GUIDEBOOK
on Mainstreaming Climate Change in Biodiversity Planning and Management in the Philippines

Rodel Lasco
Florencia Pulhin
Perlyn Pulhin

2013

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This Guidebook is a living document and we would be particularly pleased to hear about your experiences using the Guidebook and suggestions for its improvement. Please send feedback and suggestions to ICRAF-Philippines@cgiar.org.

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About the Authors

Dr. Rodel D. Lasco is the Philippines Coordinator of the World Agroforestry Centre (ICRAF) since April 2004, a center devoted to promoting "tree on farms". Concurrently, he is the Scientific Director of the Oscar M. Lopez Center for Climate Change Adaptation and Disaster Risk Management Foundation, Inc. (OML Center), a corporate foundation whose mission is to promote research on climate adaptation and disasters risk reduction. He is a member of the National Academy of Science and Technology in the Philippines, an affiliate professor at the University of the Philippines Los Baños (UPLB), and a member of the Intergovernmental Panel on Climate Change, the 2007 co-winner of the Nobel Peace Prize. Dr. Lasco has nearly 30 years of experience in natural resources and environmental research, conservation, education and development at the national and international level. He is a multi-awarded scientist with over 80 technical publications in national and international journals dealing with the various aspects of natural resources conservation and environmental management.

Dr. Florencia Pulhin is a University Researcher of the Forestry Development Center, College of Forestry and Natural Resources, University of the Philippines Los Baños. She holds a PhD in Forestry degree with specialization in the fields of Climate Change, Silviculture and Forest Influences and Environmental Forestry. She is one of the few researchers in the Philippines, and possibly in Southeast Asia, who has done pioneering researches on tropical forests and climate change. With 15 years of rich experience in researches related to climate change, she has authored and co-authored a number of publications and presented papers and posters in many local and international scientific meetings.

Ms. Perlyn Pulhin is the Program Manager of the OML Center. Prior to this, she worked at the Asia-Pacific Network for Global Change Research, an international organization based in Japan promoting global change research. She also has been involved on a part-time basis with ICRAF. Her undergraduate and MS thesis in UPLB are both environmentally-inclined, the latter focusing on the assessment of climate-disaster resilience. Ms. Pulhin has been working on environmental research, capacity building and outreach, science-policy, knowledge management and communications and development for about 11 years. She has co-authored a number of publications, presented papers and posters at national and international conferences and organized/participated on various fora most of which are climate change-related.

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Foreword

One of the pathways to a broad-based and inclusive growth is to improve the country's environmental resilience, ensuring that natural resources, biodiversity and environmental services are conserved and sustainably managed while also reducing the risks of natural disasters. In the Philippines, the most destructive natural disasters in recent times have been related to climate change.

Natural ecosystems and biodiversity have been found to be particularly vulnerable to climate change. Scientific evidence is now mounting that climate change could soon overtake habitat loss as the major driver of biodiversity loss. A significant number of the world's species are at risk of extinction if global temperatures keep rising. The Intergovernmental Panel on Climate Change has predicted that, as a result of climate change, up to 50 percent of biodiversity will be at risk and as much as 88 percent of coral reefs may be lost in the next 30 years in Asia.

The Philippines' biodiversity is also greatly threatened due to its high vulnerability to climate change. Considerable efforts are necessary to prepare the country to deal with the impacts of climate change and address biodiversity loss. As climate change and biodiversity are highly interlinked, management of biological resources must take into account climate change considerations to achieve both climate change resiliency and mitigation and biodiversity conservation.

Adaptation is a key strategy to mitigate the multifaceted impacts of climate change. The challenge is to come up with approaches that strengthen the coping capacity of communities and the adaptive capacity of natural ecosystems. The U.S. Government is working closely with the Government of the Philippines to reduce the risk of disasters and is helping to address the threat of climate change through adaptation measures.

This Guidebook, which is a pioneering effort in the Philippines, will serve as a tool to mainstream climate change considerations into biodiversity planning and management as a strategic step towards proactive adaptation and environmental resilience improvement. As the Philippines is currently in the early stages of learning how to adapt to climate change and its impacts, this Guidebook will enhance the literature on mainstreaming approaches to this end.

I hope that you will find this Guidebook informative and helpful as we pursue our shared vision of broad based and inclusive growth for Filipinos.

Gloria D. Steele
Mission Director, USAID/Philippines

Foreword

The need to urgently tackle climate change adaptation was reflected in the calls to mainstream it into local, national and international development policies, planning, and activities. In the Philippines, mainstreaming efforts are initially focused on disaster risk reduction and management with the enactment of Republic Act 10121 or the Philippine Disaster Risk Reduction and Management Act of 2010. The law provides guidance for mainstreaming of climate change mitigation and adaptation into policies, programs and activities at the national and local levels and integrating disaster risk reduction and climate change adaptation in development, peace and conflict resolution processes. Since very little attention is given on mainstreaming climate change into biodiversity development planning in the country, this guidebook hopes to promote the issue and assist field, extension, and development workers as well as local government units and partner agencies in enhancing their roles as agents of biodiversity conservation through a well-mainstreamed climate change issues in biodiversity planning and management.

In using this book as a guide, climate change adaptation community must work in harmony with the (sustainable) development community to maximize synergies and reduce conflicting activities. While there is limited number of actual projects on the ground to mainstream climate change particularly into development objectives, we hope that this guidebook will be instrumental in increasing the number of mainstreaming projects. The guidebook recognizes that the current impacts of climate extremes and disasters and their links to development are the starting points for assessing future climate change impacts so discussion on these topics are included in this publication. There is a need to link climate change impact data and development statistics, which, given uncertainties and data limitations, complicates adaptation studies.

Despite efforts to reduce greenhouse gas emissions, some level of human-induced change will be realized in the 21st century according to the Intergovernmental Panel for Climate Change. This poses threat to biodiversity. At this stage for example, climate change is already impacting protected areas' ecosystems and resources in terms of distribution, phenology, and composition of species; landscape physiography; and the provision of recreational opportunities. Therefore, protected areas are crucial natural resource where climate change adaptation planning is urgently needed. This could be a strategic entry point for mainstreaming efforts.

Dialogue between climate researchers, concerned community, policy-making authorities and other stakeholders are needed to facilitate mainstreaming. This guidebook will serve as one of the tools in coping with the challenges of biodiversity and climate change that demands relevant capacity building and development for effective implementation of any mainstreaming initiatives. Useful guides are in this publication particularly for those stakeholders currently involved in conservation and the sustainable use of biodiversity that are not very keen on considering the threats and opportunities of climate change in their strategies to protect biodiversity.

Scientists and experts always remind us that climate change will steer in new risks which could exceed the limits of current adaptive capacity. New forms of adaptation that is comprehensive are therefore necessary. This means that in addition to technological adaptation measures, mainstreaming efforts should address a range of stressors and underlying causes of vulnerability. To make it simple, practical ways to mainstream climate change in biodiversity planning and management are presented in this book.

Ramon J. Paje
Secretary, Department of Environment and Natural Resources

Executive Summary

The Philippines, as a mega-diverse country, holds a key role to a sustainable future for its people and the world but climate change is adversely affecting biodiversity. As climate change threatens biodiversity, achievement of the UN Millennium Development Goals (MDGs) is also compromised. Since the climate change impacts are multifaceted, the challenge is to come up with approaches that would strengthen the coping capacity of the communities and the natural ecosystems to adapt in the changing climate. The guidebook will serve as a tool to mainstream climate change particularly in biodiversity planning and management as a strategic step towards proactive adaptation.

This guidebook is one among the early attempts in the country to discuss the links between climate change and biodiversity at the planning and management perspectives. As efforts to mainstream climate change in national development planning are still at a relatively early stage in many countries, it is intended to become an evolving material that can be added to and improved over time to assure that climate change impacts are continuously scored in the biodiversity planning and management. It draws lessons on past mainstreaming activities and experiences in the communities and governments in the Philippines and around the globe.

While this is designed for biodiversity managers and planners who recognize the need to take into account the changing climate into biodiversity management plans and development programs, it may also prove useful to decision-makers in their resource allocation and to other donors and funding agencies as well to help them in prioritizing which projects to support.

A basic overview of the concepts that underpin climate change and biodiversity is provided in this guidebook. It highlights the state of Philippine biodiversity resources and the linkages to climate change. The guidebook explains the science of climate change illustrating how the climate has changed, is changing, and is likely to change in the coming years.

Information highlighting associated climate change impacts to biodiversity and how they will affect various sectors are supported with proper citation. The guidebook also discusses responses at the international level to address both climate change impacts and biodiversity loss and Philippines' efforts including laws, policies, programs, local activities and other community initiatives that contribute in facing the challenge of climate change and conserving biodiversity. Both adaptation and mitigation are bridged to development in the context of biodiversity-climate linkages and at different scales or levels.

Highlighted in this guidebook is an account on how the concept of "mainstreaming" evolved through the years after it has gained attention at the World Summit on Sustainable Development. The barriers limiting the implementation of projects on the ground to mainstream climate change particularly into development objectives are also presented. A section focusing on the approaches and strategies geared towards

mainstreaming climate change in biodiversity planning and management enumerates entry points and potential pathways. Successful initiatives and lessons learnt on mainstreaming climate change are also tackled.

Another highlight is the step-by-step procedures on how climate change can be mainstreamed in biodiversity planning and management. The procedures describe vulnerability and risk assessment tools and techniques that can be used to support adaptive management in a rapidly changing climate. To demonstrate how a suite of tools can be used to inform climate change adaptation and biodiversity conservation efforts, this guidebook provide guide questions, worksheets and examples. Users may select and combine tools and techniques to enhance the capacity to address threats and opportunities resulting from climate change that are unique to the location and/or sector.

This publication hopes to promote the issue and assist field and extension workers as well as local government units and other organizations in enhancing their roles as agents of biodiversity conservation through a well-mainstreamed climate change issues in biodiversity planning and management. It is suggested that the approaches, options, models and frameworks in this guidebook be tested and enhanced as the wealth of experience across the country increases.

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We welcome your comments and enquiries and should be addressed to:

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Definition of Terms

Adaptation - Adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation.

