Policy Brief
SENATE ECONOMIC PLANNING OFFICE
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Improving Resiliency: Addressing the Threat of Climate Change

As the world grapples with the effects of climate change, there is a pressing need for policymakers to understand its implications and identify the appropriate policy responses that will minimize these effects.

The SEPO Policy Brief, a publication of the Senate Economic Planning Office, provides analysis and discussion on important socioeconomic issues as inputs to the work of Senators and Senate Officials. The SEPO Policy Brief is also available at www.senate.gov.ph.

Introduction

The increasing occurrence and intensity of typhoons and droughts over the last 20 years has put the spotlight on climate change and how it can severely affect the way Filipinos go about with their daily lives. Just last year, Typhoons Ondoy and Pepeng left 355 people dead, displaced 3.9 million people, and caused damages estimated at US$4.4 billion (2.6 percent of the country's gross domestic product) by the World Bank. Typhoon Frank, which hit the country in June 2008, was similarly destructive, taking the lives of 622 people and causing US$260 million in damages. In February 2006, 10 straight days of heavy rain and a minor earthquake triggered a massive landslide in Guinsaugon, Southern Leyte, killing 1,126 people in one of the world's deadliest landslides ever.

The occurrence of super typhoons and other extreme weather patterns (e.g., El Niño and La Niña phenomena) are expected to become more prevalent in the future as the world continues to grapple with the immediate and long-term effects of climate change. With this in mind, there is a pressing need for policymakers to have a clear understanding of what climate change really is and why it needs to be immediately addressed at all levels of governance. The purpose of this paper therefore is to provide an overview of how climate change can significantly impact on the economy (particularly on food security, water supply, and public health and safety) and identify the appropriate policy responses that will minimize these effects.

Defining Climate Change

Any discussion on climate change necessarily begins with the weather. Weather refers to the elements that people in a specific location experience everyday such as temperature, humidity, wind speed, etc. The climate of a given area is the long-term average of daily weather conditions in that area. The 2007 Intergovernmental Panel on Climate Change (IPCC) Synthesis Report defines climate change as *"a change in the state of the climate that can be identified (using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period"* (Intergovernmental Panel on Climate Change (IPCC) Synthesis Report, 2007).

Climate Change vs. Global Warming

At this point, it is necessary to differentiate between climate change and global warming, two terms that are often interchanged but in reality mean two different things. Global warming refers to the increase in Earth's average surface temperature. Global warming is a type of climate change. Climate change is a broader term that refers to long-term modifications in climate conditions such as average temperature, humidity, and precipitation.

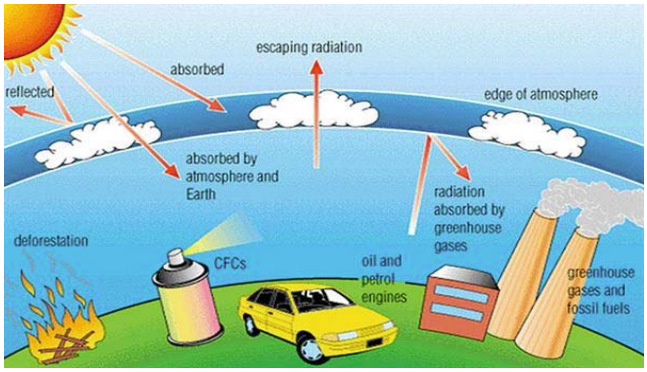
Much of the debate on climate change revolves around its causes, specifically whether the extreme changes in climate are products largely of natural processes or anthropogenic factors.

Greenhouse gases (GHGs) such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) occur naturally in the atmosphere and absorb heat and energy from the sun to support biological life on the planet (Figure 1). This natural phenomenon is called the greenhouse effect. There is a widely held view among climate scientists that anthropogenic activities (such as the massive conversion of forested land for human settlement and food production and the emissions produced by power generation, industrial production, and transportation)[1] have directly or indirectly exacerbated the natural greenhouse effect to the point that extreme and rapid changes in the earth's climate have become more and more pronounced. The IPCC, in its 2007 Synthesis Report, concluded that *"the observed widespread warming of the atmosphere and ocean, together with ice mass loss, support the conclusion that it is extremely unlikely that global climate change of the past 50 years can be explained without external [factors] and very likely that it is not due to known natural causes alone"*. Similarly, in its climate change study released in June 2009, the US Global Change Research Program[2] confirmed evidence that global temperature increases in recent decades have been primarily due to greenhouse gases (the CO_2 in particular) emitted by human activities. The report took into account new data that were not yet available when previous large national and global assessments were made to present the ongoing and expected future impacts of climate change in the US.

[1] Water vapor is actually the most abundant greenhouse gas in the atmosphere, comprising between 36-72 percent. However, it must be noted that the amount of water vapor in the atmosphere is dependent upon the natural processes of water evaporation/condensation and is not related to anthropogenic activities.

