bureau of Agricultural Statistics
CAN	Climate Action Network
CC	Climate Change
CDM	Clean Development Mechanism
COP	Conference of Parties
DA	Department of Agriculture
DBP	Development Bank of the Philippines
DENR	Department of Environment and Natural Resources
DOE	Department of Energy
DOH	Department of Health
DOST	Department of Science and Technology
DOTC	Department of Transportation and Communication
EHS	Environmental Health Service
ENSO	El Niño Oscillation
ESMAP	Energy Sector Management Assistance Program
FMB	Forest Management Bureau
FP-RH	Family Planning-Reproductive Health
GATT-WTO	General Agreements on Tariffs and Trade – World Trade Organization
GCM	Global Circulation Models
GDP	Gross Domestic Product

GEF	Global Environment Facility
GWP	Global Warming Potential
IACCC	Inter-Agency Committee on Climate Change
ICLEI	International Council for Local Environmental Initiatives
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRRI	International Rice Research Institute
JICA	Japan International Cooperation Agency
LGA	Local Government Academy
LGU	Local Government Unit
LogoDef	Local Government Development Foundation
LUCF	Land Use Change and Forestry
MSW	Municipal Solid Waste
NCED	Non-Conventional Energy Division
NEDA	National Economic Development Authority
NGO	Non-government Organization
NOAA	National Oceanographic and Atmospheric Administration
NPC	National Power Corporation
NRE	New and Renewable Energy
NSCB	National Statistical Coordinating Board
OECD	Organization for Economic Co-operation and Development
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PCSD	Philippine Council for Sustainable Development
Philreefs	Coral Reef Information Network of the Philippines
SBSTA	Subsidiary Body for Scientific and Technological Advice
UNCED	UN Conference on Environment and Development
UNCTAD	UN Conference on Trade and Development
UNFCCC	United Nations Framework Convention on Climate Change
US EPA	United States Environmental Protection Agency
WHO	World Health Organization