Adaptive capacity - The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or cope with the consequences.

Biodiversity - The variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems. Biodiversity forms the foundation of the vast array of ecosystem services that critically contribute to human well-being.

Climate change - A change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.

Climate change adaption - Climate change adaptation refers to the ability of society to plan for and respond to change in a way that makes it better equipped to manage its exposure and sensitivity to climate change. Adaptive capacity depends on economic well-being, ecological well-being, the extent of dependency on natural resources, infrastructure (human-built or natural), effectiveness of institutions and governance systems, insurance, secure land tenure and mediation measures, and information and communication systems. A community with the capacity to adapt is likely to be more resistant to impacts or able to recover from stressful events and conditions.

Climate extremes - Rare weather event at a particular place and time of the year and may persist for a time such as El Niño and La Niña Phenomena and strong typhoons.

Climate risk - Refers to the product of climate and related hazards working over the vulnerability of human and natural ecosystems.

Climate risk reduction - Minimizing injury or loss as a measure of probability and severity of an adverse effect to health, property, the environment or other things of value resulting from climate change and affecting natural and human systems.

Climate scenario - A projection of future climatic conditions.

Climate variability - Fluctuations in climate over a shorter term - the departures from long-term averages or trends, over seasons or a few years, such as those caused by the El Niño Southern Oscillation phenomenon.

Data - Information expressed in a conventional form so that it can be processed by suitable means.

Disaster - A serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community/society to cope using its own resources. A disaster is a function of the risk process. It results from the combination of hazards, conditions of vulnerability and insufficient capacity or measures to reduce the potential negative consequences of risk.

Disaster risk reduction - The concept and practice of reducing disaster risks through systematic efforts to analyze and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.

Ecosystem-based management - An integrated approach that considers the entire ecosystem (including humans), and aims to maintain an ecosystem in a healthy, productive and resilient condition so that it can provide the services humans require.

Evaluation - The determination of the significance of effects. Evaluation involves making judgments as to the value of what is being affected and the risk that the effect will occur and be unacceptable.

Framework - A set of conditions, hypotheses and assumptions that determine the way to approach, perceive, understand or analyze a problem, issue or theme. It also refers to a way to structure and organize data in order to analyze and build the information needed to analyze and understand problems and issues.

Frequency - The number of occurrences of an event within a specific period of time.

Greenhouse effect - The process by which the absorption of infrared radiation by the atmosphere warms the Earth.

Greenhouse gases - Defined to be: carbon dioxide (CO_2), carbon monoxide (CO), nitrous oxide (N_2O), oxides of nitrogen (NO_x), methane (CH_4), and non-methane volatile organic compounds (NMVOCs). The *Kyoto Protocol* also addresses hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).

Hazard - A source of potential harm, or a situation with a potential for causing harm, in terms of human injury; damage to health, property, the environment, and other things of value; or some combination of these.

Impact - Something that logically or naturally follows from an action or condition related to climate change or climate variability.

Indicator - A signal used to detect a phenomenon and trends. A variable selected to transmit information about the state and evolution of a system.

Information - Information or a set of information held for a given subject. It is also knowledge that reduces or eliminates uncertainty regarding the realization of a particular event belonging to a determined set of possible events. Information available in written, visual, oral, electronic or any other format is used, for example, to reduce negative environmental impacts.

Livelihoods - Means of existence including capacities, assets (social and material resources) and the activities needed (methods of existence: small farmers, traders, etc.) for well-being. A means of existence is sustainable when faced with constraints and impacts it can overcome them, and maintain or improve its capacities and assets, now or in the future, without harming natural resources.

Loss - An injury or damage to health, property, the environment, or something else of value.

Magnitude - A measure of how adverse or beneficial an effect may be.

Mainstreaming - Refers to the integration of policies and measures that address climate change into development planning and sectoral decision-making.

Mitigation - Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards. In the context of climate change, mitigation means a human intervention to reduce the sources or enhance the sinks of greenhouse gases.

Monitoring - A continuing assessment of conditions at and surrounding the action. This determines if effects occur as predicted or if operations remain within acceptable limits, and if mitigation measures are as effective as predicted.

Options - The various potential technological, political and other measures for responding to the impacts and effects of climate change. The known technological options are those technologies that are currently operational or at the pilot stage.

Partners - Any stakeholder or group of stakeholders with a particular interest in the considered problem, and who could play an active and useful role in solving this problem. Partners generally represent specific interests.

Planning - Designing and organizing activities via plans drawn-up for a period of several years and in accordance with established priorities.

Resilience/resilient - The capacity of a system, community or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable or organizing itself to increase this capacity for learning from past disasters for better future protection and to improve risk reduction measures.

Risk - The chance of injury or loss as defined as a measure of the probability and severity of an adverse effect to health, property, the environment, or other things of value.

Risk assessment - The overall process of risk analysis and risk evaluation.

Risk management - The systematic application of management policies, procedures, and practices to the tasks of analyzing, evaluating, controlling, and communicating about risk issues.

Scales (spatial and temporal) - The climate may vary across a wide range of spatial and temporal scales. Spatial scales may be local (under 100,000 km^2), regional (100,000 to 10 million km^2) or continental (10 to 100 million km^2). Temporal scales may be anywhere between seasonal to geological (up to hundreds of millions of years).

Scenario - A plausible, often simplified description of how the future may develop based on a coherent and internally consistent set of assumptions about driving forces and key relationships (e.g. pace of technological change, demographic growth, prices evolution). Scenarios are neither forecasts nor predictions and may sometimes be based on “narrative storylines”. They may be obtained from projections, but are often based on additional information from other sources.

Sensitivity - The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. These stimuli include all the elements linked to climate change, including average climate characteristics, climate variability and the frequency and intensity of extreme events. The effects may be direct (e.g. a change in crop yields) or indirect (e.g. the damage caused by the increasing frequency of coastal flooding due to sea level rise).

Sea level rise - An increase in sea level which may be influenced by factors like global warming through expansion of sea water as the oceans warm and melting of ice over land and local factors such as land subsidence.

Stakeholder - Any individual, group, or organization able to affect, be affected by, or believe it might be affected by, a decision or activity. The decision-maker(s) is/are a stakeholder(s).

Strategies - A set of coordinated and measured operations to achieve a goal.

Susceptibility - Level/magnitude at which a system or a component of the system may experience losses or suffer impacts following disturbances or stress.

Tool - An instrument used to carry out a task. In the field of climate change, researchers have developed many “toolkits”. These kits offer a range of methods that may be used on their own or in combination, depending on the types and stages of assessments of vulnerability or adaptation studies.

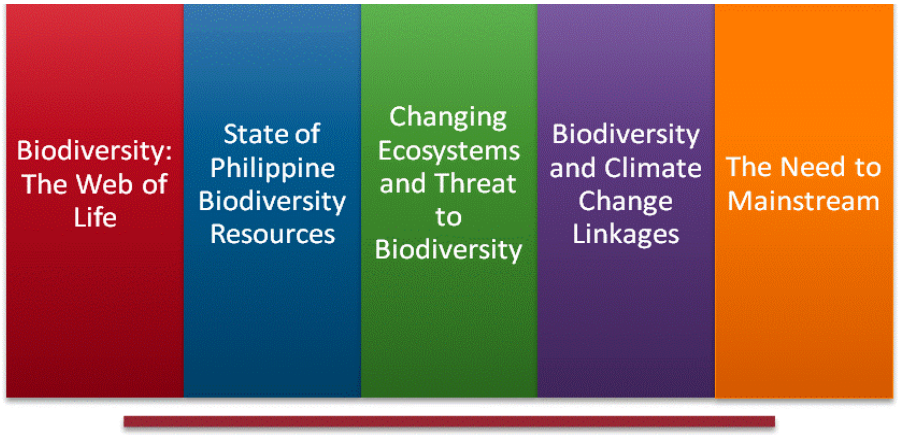
Threat - An event or situation that is a precursor of imminent danger.

Uncertainty - Expression of the degree to which a value (for example the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known, or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behavior. Uncertainty can therefore be represented by quantitative measures (for example a set of values calculated from a range of models) or by qualitative statements (e.g. reflecting the opinion of a team of experts).

Vulnerability - The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is the function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

INTRODUCTION

I. Introduction



The guidebook is designed for biodiversity managers and planners who recognize the need to take into account the changing climate into biodiversity management plans and development programs. It may also prove useful to decision-makers in their resource allocation and to other donors and funding agencies as well to help them in prioritizing which projects to support. This publication also hopes to promote the issue and assist field and extension workers as well as local government units and other organizations in enhancing their roles as agents of biodiversity conservation through a well-mainstreamed climate change issues in biodiversity planning and management.

With the twin goals of presenting a comprehensive understanding of what mainstreaming climate change into biodiversity development planning is all about and providing guidance on how mainstreaming climate change can be put into practice, it is crucial to present the basic overview of the concepts that underpin climate change and biodiversity. The introductory chapter has five sub-sections: a) Biodiversity: The Web of Life; b) State of Philippine Biodiversity Resources; c) Changing Ecosystems and Threat to Biodiversity; d) Biodiversity and Climate Change Linkages; and e) The Need to Mainstream.

The first sub-section describes biodiversity and its major components. Following a brief description is an enumeration of the importance of biodiversity highlighting the ecosystem services. The second sub-section highlights wealth of the country's biodiversity resources supported by statistics and assessments. Since the country's biodiversity is alarmingly endangered, making the Philippines a biodiversity hotspot as well, rapid and effective responses and strategies to accelerate the coverage of conservation efforts are necessary.

As biodiversity loss is posing greater risk to human existence, the third sub-section emphasizes on rapid and extensive ecosystem changes. The fourth sub-section

describes the inter-link between biodiversity and climate change: climate change as driver of biodiversity loss; but conservation and proper management of biodiversity (maintenance of ecosystem integrity) can reduce climate change impacts. The last sub-section stresses that mainstreaming climate change into policy, planning, and management program is gaining recognition in scientific literature as a strategic step towards pro-active adaptation.

Biodiversity: The Web of Life

What is biodiversity?