[2] The report "Global Climate Change Impacts in the United States" was produced by a consortium of experts from13 U.S. government science agencies, including the the National Oceanic and Atmospheric Administration as well as several major universities and research institutes.

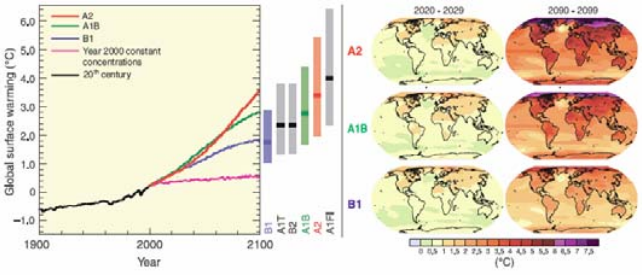
Figure 1: The Greenhouse Effect



Source: www.myclimatechange.net

Note: Global atmospheric concentrations of GHGs have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning thousands of years. The atmospheric concentrations of CO2 and CH4 in 2005 exceed by far the natural range over the last 650,000 years. Global increases in CO2 concentrations are due primarily to fossil fuel use, with land-use change providing another significant but smaller contribution. It is very likely that the observed increase in CH4 concentration is predominantly due to agriculture and fossil fuel use. The increase in N2O concentration is primarily due to agriculture. (IPCC Synthesis Report, 2007)

Figure 2: Atmosphere-Ocean General Circulation Model Projections of Surface Warming



Source: 2007 IPCC Synthesis Report

Note: According to the IPCC, average global surface temperatures are expected to rise by 0.2°C per decade over the next twenty years based on current emission levels. Even if by some miracle, GHG levels are kept constant at year 2000 levels, average global temperatures will continue to rise by at least 0.1°C per decade until 2100, given the amount of greenhouse gases already present in the atmosphere (IPCC Synthesis Report, 2007)

However, critics of human-induced climate change claim that there is no strong scientific evidence supporting the causal relationship between atmospheric CO2 and air temperature. They further point out that there is actually a reverse correlation- -that the increase in global temperature actually precedes and hence, causes the increase in CO2 level, and not the other way around. It was also argued that natural causes such as solar irradiance, cloud cover, galactic cosmic rays and sunspot activity, rather than human interventions, are still the dominant drivers of climate change.

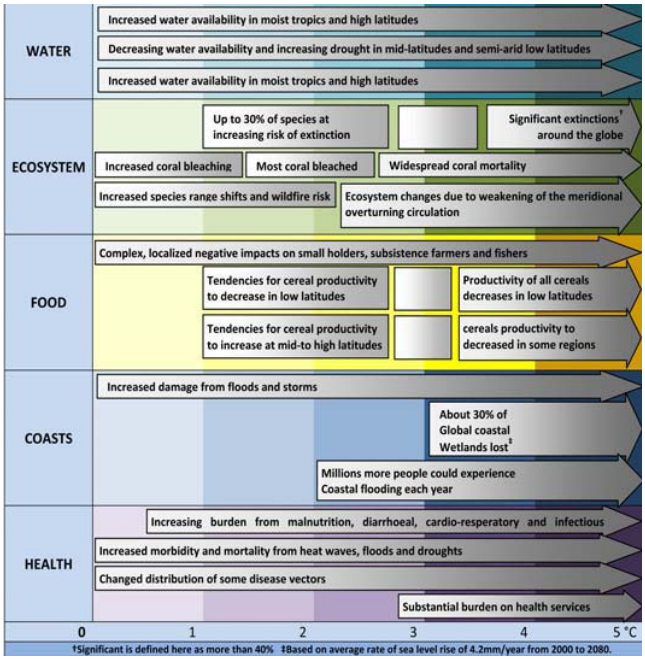
Regardless of the cause, there is an overwhelming consensus that the global climate is changing. Its signs

are everywhere. Australia (in the Southern Hemisphere) was in the midst of its second hottest summer on record, marked by *"extreme bushfires, dust-storms, lingering rainfall deficiencies, areas of flooding, and record-breaking heatwaves"* (Australian Bureau of Meteorology). Initial data from the US National Aeronautics and Space Agency (NASA) revealed that the 2009 was the fifth warmest year on record and that the five hottest years (since official recordkeeping began in 1850) occurred during the last two decades. At the same time, countries in the Northern Hemisphere, such as the United States, China, South Korea, and those in Western Europe experienced record low temperatures during the winter of 2009.

Impacts of Climate Change

Climate change will have a number of significant negative effects on developing tropical island nations such as the Philippines (Figure 3). As the second largest archipelago in the world, the Philippines is considered to be a climate hotspot and is tied with the Dominican Republic in the 8th place in the 2010 Long-Term Global Climate Risk Index (Table 1). Small island nations (or provinces, in the case of the Philippines) are particularly vulnerable to climate change where rising sea levels are slowly reclaiming whatever habitable land there is. According to the IPCC, global average sea levels are expected to rise by 5 mm per year over the next 100 years (or 0.5 m by 2100). In the Philippines, data from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) showed that the country's sea level rose by an average of 1.8 mm per year from 1961-2003. Coastal areas in Metro Manila, Legazpi, and Davao, have risen by nearly 150 mm since 1970 (Greenpeace). Recent estimates predict that the country will lose 90,000-140,000 hectares of land if sea levels rise by one meter, or 45,000-70,000 hectares by 2100 when taking into consideration the sea rise projected by the IPCC.