Try to look around and you will see different kinds of plants, ferns, trees, insects, birds, fish and animals and the places they live in such as mangrove swamps, rivers, mountains and coastal areas. All these living forms including humans and the services they provide like the water we drink, the air we breathe and the clothes we wear are part of the integrated web of life that brings about the concept of biodiversity.

Biodiversity is the variety and variability among life forms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes in which they occur. It is described as the "diversity of life on Earth" which forms the base of the wide-ranging ecosystems services that vitally support human well being. This means that said life forms undergo processes to help sustain life on earth (MEA, 2005).

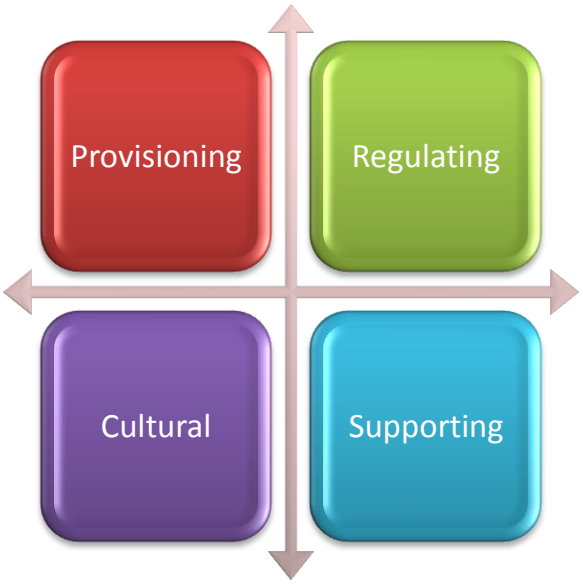
What are the major components of biodiversity? Genes, species, and ecosystems are the major components of biodiversity.

- **Genetic diversity** refers to the number of genetic strains or varieties or breed that is present in a species. It provides the basis for new breeding programs, improved crops, enhanced agricultural production, and food security.
- **Species diversity** is described as the number and variety of species found in the community and the evenness of distribution of individuals representing the population of each species.
- **Ecosystem diversity** is the many different unique habitats and communities and ecological complexes in the biosphere. It is the variety of ecosystems that occurs within a larger landscape, ranging from biome (the largest ecological unit) to microhabitat (Leveque and Mounolou, 2003).

Why is biodiversity important? Biodiversity is important in providing different ecosystem services that include:

Provisioning services
Biodiversity gives us food, water, clean air, oxygen, timber, fiber, shelter, clothing, medicines and other basic needs for us to survive.

Regulating services
Biodiversity regulates the ecosystem and other complex biological processes and interactions including climate, floods, disease, wastes, and water quality.



Cultural services
Biodiversity provides and facilitates aesthetic enjoyment, educational growth, recreation or leisure, religious or spiritual fulfillment and cultural preservation. It plays a big role in shaping the rich cultural diversity of many communities.

Supporting services
Biodiversity supports soil formation, pollination, photosynthesis, nutrient cycling and other life processes on earth for the present and future generation. It allows living organisms to adapt and evolve over changing environmental conditions (MEA, 2005).

The biodiversity components critically contribute to agriculture, forests, and fisheries sectors, as well as in soil conservation and improving water quality. Forests, grasslands, freshwater, and marine and other natural ecosystems provide an array of services, often not recognized in national economic accounts but essential to human welfare. By providing raw materials, the biological resources serve as pillars of livelihoods, sustenance, medicines and health, security, trade, resiliency, social relations, tourism and industry, freedom of choice and actions (CBD, 2007).

State of Philippine Biodiversity Resources

What is the current state of the country's biodiversity resources? The Philippines is wealthy of biodiversity resources. It serves as haven of rich terrestrial biodiversity and is the center of global marine biodiversity according to recent biodiversity assessments. Situated at the apex of the coral triangle, the country is considered to be the **richest marine eco-region** and has the **second highest seagrass diversity in the world**.

It also has the **2nd largest coral reef cover globally** and a coastline which is roughly the equivalent of the earth's circumference according to the Bureau of Fisheries and Aquatic Resources (BFAR). Coral reefs contribute up to 70% of the total fishery production; and small fishers comprising about 62% of the population living along coastal areas directly depend on reefs for livelihood (Castillo, 2010).

Many kinds of plants, animals, birds, and other species are found in the Philippines. However, they are alarmingly endangered making the country a biodiversity HOTSPOT as well.

As a treasure trove of biodiversity, the Philippines' terrestrial ecosystems host many of the best and rarest wildlife species. It is home to **more than 52,000 described species**, half of which are endemic or found nowhere else on earth. **More than 1,000 terrestrial wildlife species** (about half are endemic, 157 are threatened, 128 are both threatened and endemic) are recorded for the Philippines (Conservation International, 2006).

In terms of floral diversity, the country assessment boasts **between 10,000 and 14,000 species of vascular and non-vascular plants**, more than half of which are endemic to the Philippines. Altogether, it is **host to some 5% of the world's species of flora and ranks 5th globally in terms of number of plant species**. The country is also known as one of the most important **center of amphibian (101 species) and reptile (258 species) diversity in Southeast Asia**.

About **70% or 246 of the total 359 species are endemic – the highest endemism rate so far among vertebrates**. The percentage of **bird endemism** is also high, placing the country **4th in worldwide ranking**. About 576 species of birds (195 are endemic, 45 species are either extinct in the wild, critical, or endangered) are recorded for the Philippines (DENR-PAWB *et.al*., 2009).

The archipelago has the **greatest concentration of terrestrial mammalian diversity and the most number of endemic mammals in the world on a per unit basis** (174 mammalian species, 111 are endemic). With 50 threatened species, the mammal assemblage in the Philippines is the **8th most threatened in the world** (Conservation International, 2008).

It is believed that **the Philippines harbor more diversity of life than any other country on earth on a per hectare basis**. It is **one of the 17 mega-diverse countries in the world**, which together hosts **70-80% of the world's biodiversity**. However, the country's biodiversity is alarmingly endangered, making the Philippines a **BIODIVERSITY HOTSPOT** as well. This calls for a rapid and effective response to accelerate the coverage of conservation efforts in the mega-diverse country which holds the key to a sustainable future for its people and the world.

> ***HOTSPOT*** *is an area with high numbers of endemic species and facing extreme threats.*

Changing Ecosystem and Threat to Biodiversity

What is happening to our ecosystems? How are they affecting the biodiversity?

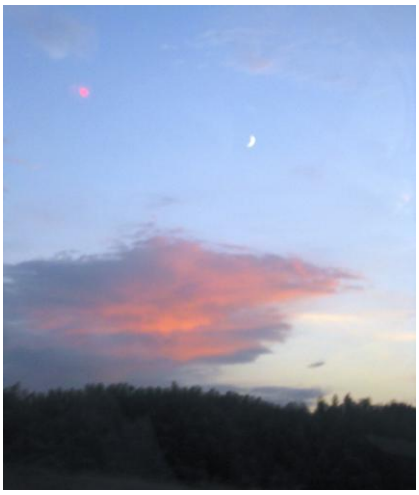
The Earths's ecosystems have been transforming dramatically. Over the past 50 years human activities have changed ecosystems more rapidly and extensively than at any comparable period in the history according to the Millennium Ecosystem Assessment (MEA). While conversion of natural ecosystems to human-dominated ecosystems and the exploitation of biodiversity have benefited many people over the last century, the associated changes in the ecosystem services have caused experiences of well-being decline to other people, pushing some groups into poverty.

Most rapid changes in ecosystems are taking place in developing countries. **More land was converted to cropland** in the 30 years after 1950 than in the 150 years between 1700 and 1850. **Reservoir storage capacity increased** four times between 1960 and 2000.

The amount of water stored behind large dams is estimated to be three to six times the amount of water flowing through rivers at any one time. In countries with adequate available data (encompassing about half of the total mangrove area), records show that some **35% of mangroves have been lost** in the last two decades. Of the known coral reefs, **20% have been destroyed recently** and another 20% degraded in the last several decades (MEA, 2005).

The following are some of the threats to biodiversity that have made the Philippines a top priority for global conservation: habitat destruction, over-exploitation, poaching and illegal trade, biological and chemical pollution and climate change.

In the Philippines, for instance, **reefs may be in a steady state of decline** (from 5% to 3% to >1%) although better reefs can still be found in Celebes Sea, Southern Philippine Sea, Sulu Sea and the Visayas Biogeographic regions. The country is considered to be **one of the highly threatened reef areas in the world**. It is also **facing widespread coral bleaching and invasive species and Crown of Thorns starfish infestations** (Castillo, 2010).



The 2009 Global Assessment Report of the United Nations (UN) found that in addition to the general decline of ecosystem services, trade-offs between ecosystem services exist: **mangroves have been destroyed to create shrimp ponds thereby increasing storm surge hazard; wetlands have been drained thereby increasing flood hazard; and deforestation has increased landslide hazard**. The ecosystem changes may have contributed to economic development but at growing environmental costs: biodiversity loss, land degradation, and reduced access to adequate water and natural resources for many of the world's poorest people.

Habitat loss and fragmentation, overexploitation, pollution, the impact of invasive alien species and, increasingly, climate change all threaten global biodiversity. Since species and habitats are the building blocks on which people depend for their livelihood – the foundation for production, forests, fisheries, and agricultural crops – **biodiversity loss is posing greater risk to human existence** (CBD, 2007).

Biodiversity and Climate Change Linkages

How are biodiversity and climate change related? How is the changing climate affecting biodiversity?

The connection between climate change and biodiversity has long been established. Although throughout Earth's history the climate has always changed with ecosystems and species coming and going, rapid climate change affects ecosystems' and species' ability to adapt and so biodiversity loss increases.

Biodiversity and climate change are interlinked – climate change is a driver of biodiversity loss but conservation and proper management of biodiversity as well as maintenance of ecosystem integrity can reduce climate change impacts. Both biodiversity and climate change are also connected to environmental sustainability. As climate change threatens biodiversity, achievement of the UN Millennium Development Goals (MDGs) is compromised.

Direct impacts of climate change to biodiversity include:

- Changes in the timing of biological events,
- Changes in species distribution and behavior in plants and animals, and
- Increased frequency and intensity of pests and diseases.

The following potential impacts have also been identified: increased vulnerability of species to extinction and potential losses of net productivity of ecosystems. For instance, **farms experiencing drought or too much rain tend to decrease yield, productivity and income**. Climate change may increase both the ongoing impoverishment of global biodiversity caused by unsound use of natural capital and the degradation of land, freshwater, and marine systems (CBD, 2007).

The quality and productivity of natural resources and ecosystems can be prone to the changing climate thereby reducing biodiversity and worsening an existing environmental problem. **Changes in rainfall patterns, greater periods of drought, and saltwater intrusion into freshwater reserves may affect the supply of drinking water. Rising sea levels, associated to climate change, may cause loss of arable land in coastal areas. The condition may lead to displacement of people living in flood-prone areas and force them to move in the uplands to open new forest areas.**

In some countries, climate change is already forcing species to adapt either through shifting habitat, changing life cycles, or the development of new physical traits. **Species that cannot adapt to the changing climate eventually die**. The warming of coastal waters, coral die-off, and impacts on coastal fisheries caused by climate change are exacerbating the impacts on marine systems from overexploitation by industrial and artisanal fisheries, as well as pollution from ships' waste and land sources. Both the terrestrial and aquatic ecosystems are facing degradation and disturbance that can generate niches for **invasive exotic species exploitation** (McCarthy, 2001).

Exotic species *are organisms that exist in the free state in an area but are not native to that area. They also refer to animals from outside the country in which they are held in captive or free-ranging populations.*

Marine Protected Area (MPA) *is an area of sea (or coast) especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means.*

The Philippines is likely to experience a recurrence of massive coral bleaching similar to the one occurred in marine protected areas and conservation priority sites in the provinces of Pangasinan, Puerto Galera, Negros, Dumaguete and Palawan last 1998. Those incidences were linked to the **increase in ocean surface temperature that was brought about by the El Niño phenomenon** (Arceo *et.al*., 2001). Coastal areas, island ecosystems and low-lying communities which are already experiencing subsidence and haphazard coastal development is

threatened by an increase in sea level due to thermal expansion, melting of glaciers, ice caps and ice sheets brought by climate change.

How can we address the impacts of climate change to biodiversity and the ecosystem services they provide?

Collaborative action on mitigation and adaptation must be well coordinated to simultaneously respond to the challenges brought by the changing climate. Addressing climate change impacts on ecosystems and livelihoods **requires enhanced protection and management of biological resources**. Adoption of biodiversity-based adaptive and mitigative strategies can boost the resilience of ecosystems and reduce the risk of damage to human and natural ecosystems. The Ad hoc Technical Expert Group on Biological Diversity and Climate Change defines **mitigation as human intervention to reduce GHG sources or enhance carbon sequestration**.

Adaptation to climate change, on the other hand, is described as adjustments in natural or human systems in response to climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Following are some of the activities identified by the Expert Group that promote mitigation of or adaptation to climate change:

- Maintaining and restoring native ecosystems,
- Protecting and enhancing ecosystem services,
- Managing habitats for endangered species,
- Creating refuges and buffer zones, and
- Establishing networks of terrestrial, freshwater and marine protected areas that take into account projected changes in climate.

The list of activities above can achieve the twin goals of conserving biodiversity and addressing climate change through mitigation and by contributing to existing efforts of nations and communities striving towards effective climate change adaptation.

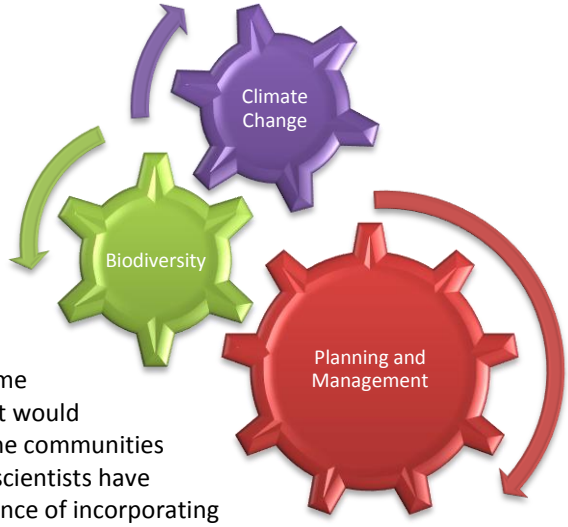
To highlight biodiversity as both a response variable affected by climate change and a factor changing ecosystem processes and services such as climate regulation thereby affecting human well-being, the MEA cited few specific examples. **Biodiversity influences climate at local, regional, and global scales through its carbon sequestration capacity**. Its effects on species characteristics determine the amount of carbon taken up from the atmosphere (assimilation) and the amount released into it (decomposition, combustion).

Carbon inputs depend on plants' growth rate and woodiness. Woody plants tend to contain more carbon, live longer, and decompose more slowly than smaller herbaceous plants. When activities entail afforestation, reforestation, reduced deforestation, and biofuel plantations, the above biodiversity components are important to consider in achieving carbon-based climate change mitigation targets (MEA, 2005).

Marine biodiversity also plays major role in climate regulation. Oceans are important source of carbon, with approximately 50 times more carbon than what the atmosphere contains. Marine vertebrates may also sequester carbon at depth according to new researches. While marine and coastal ecosystems, including coral reefs and coastal wetlands, are important carbon sinks, they are also very sensitive to climate change. **Prolonged warming can cause massive coral die-off and even slight increases in seasonal maximum sea surface temperatures may distress coral reefs. Carbon dioxide (CO_2) increase and sea acidity affect calcification and reduce the ability of reefs to grow vertically as sea levels rise** (CBD, 2007).

With the dwindling biodiversity resources in the face of changing climate, it is crucial to take necessary steps in protecting ecosystems that would sustain the services they provide. The impacts of climate change on biodiversity and related ecosystem services should be taken into account in any biodiversity conservation efforts.

The Need to Mainstream



Why is it important to mainstream climate change into biodiversity planning and management?

As noted earlier, people respond to climate change in two ways: mitigation and adaptation. Since the climate change impacts are multifaceted, the challenge is to come up with an integrated approach that would strengthen the coping capacity of the communities and the natural ecosystems. Many scientists have increasingly recognized the importance of incorporating adaptation measures into sustainable development and poverty reduction strategies, that is, **'mainstreaming' as the most effective means of addressing climate change impacts** (Klein *et. al*., 2007; Huq *et. al*., 2006; Sperling, 2003).

Does it require new approaches to address the impacts of climate change?

> ***Mainstreaming*** *refers to the integration of policies and measures that address climate change into development planning and sectoral decision-making.*

This adaptation approach may not require completely new actions or programs but should be mainstreamed into the development planning, particularly at the community level as the impacts are localized depending on the vulnerability context to climate change. **Efforts to raise the awareness of the communities and the local stakeholders on climate change and its impacts are crucial to mainstream the issue into regular plans and programs. It is important to recognize this issue at the national level to come up with policies and institutional support that better incorporate these issues into an overall national development process.**

In some developing countries like those of Central Africa, climate change adaptation is being mainstreamed into forestry planning as key to improving policy coherence towards development and effectiveness in forest management and climate change adaptation. For instance, over 80% of the predominantly rural communities in the Congo Basin, depend on agriculture and forest activities for their basic needs (Bele *et. al.,* 2011; Gockowski and Sonwa, 2011; Somorin *et. al.*, 2011; and Wasseige *et. al.,* 2009). As agriculture and forestry are climate sensitive sectors, it becomes more challenging to address national development goals and it also makes adaptation inseparable from development. The mainstreaming efforts will help better assess the vulnerability of both the forest ecosystems and the dependent populations to climate change effects (Sonwa *et. al*., 2012).

In the Philippines, we have earlier analyzed the level of mainstreaming in the country (Lasco *et. al*., 2009). The **key factors hindering climate change mainstreaming** include:

- Lack of funds,
- Insufficient advocacy by civil society,
- Lack of political will, and
- Inadequate knowledge.

Since the time this study has been published, there have been significant gains in integrating climate change in government plans and programs, primarily spurred by the creation of the Climate Change Commission and the vastly enhanced flow of funds from donors. For instance, there are ongoing programs for disaster risk management (DRM) that are taking climate change into

consideration. These programs include hazard mapping, early warning systems, parametric insurance, community-based DRM, capacity building, and many others. Implemented in selected areas, the programs are being undertaken by various government agencies, such as the National Economic and Development Authority (NEDA), Office of Civil Defense-National Disaster Coordinating Council (OCD-NDCC), and Department of Interior and Local Government (DILG) (World Bank, 2010).

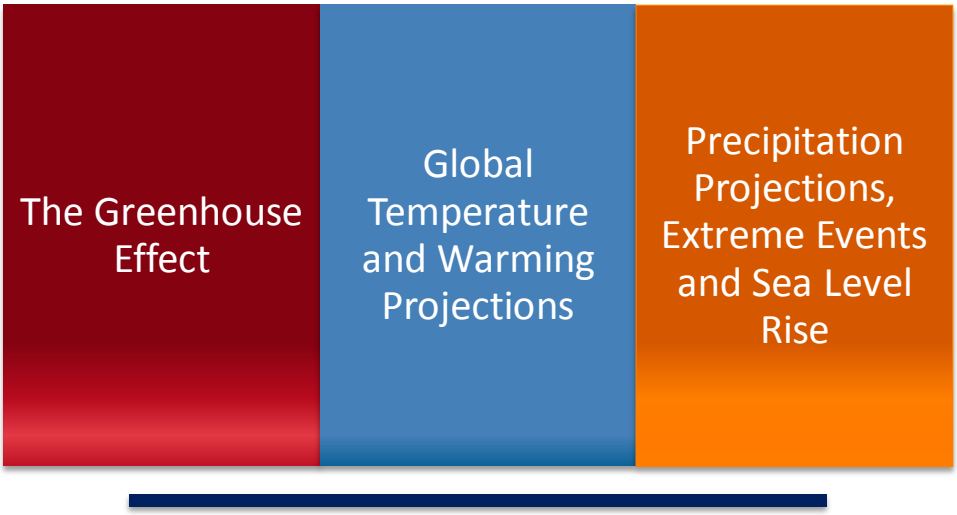
A number of these programs and projects are supported by various development partner agencies, including the Australian Agency for International Development (AusAID), Asian Development Bank (ADB), the European Union and its European Commission Humanitarian Aid Department's Disaster Preparedness Programme (DIPECHO), United Nations Development Program (UNDP), German Organisation for Technical Cooperation (GTZ), and Spanish Aid. While many of these programs that combine DRM and climate change adaptation measures operate through national agencies, there are also a number of civil society DRM programs integrating climate change adaptation and most of which are at local and grassroots levels (World Bank, 2010).