Figure 3: Projected Global Impacts of Rising Temperatures



Source: 2007 IPCC Synthesis Report

Table No. 1: Long-Term Climate Risk Index– Top 10 Affected Countries (1990-2008)

Rank	Country	Climate Risk Index Score	Annual Death Toll	Annual losses (US$ Million)	Annual GDP percent loss
1	Bangladesh	8.00	8,241	2,189	1.81
2	Myanmar	8.25	4,522	707	2.55
3	Honduras	12.00	340	660	3.37
4	Vietnam	18.83	466	1,525	1.31
5	Nicaragua	21.00	164	211	2.03
6	Haiti	22.83	335	95	1.08
7	India	25.83	3,255	6,132	0.38
8-9	Dominican Republic	27.58	222	191	0.45
	Philippines	27.67	799	544	0.30
10	China	28.58	2,023	25,961	0.78

Source: 2010, Germanwatch. It must be noted that all the countries on this list are still developing, emphasizing the fact that poorer countries will be more vulnerable to the damaging effects of climate change. This is ironic given the fact that most of the GHGs in the atmosphere were emitted by developed countries such as the US and those in Western Europe. All members of the G8 (with the exception of France) are among the top 10 carbon emitting countries in the world. On the other hand, the Philippines accounts for only 0.2 percent of global carbon emissions (US Carbon Dioxide Information Analysis Center).

Millions of people are at risk. A study conducted by the International Institute for Environment and Development (IIED) has estimated that more than 634 million people (a tenth of the global population) live in Low Elevation Coastal Zones (LCEZs) and are expected to bear the brunt of climate change's effects.[3] In the Philippines, 70 percent of all *barangays* and municipalities (or 56% of the total population) are located along or near the country's lengthy coastline. Communities the coastline (and those found in low-lying areas) will be particularly exposed to increasing risk of flooding (Annex 1).

Historically, the Philippines has always been "climate-sensitive" and prone to extreme weather phenomena. Every year, the country is visited by an average of 20 typhoons, with heavey impact on the health and safety of the general population, and considerable damage to physical infrastructure and private property. Storms and typhoons accompanied by strong winds and heavy rain often result in massive

[3] The same study found that the Philippines is among the 10 countries with the highest population densities in coastal and low-lying areas, along with China, India, Bangladesh, Vietnam, Indonesia, Japan, Egypt, United States and Vietnam.

flooding and landslides, increasing the threat of physical danger and exposure to various cardio-respiratory and water-borne diseases such as pneumonia, dengue, and malaria. Climate change will magnify the effects of these storms by making them stronger and more frequent in the foreseeable future.

Rising global surface temperatures coupled with decreasing precipitation levels will result in diminishing levels of water available for drinking, sanitation, agricultural production and power generation. The El Niño Southern Oscillation (ENSO), marked by hot and dry days in the Philippines, generally occurs every five years.[4] However, since the 1970s, El Niño/La Niña episodes have been occurring more often (Figure 5). From 1970-2000, the country experienced five La Niña and seven 7 El Niño seasons.

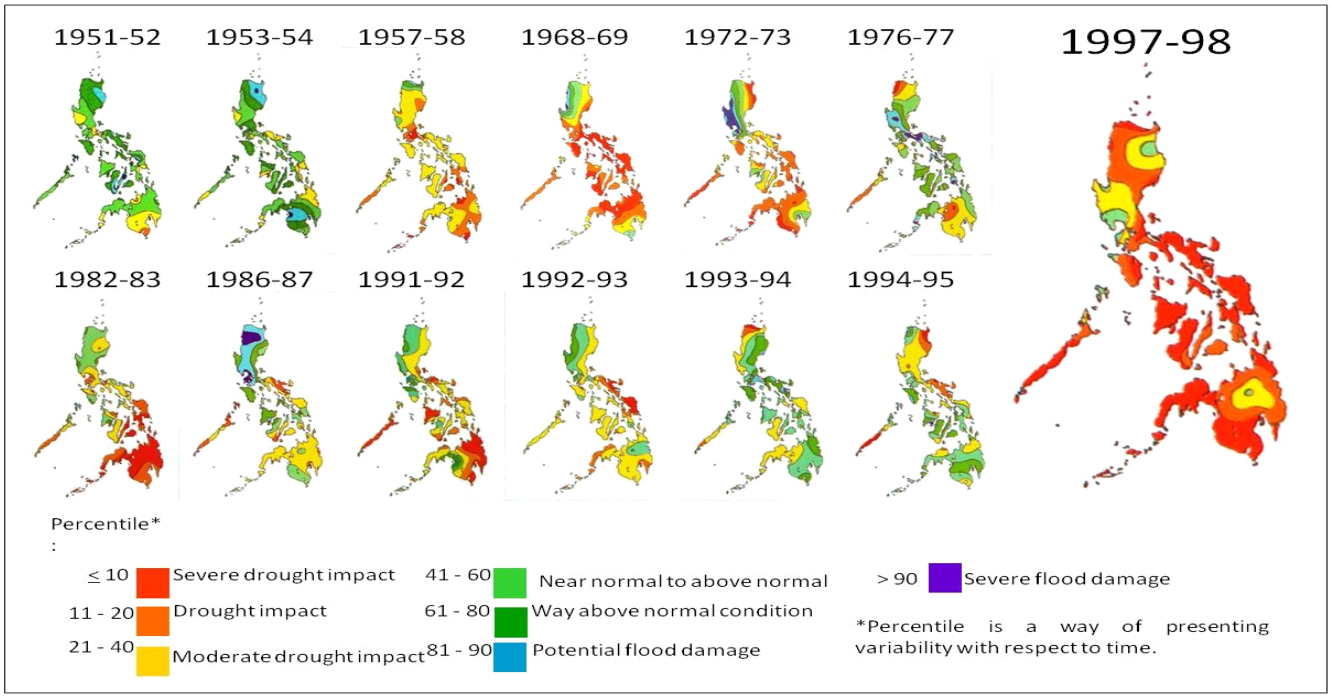
More than half of the country's 80 provinces are expected to bear the brunt of this year's El Niño. The Department of Agriculture (DA) has identified 24 highly vulnerable provinces and 23 moderately vulnerable provinces where falling water levels are expected to severely limit the amount of water available for irrigation and power generation (Table 2). The DA estimates that losses in agricultural production due to this year's El Niño have already reached PhP11.2 billion as of March 2010 and may go as high as PhP20 billion for the whole year.

Table 2: Drought Affected Provinces due to El Nino 2010

Highly Vulnerable	Moderately Vulnerable
1. Ilocos Norte	1. Abra
2. Ilocos Sur	2. Apayao
3. La Union	3. Benguet
4. Pangasinan	4. Ifugao
5. Cagayan	5. Mountain Province
6. Isabela	6. Nueva Vizcaya
7. Aurora	7. Quirino
8. Bataan	8. Batangas
9. Bulacan	9. Laguna
10. Nueva Ecija	10. Quezon
11. Pampanga	11. Romblon
12. Tarlac	12. Sorsogon
13. Zambales	13. Aklan
14. Cavite	14. Antique
15. Rizal	15. Bohol
16. Occidental Mindoro	16. Samar
17. Palawan	17. Zamboanga del Norte
18. Capiz	18. Zamboanga Sibugay
19. Iloilo	19. Zamboanga del Sur
20. Negros Occidental	20. Bukidnon
21. Misamis Oriental	21. Davao Oriental
22. Zamboanga City	22. Davao del Sur
23. Sarangani	23. Davao city
24. South Cotobato	

Source: DA

Figure 4: ENSO Events in the Philippines



Source: Presentation on Philippine Climate Change Impacts and Vulnerabilities by Dr. Rosa T. Perez, 2009.

[4] According to the PAGASA, the El Niño /La Niña Southern Oscillation (ENSO) is defined as *"a condition in the Pacific Ocean that is characterized by the warming (El Niño) or cooling (La Niña) of the Central and Eastern Equatorial Pacific"*.

Falling water levels also threaten the supply of power in the country, given the fact that hydroelectric power accounts for 20.6 percent of the country's energy mix. Water levels in major hydroelectric power dams (such as the Magat, Angat, Agus and Pulangi) have already fallen below critical levels. This is expected to have serious repercussions on the country's socioeconomic growth and development. Sustained power outages will result in massive losses in productivity, interruptions in the delivery of basic services, loss of economic opportunities and foregone revenues. The World Bank has estimated that the Philippine economy sustained losses between US$600-US$800 million per year during the power crisis of the early 1990s, wherein practically the entire country suffered daily power outages of up to 12 hours.

Globally, regions affected by drought have been increasing since the 1970s. The growing incidence of drought will constrain crop and livestock production, threatening food security and increasing the occurrence of famine and hunger in many regions, particularly in Asia and Africa. The supply of fish and other marine products will likewise be constrained as rising sea temperatures result in massive coral bleaching and seagrass regression that seriously hinders the natural ability of marine ecosystems to regenerate and replenish their stock. In the Philippines, losses in domestic agricultural and fisheries productivity caused by climate change will lead to a growing reliance on agricultural imports to meet the food requirements of a burgeoning population. Unfortunately, higher imports will result in raising the prices of basic food items which is worrisome in a country where more than a third of the population live below the poverty line (National Statistical Coordination Board, 2006).