Details of some mentioned programs are found in Chapter IV under sub-section *Success Stories and Lessons Learnt*.

Mainstreaming climate change into policy, planning, and management program functions is gaining recognition in scientific literature as a strategic step towards pro-active adaptation. **Adapting now is more effective than adapting later in terms of cost effectiveness and efficiency in reducing the potential for irreversible impacts, such as species extinction** (Smit *et. al.,* 1999; Burton *et. al*., 2002; Stern, 2007; Pearson and Burton, 2009; and Lemieux, 2011).

Key Issues on Climate Change: Evidences and Projections

II. Key Issues on Climate Change: Evidences and Projections

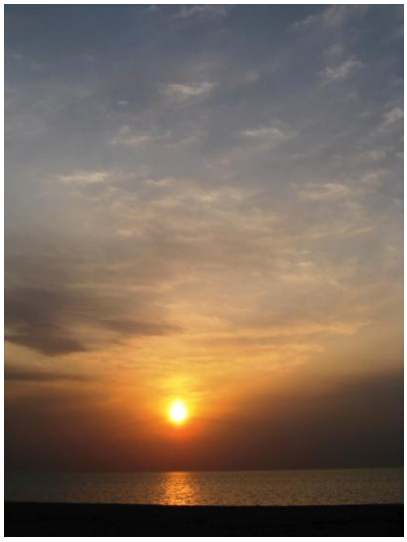


This chapter explains the science of climate change illustrating how the climate has changed, is changing, and is likely to change in the coming years.

The Earth's climate system is undergoing significant changes including increasing air and ocean temperatures, rising sea levels and melting of snow and ice. Recent reports of the Intergovernmental Panel on Climate Change (IPCC) highlight that warming of the Earth's climate system is now "unequivocal". These put climate change and global warming as the most serious environmental threat being faced by mankind.

While warming trend has been observed by the scientists as early as the late 1800s, the most rapid warming has occurred in recent decades. This warming is believed to be due to natural factors such as volcanic eruptions, changes in the Earth's orbit, and the amount of energy released from the Sun. Most of this warming is also very likely the result of human activities associated with the Industrial Revolution that changed the composition of the atmosphere and until now, are influencing the Earth's climate (IPCC, 2007).

These changes in composition include the **"greenhouse gases (GHGs)" that are released into the atmosphere due to human activities**. Studies showed that the levels of these gases are increasing at a faster rate than at any time in hundreds of thousands of years and are trapping the heat. **If human activities continue to**



release GHGs at or above the current rate, average temperatures around the globe will also continue to increase. Earth's capacity to sustain life will be threatened as increases in global temperatures will most likely change the planet's climate in ways that will have significant long-term impacts both on people and the environment (IPCC, 2007).

Climate change would mean changes in the hydrological cycle with **less snow and more rain**, as well as **extreme and more frequent events such as fires, floods, droughts and storms**. Such changes could occur even with relatively small increases in temperature and could have serious impacts on agriculture-based livelihoods, infrastructure and health.

The Philippines is not a major emitter of GHGs accounting for only 0.27% of the total global GHG emissions. However, it is one of the most vulnerable countries to the adverse impacts of climate change due to its geographical location and physical characteristics. It is one of the most disaster-prone countries in the world (Bildan, 2003; World Bank, 2006; Fortes and Jose, 2006 as cited in Lasco *et. al*., 2008) and with climate change it is expected that existing stresses in the country will be exacerbated (DENR, 1999).

The Greenhouse Effect

The IPCC has reached a strong consensus regarding the science of global warming and climate change. Undoubtedly, the world is warming, as noted by the scientific community. The burning of fossil fuels and deforestation for over the past 200 years, have caused the concentrations of heat-trapping "GHGs" to increase significantly in the atmosphere. These gases prevent heat from escaping to space, similar to the glass panels of a greenhouse.

Natural and Enhanced Greenhouse Effect

What is the greenhouse effect?

The greenhouse effect (Figure 1) is the natural occurrence that helps regulate the Earth's temperature. Through this process, GHGs trap the Sun's warmth and maintain the earth's surface temperature at the level that could support life. When the sun heats the earth, some of this heat escapes back to space. The remaining heat, also

known as infrared radiation, is trapped in the atmosphere by clouds and GHGs, such as water vapor and carbon dioxide.

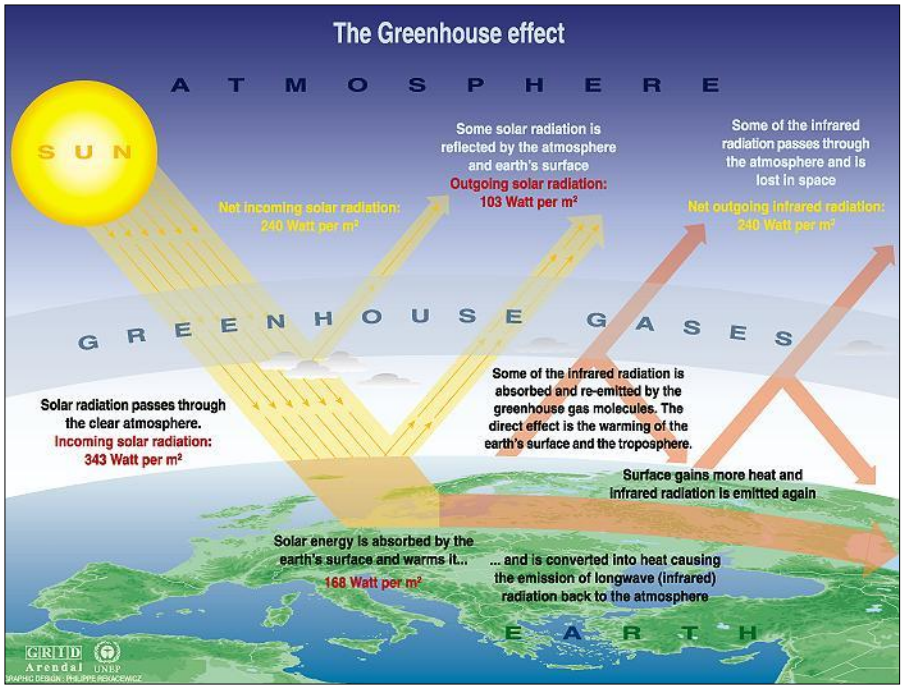


Figure 1. The greenhouse effect. Source: UNFCCC website

By adding GHGs to the atmosphere, human activities have enhanced the natural greenhouse effect and very likely causing the Earth's average temperature to rise. These additional GHGs come from burning fossil fuels such as coal, natural gas, and oil to power cars, factories, power plants, homes, offices, and schools. Cutting down trees, generating waste, farming activities and biomass burning also produce GHGs.

Important GHGs

Do you know which are the most important GHGs, where are they coming from and how have these gases changed?

Water vapor and carbon dioxide (CO_2) are naturally occurring GHGs. Other important GHGs include methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). These gases are produced by human activities which are adding large amounts of carbon dioxide and other gases to the natural mix at a faster rate than at any other time on record. Figure 2 below shows that since 1750, atmospheric concentrations of CO_2, CH_4 and

N_2O have increased by over 36%, 148% and 18%, respectively. Scientists have concluded that this is due primarily to human activities (IPCC, 2007).

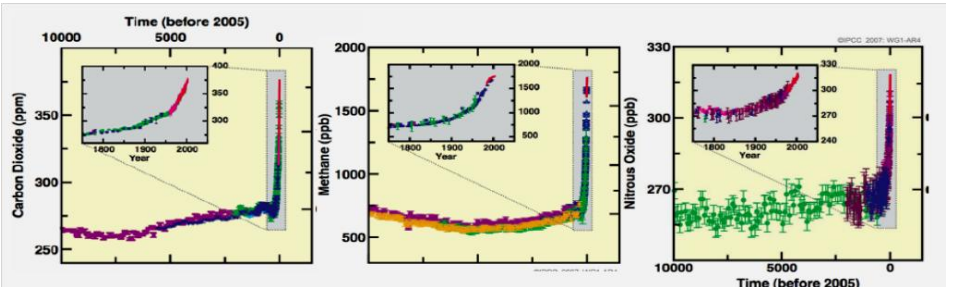


Figure 2. Atmospheric concentrations of carbon dioxide (in parts per million), methane (in parts per billion) and nitrous oxide (in parts per billion) over the last 10,000 years (large panels) and since 1750 (inset panels). Measurements are shown from ice cores (symbols with different colors for different studies) and atmospheric samples (red lines). Source: IPCC, 2007

Global Temperature and Warming Projections

How do scientists make projections about future climate change?

The Environment Protection Agency noted that interactions of air, land, and ocean in the Earth's climate, make the system very complex. Computer models are necessary to study their interactions and influence to one another. **Scientists use computer models to project future climate changes based on expected changes to the atmosphere.**

Though these models are not exact, they can simulate climate and many of its aspects. If the models are able to mimic currently observed features of the climate, then the scientists argued that they are also most likely able to project future changes. **There are firm evidences of climate changes and projections based on the simulation and studies that the climate change experts have conducted in the past.**

What does the record tells about our warming planet?

The global temperature record shows an average warming of about 1.3°F over the past century (Figure 3). The conclusion was based on the IPCC observations of increases in average air and ocean temperatures, melting of snow and ice, and average sea level across the globe. According to the IPCC scientists, there is greater than 90% chance that most of the warming the Earth has experienced since the 1950s is due to the increase in GHG emissions from human activities.

A more recent study released by the National Oceanic and Atmospheric Administration (NOAA) with timeframe until 2010 reveals that seven of the eight warmest years on record have occurred since 2001. Within the past 30 years, the rate of warming across the globe has been approximately three times greater than the rate over the last 100 years.