By 2050, the IPCC projects that freshwater availability in Central, South, East and South-East Asia will have decreased significantly (IPCC Synthesis Report, 2007). In the Philippines, 15 percent of all households remain without access to clean and potable water (National Economic and Development Authority, 2005). This situation is expected to deteriorate further as population growth results in an increasing demand for water resources. With an annual growth rate of 2.04 percent, the Philippine population is expected to reach 100 million by 2014 (National Statistics Office, 2000). Rising surface temperatures, coupled with the effects of rapid population growth and the severe deforestation of the Philippines' critical watershed areas, have already reduced the availability of groundwater significantly. Since the 1990s, acute water shortages have been recorded during the dry season, especially in densely populated urban areas such as Metro Manila, Metro Cebu and Baguio City. It has been estimated that all major cities in the Philippines will experience water shortage by 2025 if additional water sources are not developed (Japan International Cooperation Agency and National Water Resources Board, 1998). It must also be noted that prolonged dry spells (especially during the hot summer months) will cause serious problems for many of the smaller island provinces that depend mostly on rainwater as their main source of water.

While the problem of climate change necessarily affects all members of society, it must be stressed that its impacts will be felt most strongly by the poor and the marginalized (especially those living in mountainous, coastal, and low-lying areas) whose survival and livelihood largely depend on the health and availability of climate-sensitive natural resources. According to the 2004 Global Climate Risk Index, the provinces in the country projected to be most vulnerable are in Regions V (Bicol), VIII (Eastern Visayas), IX (Zamboanga Peninsula), and the Autonomous Region of Muslim Mindanao (ARMM), regions that have suffered from the highest levels of poverty and food insecurity in the country.

Addressing Climate Change: Minimizing risks and preparing for disasters

Governments across the world are addressing the threat of climate change using two different yet complementary approaches: adaptation and mitigation. Adaptation measures are immediate and pragmatic solutions that enable countries to adapt to the actual (and projected) adverse impacts of climate change in various ways. Examples of adaptation measures include the relocation of low-lying communities to higher ground, implementation of water conservation measures for drinking, sanitation, and agricultural production, and the preparation of flood control and natural disaster emergency plans (Annex 2).

According to the IPCC, many adaptation measures have *"multiple drivers, such as economic development and poverty alleviation, and [should be] embedded within broader development, sectoral, regional, and local planning initiatives"* such as land-use plans and socioeconomic development policies and programs. It must be noted that the benefits of adaptation measures will not only be more immediately felt, they will also drastically reduce the vulnerability of affected communities in the long run.

While adaptation measures are crucial to mankind's immediate survival, it must be stressed that adaptation alone cannot be expected to solve the problem of climate change since it does not directly address its causes, only

its effects. To successfully impede the rate and magnitude of climate change, one must find its causes and address them directly. This is where mitigation comes in. Mitigation differs from adaptation. It is more future-oriented in scope and is focused on preventing or mitigating the projected adverse effects of climate change over the longterm. These strategies generally entail the significant reduction of carbon emissions through major changes in domestic energy policies and the imposition of taxes/tariffs on major carbon emitting activities such as power generation, industrial production and transportation (Annex 3). While mitigation strategies may be viewed by some quarters as less urgent (since the Philippines is not a major carbon producer and that it will actually take centuries for global carbon levels to lower substantially), it must be pointed out that these strategies may also have more immediate benefits, such as cleaner air that will result from stricter vehicle emission controls. It must also be remembered that climate change is a continuous threat that requires long-term solutions that need to be developed and implemented as soon as possible.

Continuing Legislative Efforts towards Climate Resiliency

The Philippines already has a number of critical laws that will enable the country to effectively confront the growing threat of climate change. Last year, President Gloria Macapagal-Arroyo signed into law the Climate Change Act of 2009 (Republic Act 9729). The law, which is a consolidation of Senate Bill No. 2583 and House Bill No. 5982 (authored by Senator Loren Legarda and Congressman Roilo Golez respectively), institutionalizes the government's climate change response mechanisms and will harmonize the government's existing policies and programs by creating the National Commission on Climate Change. The new commission will consolidate the planning, monitoring, and evaluation duties and functions of the Presidential Task Force on Climate Change and the Interagency Committee on Climate Change and will be tasked to formulate and fully implement a National Climate Change Action Plan that outlines the mitigation policies and adaptation programs of the Philippine government.

The Climate Change Act of 2009 is also complemented by a number of key environmental laws that, when implemented effectively, will drastically-reduce the country's vulnerability to climate change. The Renewable Energy Act of 2008 (RA 9729) and the Clean Air Act of 1999 (RA 8749) are both aimed at improving air quality and reduce the amount of carbon emissions released into the atmosphere by mandating the use of more efficient technologies for transportation and reducing the Philippines' reliance on imported carbon-based fossil fuels for power generation through the promotion and development of the country's extensive renewable energy resources. The Clean Water Act of 2004 (RA 9275) calls for the protection of domestic water resources from pollution and contamination by regulating the activities of industrial, agricultural, and domestic/household users and prohibiting them from indiscriminately discharging their waste and other pollutants into bodies of water. Water pollution and other problems associated with inadequate garbage disposal (such as flooding) are also addressed by the Ecological Solid Waste Management Act of 2000 (RA 9003), which provides the legal framework for a systematic and comprehensive ecological solid waste management program.

While these laws are critical in mitigating the effects of climate change, they are not enough. A number of legislative proposals still need to be enacted into law, namely the Disaster Risk Management Act (SB No. 3086), the PAGASA Modernization Act (SB No. 1397), and the National Land Use Act (SB No. 641). The passage of these bills is deemed urgent as they will significantly improve the way ordinary Filipinos respond and adapt to the threat of an increasingly changing climate.

The Disaster Risk Management Bill is an important piece of legislation that emphasizes the need for a more proactive approach to emergency disaster response. The bill seeks to overhaul the country's current emergency disaster response framework by reorganizing the National Disaster Coordinating Council (NDCC) into the National Disaster Risk Management Council (NDRMC), which will continue to be headed by the Secretary of National Defense. The NDRMC, in cooperation with other executive agencies, local government units (LGUs), and civil society, will formulate and implement a comprehensive National Disaster Risk Management Plan that will be adapted and implemented by Disaster Risk Management Offices (DRMOs) that will be established at the provincial, city/municipal, and *barangay* levels. Teams of Accredited Community Disaster Volunteers (ACDVs) will also be organized to provide additional manpower during emergency disaster preparedness and response mechanisms and activities. Under the bill, LGUs will also be mandated to set aside at least 5 percent of their total revenues to establish local disaster risk management funds (LDRMF) that will support local disaster risk reduction and emergency preparedness activities as well as disaster response, rehabilitation, and reconstruction. The bill was recently approved by the Bicameral Conference Committee, paving the way for its ratification and submission to the President for approval.

The availability of accurate and timely weather data is vital in helping countries plan and prepare for storms, droughts, and other extreme weather phenomena. However, the government's capacity to provide accurate weather data is severely constrained by the fact that the PAGASA's equipment and methods are antiquated and have been overtaken by more current technologies. The PAGASA's inability to accurately predict localized weather patterns effectively limits the government's ability to adequately respond to the adverse effects of climate change on food and water security, and make the necessary preparations that will prevent the loss of human lives and limit damages to physical infrastructure. To this end, the PAGASA Modernization Bill seeks to appropriate PhP5 billion (US$100 million) that will be used for the purchase of new equipment and for staff training and education. However, the bill was not passed before the 14th Congress adjourned and will be re-filed once the 15th Congress is convened this year.

As discussed earlier, the country's land area is slowly shrinking as sea levels rise because of increasing global temperatures. Land (and all the resources found on it) therefore becomes increasingly valuable for the country's continued survival and prosperity in the face of climate change. However, historically, the Philippine government has a poor track record in managing its natural resources. Pundits have often argued that our country's vulnerability to climate change has been largely exacerbated by the indiscriminate and unregulated use of the country's increasingly scarce and sensitive natural resources (such as land and water) over the last 50 years.

Long-term resilience to climate change can be significantly improved if the country will adopt a resource-based development framework that focuses on ecological stability and sustainability. The National Land Use bill will institutionalize land use and physical planning at the national and local levels, and promote responsible and equitable allocation and administration of land and its corresponding natural resources. Under the bill, critical areas (such as national parks, upland watershed areas, and strategic agricultural and fisheries zones) will be identified and set aside first to ensure the country's ecological integrity and guarantee food and water security for the population. Areas vulnerable to flooding, landslides, and rising sea levels should also be identified and cordoned off. Like the PAGASA Modernization bill, the National Land Use bill was filed but not passed during the 14th Congress. It is hoped that both bills will be re-filed and eventually be passed when the 15th Congress convenes this year.

Beyond Legislation: Providing Funds and Ensuring the Full Implementation of Existing Laws

Congress' ability to improve the Philippines' climate resiliency is not limited to its legislative powers. While passing laws is a vital part of limiting the damaging effects of climate change in the country, it is clearly not enough. As discussed earlier, Congress has already passed an array of laws that will significantly reduce the climate vulnerability of ordinary Filipinos and improve their ability to cope with the changing climate. However, many of these laws (such as the Clean Air Act, Clean Water Act, Ecological Solid Waste Management Act, etc.) are not consistently and effectively implemented and enforced by the concerned national line agencies and LGUs. Antonio Oposa Jr., renowned environmental lawyer and 2009 Ramon Magsaysay Awardee, pointed out in an interview last year that *"[the Philippines has] the most number of laws passed but in the matter of implementation much still has to be accomplished"*. To improve enforcement, Congress should use its oversight functions to regularly check up on national line agencies and ensure that the various environmental laws that they have passed are really being implemented, otherwise the valuable time, effort, and resources put into crafting these various laws will have been wasted.