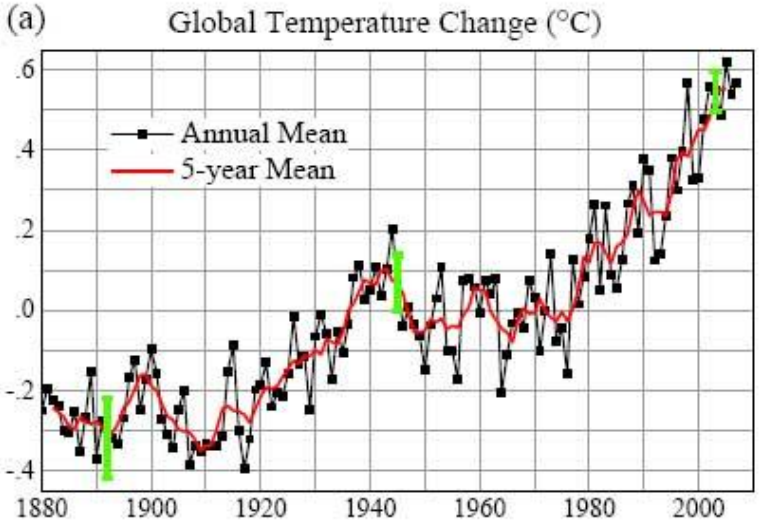


Figure 3. Global annual surface temperatures relative to 1951-1980 mean temperature. Air and ocean data from weather stations, ships and satellites. Source: NASA, adapted from IPCC, 2007

If emissions of GHGs continue to rise, how much will the Earth warm?

An average global temperature increase of 3 to 7°F by 2100 is projected if humans will continue to emit GHGs at or above the current pace (Figure 4). Greater warming would most likely be felt in the succeeding years after that. Based also on current observed changes, temperatures in some parts of the globe (e.g., over land and in the polar regions) are expected to rise even more (IPCC, 2007).

While it is possible and efforts can be exerted in order to drastically reduce GHG emissions, pegging them at the same levels as in the year 2000 levels and holding those constant, the Earth would still warm about 1°F over the next 100 years. The Environment Protection Agency explains **that the long life time of many GHGs and the slow cycling of heat from the ocean to the atmosphere are the main attributes of the warming**.

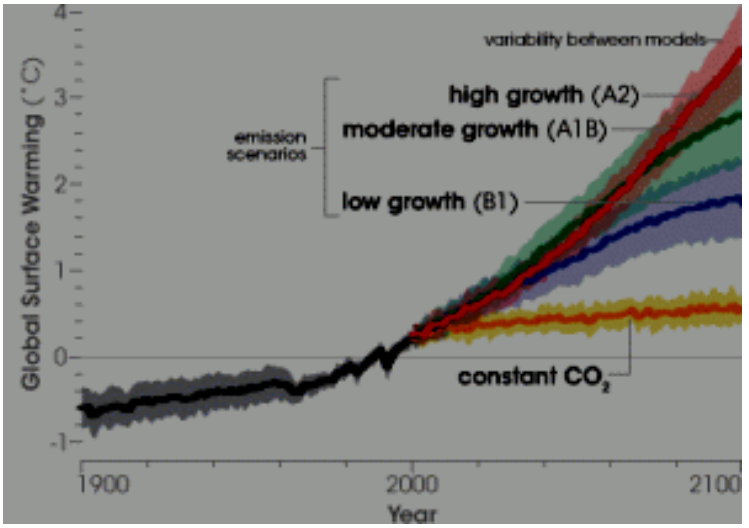


Figure 4. Temperature projections to the year 2100, based on a range of emission scenarios and global climate models. Scenarios that assume the highest growth in GHG emissions provide the estimates in the top end of the temperature range. The orange line ("constant CO_2") projects global temperatures with GHG concentrations stabilized at year 2000 levels. Source: NASA, adapted from IPCC, 2007

What is the temperature projection for the Philippines?

All areas of the Philippines will get warmer, to a greater degree in the relatively warmer summer (March-April-May) period (Figure 5). Mean temperatures in all parts of the country are expected to rise by 0.9 °C to 1.1 °C in 2020 and by 1.8 °C to 2.2 °C in 2050. Likewise, all seasonal mean temperatures will also increase. While the increases during the four seasons are quite consistent in all areas, largest temperature increase is projected during the March-April-May (MAM) season (PAGASA, 2011).

The projections from PAGASA also show that hot temperatures will continue to become more frequent in the future. Under the mid-range scenario, the number of days with maximum temperature exceeding 35 °C (following value used by other countries in the Asia Pacific region in extreme events analysis) is increasing in 2020 and 2050.

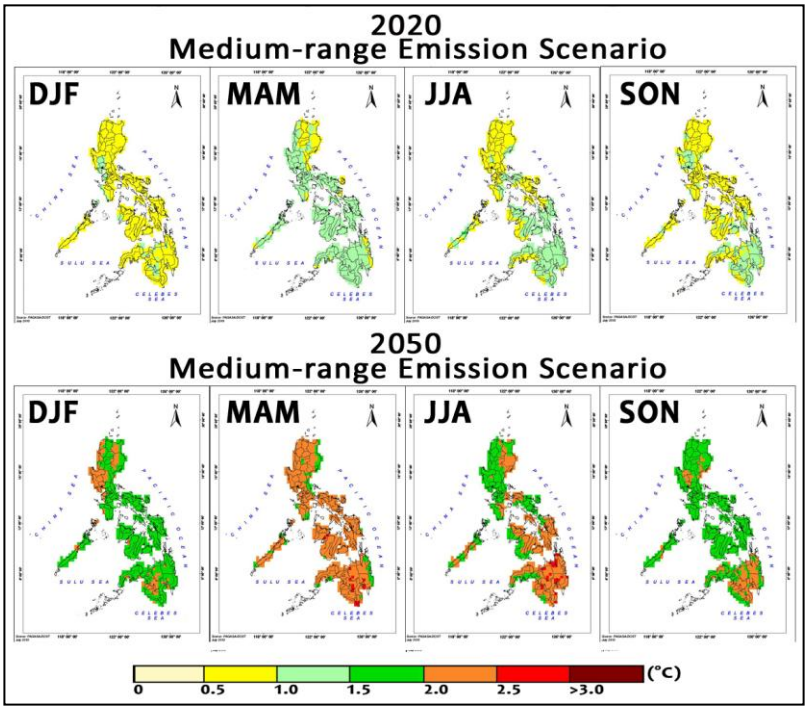


Figure 5. Maps showing the projected seasonal temperature increase (in °C) in the Philippines in 2020 and 2050. Source: PAGASA, 2011

Precipitation Projections, Extreme Events and Sea Level Rise

How is precipitation affected by the warming climate?

When the temperatures rise, the Earth's water cycle will be intensified. While increased evaporation will make more water available in the air for storms, it will contribute to drying over some land areas. As a result, storm-affected areas are likely to experience increases in precipitation and increased risk of flooding. **A 59-year record of tropical cyclones in the Philippines reveals that the intensity of typhoons in the country is getting stronger, from 1990s in particular (Hilario, 2008).**

Areas located far away from storm tracks, however, are likely to experience less precipitation and increased risk of drought. These changes will vary by season and depending on weather fluctuations. Figure 6 shows the projected increase and decrease in precipitation in various simulations.

How will a warming climate cause extreme events?

In terms of extreme events, **a warming climate will alter the frequency and severity of extreme temperature events according to most scientists**. Increases in heat waves and decreases in cold spells are expected. These effects will vary in different parts of the globe (Mertz *et. al.,* 2009).

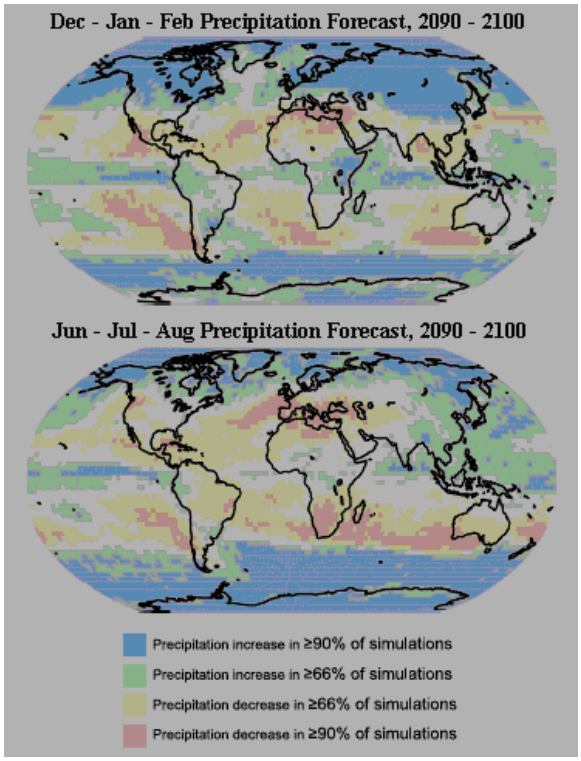


Figure 6. Projected precipitation changes in various simulations. Source: IPCC, 2007

What is the precipitation projection for the Philippines?

In 2020 and 2050, heavy daily rainfall will continue to become more frequent, extreme rainfall is projected to increase in Luzon and Visayas only, but number of dry days is expected to increase in all areas of the Philippines. Data from PAGASA shows the projected increase in number of dry days (with dry day defined as that with rainfall less than 2.5 mm) and the increase in number of days with extreme rainfall (defined as daily rainfall exceeding 300 mm) compared with the observed (baseline) values, respectively.

There is a projected reduction in rainfall during the summer (MAM) season in most parts of the country in 2020 and 2050. In the same time slice, rainfall will likely increase during the southwest monsoon (June-July-August) season until the transition (September-October-November) season in most areas of Luzon and Visayas, and also, during the northeast monsoon (December-January-February) season, particularly, in provinces characterized as Type II climate. A decreasing trend in rainfall in Mindanao is projected, especially by 2050.

How is the warming climate affecting the sea levels particularly in the Philippines?