National line agencies and LGUs also often argue that they have trouble enforcing many of the country's environmental laws due to a chronic lack of funds. For instance, the DENR is one of the government's lead agencies tasked with limiting the negative effects of climate change and yet historically, it receives a very small share of the government's total annual budget, accounting for less than 1 percent since 2005. The PAGASA and the NDCC have likewise been operating with minimal funding for years. These agencies cannot be expected to fulfill their respective mandates without adequate funding. As such, Congress must also ensure that national line agencies charge of formulating and implementing climate change-related policies, programs, and activities are provided with the annual budget required to effectively perform their duties given the scope of threats and challenges that climate change poses on existing development and anti-poverty measures in the country. It must also be stressed that the financial support extended to these agencies should be continuous (as opposed to a one-time endowment) given the long-term threat of climate change.

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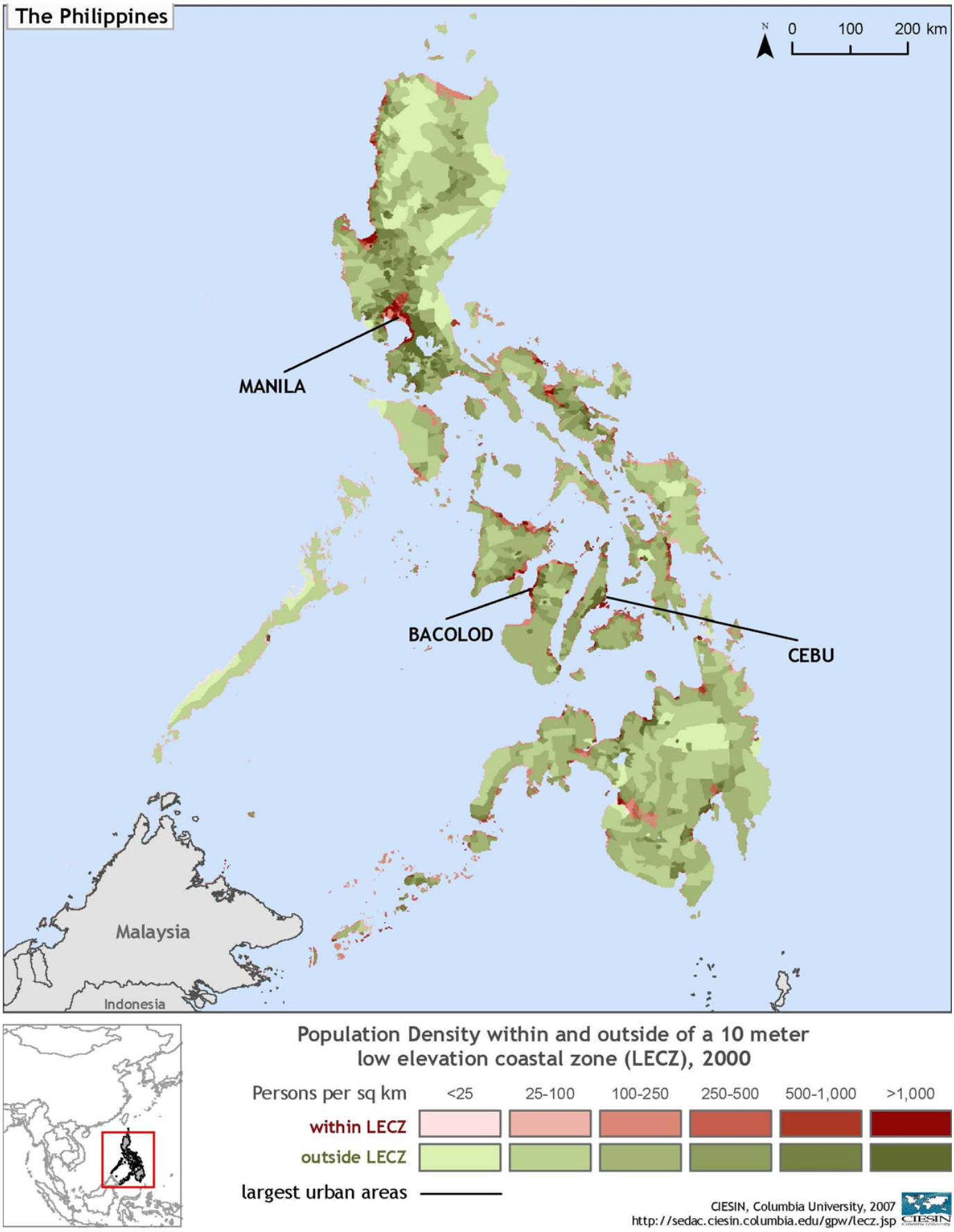
This Policy Brief was principally prepared by Harry Pasimio, Jr. under the supervision of SEPO's Directors and the overall guidance of its Director General.

ANNEX 1

Population Density within and outside of a 10m Low Elevation Coastal Zone



Source: *Socioeconomic Data and Applications Center-Center for International Earth Science Information Network (2007)*

ANNEX 2

Climate Change Adaptation Measures

Sector	Adaption option/strategy	Underlying policy framework	Key constraints or opportunities to implementation (Normal font=constraints; *italics = opportunities)*
Water	Expanded rainwater harvesting, water storage and conservation techniques, water reuse, desalination, water-use and irrigation efficiency	National water policies and integrated water resources management; water-related hazards management	Financial, human resources and physical barriers; *integrated water resources management; synergies with other sectors*
Infrastructure/ Settlements (including coastal zones)	Adjustment of planting dates and crop variety; crop relocation; improved land management, e.g. erosion control and soil protection through tree planting	R&D policies, institutional reform; land tenure and land reform; training and capacity building; crop insurance; financial incentives, e.g. subsidies and tax credits	Technological and financial constraints; access to new varieties; markets; *longer growing season in higher latitudes; revenues from new products*
Public Health	Heat-health action plans; emergency medical services; improved climate-sensitive diseases surveillance and control; safe water and improved sanitation	Public health policies that recognize climate risks; strengthen health services; regional and international cooperation	Limits to human tolerance (vulnerable groups); knowledge limitations; financial capacity; *upgraded health services; improved quality of life*
Tourism	Diversification of tourism attractions and revenues	Integrated planning (e.g. carrying capacity; linkages with other sectors); financial incentives, e.g. subsidies and tax credits	Appeal/marketing of new attractions; financial and logistical challenges; potential adverse impact on other sectors; *revenues from 'new' attractions involvement of wider group of stakeholders*
Transport	Realignment/relocation; design standards and planning for roads, rail, and other infrastructure to cope with warming and drainage	Integrating climate change considerations into national transport policies; investment in R&D for special situations, e.g. permafrost areas	Financial and technological barriers; availability of less vulnerable routes; *improved technologies and integration with key sectors (e.g. energy)*
Energy	Strengthening of overhead transmission and distribution infrastructure; underground cabling for utilities; energy efficiency; use of renewable sources of energy	National energy policies, regulations, and fiscal and financial incentives to encourage use of alternative sources; incorporating climate change in design standards	Access to viable alternatives; financial and technological barriers; acceptance of new technologies; *stimulation of new technologies; use of local resources*

Source: Climate Change 2007: Synthesis Report. Intergovernmental Panel on Climate Change (2007)

ANNEX 3

Climate Change Mitigation Strategies

Sector	Key mitigation technologies and practices currently commercially available. *Key mitigation technologies and practices projected to be commercialized before 2030 shown in italics.*	Policies, measures, and instruments shown to be environmentally effective	Key constraints and/or opportunities (Normal font=constraints; *italics = opportunities)*
Energy Supply	Improved supply and distribution efficiency; fuel switching from coal to gas; nuclear power; renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); combined heat and power; early applications of carbon dioxide capture and storage (CCS) (e.g. storage of removed CO_2 from natural gas); *CCS for gas, biomass and coal-fired electricity generating facilities; advance nuclear power; advanced renewable energy, including tidal and wave energy, concentrating solar, and solar photovoltaics*	Reduction of fossil fuel subsidies; taxes or carbon charges on fossil fuels Feed-in tariffs for renewable energy technologies; renewable energy obligations; producer subsidies	Resistance by vested interests may make them difficult to implement *May be appropriate to create markets for low-emissions technologies*
Transport	More fuel-efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; modal shifts from road transport to rail and public transport systems; non-motorized transport (cycling, walking); land-use and transport planning; *second generation biofuels; higher efficiency aircraft; advanced electric and hybrid vehicles with more powerful and reliable batteries*	Mandatory fuel economy; biofuel blending and CO_2 standards for road transport Taxes on vehicle purchase, registration, use and motor fuels; road and parking pricing Influence mobility needs through land-use regulations and infrastructure planning; investment in attractive public transport facilities and non-motorized forms of transport	Partial coverage of vehicle fleet may limit effectiveness Effectiveness may drop with higher incomes *Particularly appropriate for countries that are building up their transportation systems*
Buildings	Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; improved cook stoves, improving insulation; passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycling of fluorinated gases; *integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control; solar photovoltaics integrated in buildings*	Appliance standards and labeling Building codes and certification Demand-side management programs Public sector leadership programs, including procurement Incentives for energy service companies (ESCOs)	Periodic revision of standards needed *Attractive for new building.* Enforcement can be difficult Need for regulations so that utilities may profit *Government purchasing can expand demand for energy-efficient products* *Success factor: Access to third party financing*

Source: Climate Change 2007: Synthesis Report. Intergovernmental Panel on Climate Change (2007)