In the Philippines, sea level rise is very alarming with the presence of many coastal towns dependent on the surrounding water bodies for their livelihoods. **Based on the routine monitoring of the Global Sea Level Observing System (GLOSS) in various locations including Manila and Legaspi, there is rapid increase in sea level over the years**. If this continues, small islands located just a little above sea level might submerge. **A more rapid rise in sea level by about 20 cm to 40 cm from 1960 to 2007 was observed in Manila Bay**. Undue land reclamation and likely subsidence are believed to have worsened the accelerated sea level rise impacts (Jaranilla-Sanchez *et. al.*, 2007).

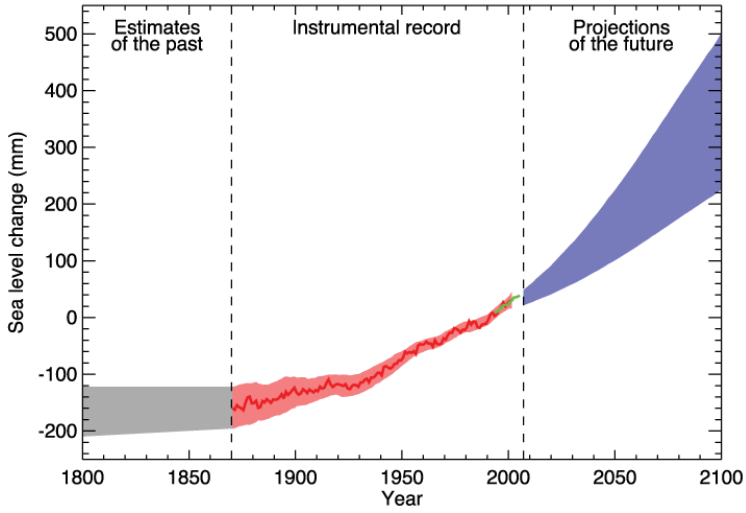


Figure 7. The gray shaded area shows the estimates of sea level change from 1800 to 1870 when measurements were not available. The red line is a reconstruction of sea level change measured by tide gauges with the surrounding shaded area depicting the uncertainty. The green line shows sea level change as measured by satellite. The purple shaded area represents the range of model projections for a medium growth emissions scenario (IPCC SRES A1B). For reference 100 mm is about 4 inches. Source: IPCC, 2007

By the year 2045, a 30 cm rise in sea level is anticipated, posing threat to over 2,000 hectares (ha) and about half million people. This is based on the analysis of Manila Bay area which converts the 100 cm rise in sea level to inundation of over 5,000 ha of the Bay area, affecting 2.5 million people. These risks, according to Hulme and Sheard (1999) as cited in IPCC (2007) could be aggravated with the continuous increase of sea surges associated with intense storm activity.

Implications and Response to Address Climate Change

III. Implications and Response to Address Climate Change

This chapter is divided into four sub-sections. As links between climate change and biodiversity have been already established in Chapter 1, the first section provides more information highlighting associated climate change impacts to biodiversity and how they will affect various sectors. The second section discusses responses at the international levels to address both climate change impacts and biodiversity loss. Philippines' efforts including laws, policies, programs, local activities and other community initiatives to contribute in facing the challenge of climate change and conserving biodiversity are highlighted under section 3. While the concepts of adaptation and mitigation have been introduced in Chapter 1, the last section of this chapter links both adaptation and mitigation to development in the context of biodiversity-climate linkages and at different scales or levels.

Impacts of Climate Change to Biodiversity

Climate change and its impacts would likely become the dominant direct driver of global biodiversity loss and change of ecosystem by the end of the century (IPCC, 2007). While ecosystem services in some regions may initially benefit from increasing temperature or precipitation, the balance of evidences from a number of climate scenarios shows a significant net damaging impact as global mean surface temperature increases to more than 2^0C above preindustrial levels by 2100. **Associated climate change impacts particularly more frequent extreme**

weather events such as hurricanes will affect coastal development, water supply, energy, agriculture, and health, among other sectors (MEA, 2005).

Depending on the nature of coastal landforms and ecosystems, the biogeophysical repercussions of sea-level rise will vary in different coastal zones globally. The impact of climate change in the biophysical characteristics of coastal areas would result to modified ecosystem structure and functioning. As a consequence, **coastal nations will have to face losses of marine biodiversity, fisheries, and shoreline habitats including wetlands and mangroves.**

For instance, nearly 30 percent of warm-water corals have disappeared in the Caribbean since the beginning of the 1980s due to increasingly frequent and intense periods of warm sea temperatures (World Bank, 2008). Researches indicate that increases in ocean temperatures cause coral bleaching followed by massive coral die out under sustained warm conditions. Increasing CO_2 concentration in the atmosphere also affects the calcification of reef plants and animals, especially corals due to oceans acidification. The reefs would reduce their ability to grow vertically and maintain pace with rising sea levels. This has long-term implications for coastal zone protection, biodiversity, ecosystem integrity, and productivity of the seas and fisheries in the tropics (World Bank, 2008).

In high-elevation mountain ranges which are warming faster than adjacent lowlands, climate change will become more pronounced according to recent research (CBD, 2007). The scale of ecological changes would threaten the unique

According to Lavides (2010), climate change studies in the Philippines are limited to projecting its impacts on the local climate and risks to human population. No literature or very little is available on projecting climate change impacts on the country's rich biodiversity. However, in other countries, landmark researches have been done on impacts of climate change on biodiversity.

biodiversity of the mountains which are sources of many environmental goods and services**. The disruption in the hydrological or water cycle would affect basin regulation, water supply, and related hydropower potential.**

On the species component of biodiversity, the consequences of climate change include (CBD, 2007):

- Changes in distribution;
- Increased extinction rates;
- Changes in reproduction timings; and
- Changes in length of growing seasons for plants.

For many species, time maybe short to find more suitable regions for migration and survival or to adapt quickly enough to the very rapid pace of change such as the rise in average global temperatures. Particularly vulnerable to the impacts of climate change are those species already threatened due to factors such as low population numbers, fragmented or restricted habitats, and narrow climatic tolerance range. Loss of intra-specific diversity and disappearance of marginal plant populations will pose threat to wild relatives of crops which may contain valuable genes for plant breeding programs to increase heat and drought resistance or resistance to pests and diseases (Chakeredza *et. al*., 2009).

How are humans affected by the changing climate?

Humans who depend on the very plants and animals that make up the natural ecosystems for livelihood and sustenance are directly affected as well. Biodiversity and the interaction of species ranging from the smallest micro-organisms to the largest predators underpin the formation of soils suitable for crop-growing, the availability of medicinal plants, the provision of fresh water and the income gained from ecotourism. **The poor rural communities who have no other options at their disposal are especially vulnerable to the loss of the essential services when an ecosystem becomes degraded due to climate change impacts** (MEA, 2005; Rudebjer *et al*., 2008).

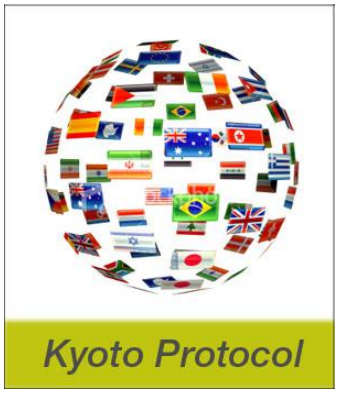
Global Efforts and International Framework

Focusing on Climate Change

The IPCC was formed jointly in 1988 by the United Nations Environment Programme (UNEP) and the UN World Meteorological Organization (WMO). **IPCC brings together the world's top scientists, economists and other experts, synthesizes peer-reviewed scientific literature on climate change studies, and produces authoritative assessments of the current state of knowledge of climate change.** The first IPCC report was issued in 1990 and concluded that the Earth is becoming warmer. It played a decisive role which led to the creation of the United Nations Framework Convention on Climate Change (UNFCCC), opened for signature in the Rio de Janeiro Summit (known as Rio Earth Summit) in 1992.

The UNFCCC's main objective is the "stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened, and to enable economic development to proceed in a sustainable manner". The Convention entered into force on 21 March 1994 and enjoys near universal membership with 192 countries having ratified (UNFCCC, 2012).

The Second Assessment Report of the IPCC in 1995 provided key input for the negotiations of the Kyoto Protocol in 1997 (Villarin *et al.* 2008). **The Kyoto Protocol is an international agreement connected to the UNFCCC that sets binding targets for 37 industrialized countries and the European community for reducing GHG emissions. The reduction is equivalent to 5 percent below their 1990 levels which should be achieved in the first commitment period (2008-2012).**



While UNFCCC encourages industrialized countries to stabilize GHG emissions, Kyoto Protocol commits them to do so. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005. Countries that have ratified this protocol have committed to reduce their emissions of carbon dioxide and five other GHGs, or engage in emissions trading if they maintain or increase emissions of these gases.

In 2001, the Third Assessment Report of the IPCC was released, together with the Special and Methodology Reports. These provided further relevant information for the development of the UNFCCC and the Kyoto Protocol. **The IPCC continues to be a major source of information for negotiations under UNFCCC, and its latest report released in 2007 (Fourth Assessment Report) together with the Stern Review on the Economics of Climate Change, has emphasized that "the cost of INACTION would be many times the cost of ACTION" (IGES, 2008; Villarin *et. al.*, 2008), hence heightened attention is being focused on adaptation much as mitigation (Figure 8).**

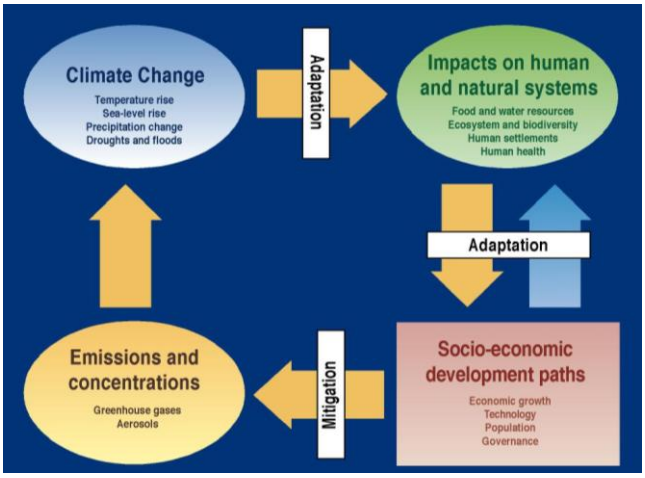


Figure 8. Climate change integrated framework. Source: IPCC, 2007

As shown on Figure 8, **IPCC recognizes the mutually beneficial relationship between climate change adaptation and mitigation**. Adaptation refers to policies, actions and other initiatives designed to limit the potential adverse impacts arising from climate variability and change (including extreme events) and exploit any positive consequences while mitigation refers to policies, actions and other initiatives that reduce the net emissions of GHGs that cause climate change through global warming (IPCC, 2007).

Under the Kyoto Protocol, developing countries can participate more actively in the mitigation of climate change in a manner consistent with sustainable development through the Clean Development Mechanism (CDM). **The basic principle of CDM is for: (a) developed countries to invest in low-cost abatement opportunities in developing countries and receive credit for the resulting emission reduction; and (b) developing countries benefit from increased investment inflows, particularly to advance sustainable development goals.** CDM shall assist Parties in non-Annex 1 (developing countries) in achieving sustainable development and Parties included in Annex 1 in achieving compliance with their quantified emission limitation and reduction commitments through projects in developing countries.

Climate Change and Biodiversity-related Conventions

Various international conventions consider the links between climate change and biodiversity in their programs, decisions, and recommendations. Some of these conventions are as follows (CBD, 2007):

- *At its eighth meeting, the Conference of the Parties to the Convention on Biological Diversity (CBD) highlighted the* ***importance of integrating biodiversity considerations into all relevant national policies, programs and plans, in response to climate change, and to rapidly develop tools for the implementation of biodiversity conservation activities that contribute to climate change adaptation.*** *The Conference of the Parties also noted the need to identify mutually supportive activities to be conducted by the secretariats of the Rio conventions, Parties, and relevant organizations (decision VIII/30).*

- *The UNFCCC which has been described earlier in this Guidebook calls upon Parties to* ***achieve that level in a time frame that allows ecosystems to adapt to climate change****.*

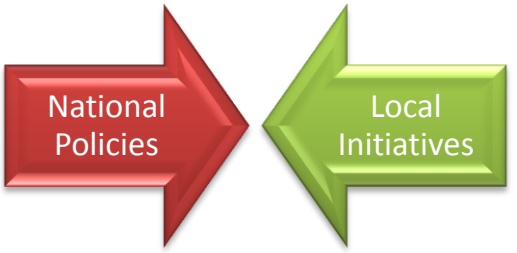
- *The United Nations Convention to Combat Desertification (UNCCD) emphasizes the need to coordinate desertification-related activities with the research efforts on climate change in order to find solutions to both problems.*

- *In March 2006, the World Heritage Committee organized a meeting of experts at the United Nations Educational, Scientific and Cultural Organization (UNESCO) headquarters in Paris. An outcome of this meeting was the elaboration of a strategy to assist States Parties to implement appropriate management responses to climate change. At its 30th session, held in Vilnius (Lithuania) in July 2006, the World Heritage Committee requested "States Parties and all partners concerned to implement this strategy to protect the Outstanding Universal Value, integrity and authenticity of World Heritage sites from the adverse effects of Climate Change, to the extent possible and within the available resources" (Decision 30 COM7.1/8).*

- *At its eighth meeting, the Conference of the Parties to the Convention on the Conservation of Migratory Species (CMS) requested their scientific council to* ***afford climate change high priority in its future program of activities and called on Parties to implement, as appropriate, adaptation measures.***

- *The Conference of the Contracting Parties of the Ramsar Convention on Wetlands, at its eighth meeting, called upon Contracting Parties to* ***manage wetlands so as to increase their resilience to climate change by promoting wetland and watershed protection and restoration*** *(Resolution VIII.3). Its science and technical review Panel is reviewing the potential impacts of climate change on wetland ecosystems' ability to deliver services, and the role of wetlands in ameliorating the effects of climate change.* ***The 10th Conference of the Parties held in 2008 considered the linkages between climate change and wetlands.***

National Policies and Local Initiatives



With the signing of **Philippine Climate Change Act of 2009**, the local governments were recognized as the frontline agencies for climate change action planning and implementation and so they must consider climate change adaptation as a regular function. The law prescribed that the **Climate Change Commission** shall develop, within six months after signing, the **National Framework Strategy on Climate Change**. Further, upon one year of the adoption of the framework, develop the **National Climate Change Action Plan**. The Philippine Climate Change Act of 2009 also recognizes the inter-linkage between climate change and disaster risk reduction and mandates the integration of disaster risk reduction into climate change programs and initiatives. Other laws that also explicitly address climate change are:

- **Agriculture and Fisheries Modernization Act (1997)** – directs the Department of Agriculture (DA) and other appropriate agencies to take into account climate change, weather disturbances, and annual productivity cycles in order to forecast and formulate appropriate agricultural and fisheries programs;

- **Philippine Clean Air Act (1999)** – instructs the Department of Environment and Natural Resources (DENR), concerned agencies, and local government units (LGUs) to prepare and implement national plans in accordance with the UNFCCC and other international agreements, conventions and protocols on reducing greenhouse emissions. In addition, it establishes that meteorological factors affecting ozone depletion and GHGs should be monitored and standards set (Merilo, 2008);

- **Ecological Solid Waste Management Act (2000)** – instructs the DENR, concerned agencies, and LGUs to prepare and implement solid waste management plans;

- **Philippine Clean Water Act (2004)** – aims to reduce water pollution through better management of sewerage and sanitation, industrial effluent, and agricultural, industrial, and residential waste;

- **Biofuels Act (2006)** – pursues energy self-sufficiency, mandates and provides incentives for the use of biofuels and the phasing out of harmful gasoline additives and/or oxygenates in order to, among others, mitigate toxic and GHG emissions;

- **Renewable Energy Bill (2008)** – seeks to, among others, encourage the development and utilization of renewable energy resources as tools to effectively prevent or reduce harmful emissions and thereby balance the goals of economic growth and development with the protection of health and the environment.

As frontline agencies, the **DILG** and the **Local Government Academy** shall facilitate the development and provision of a training program for LGUs in climate change and initiate related activities. LGUs are tasked to:

1. formulate and regularly update local climate change plans;
2. mobilize and allocate necessary personnel, resources and logistics;
3. allocate from their annual appropriations adequate funds; and
4. submit annual progress reports to the Climate Change Commission.

The **Disaster Risk Reduction and Management (DRRM) Act of 2010** prescribed the development, promotion and implementation of the National Disaster Risk Reduction and Management Plan (NDRDMP) and the establishment of permanent Local Disaster Risk Reduction and Management Offices. Disaster Coordinating Councils (DCCs) shall be renamed as National/Regional/Local Disaster Risk Reduction Management Councils (N/R/L DRRMCs); Barangay Disaster Coordinating Councils (BDCCs) shall be known as Barangay Disaster Risk Reduction and Management Committee (BDRRMC). The major highlights of this law are as follows: 1) Mainstreaming of DRR and CCA in development, peace and conflict resolution processes; 2) Local DRRM (not less than 5% of the estimated revenue from regular sources) to support DRM activities; 30% allocated as Quick Response Fund; 70% may be used for disaster preparedness.

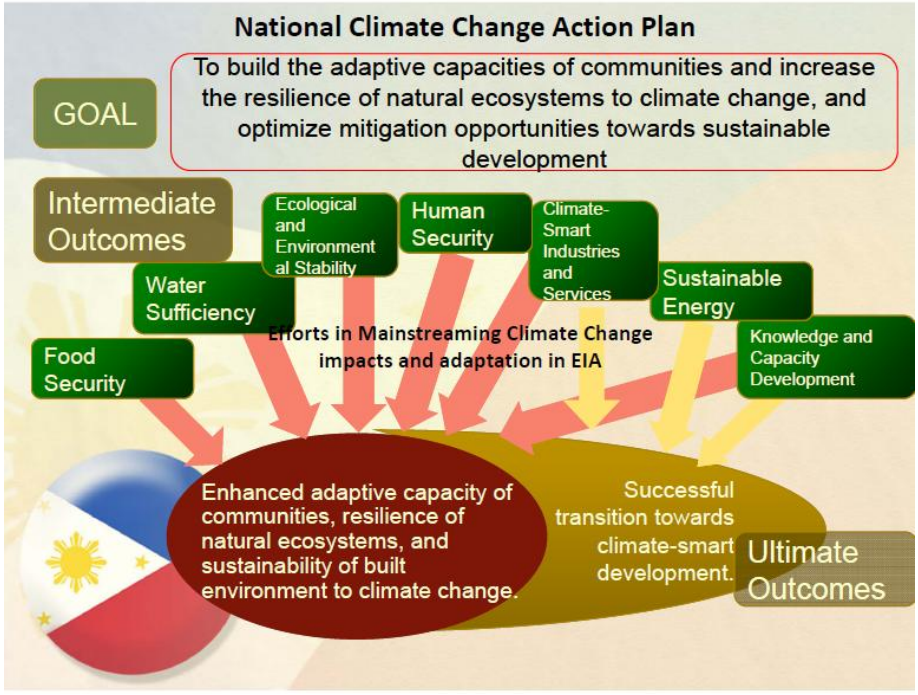
Other sector agencies, such as the **Department of Energy (DOE)**, have elaborated plans for addressing climate change through improved energy efficiency and the promotion of renewable energy (RE) sources. The Philippine Energy Plan 2004–2013 envisions sourcing 53 percent of the total energy supply from renewable energy by 2013. The **Philippine Information Agency**, on the other hand, is responsible for disseminating information on climate change, local vulnerabilities and risk, relevant laws and protocols and adaptation measures.

At the local level, some provincial governments have started actively promoting climate change risk management. In 2007, the government of Albay convened the **National Conference on Climate Change Adaptation**. The Albay Declaration on Climate Change was prepared and subsequently submitted to former President Gloria Macapagal Arroyo. In 2009, a similar climate change conference was convened by the Governor of Cebu for the Visayas region. The NEDA has exercised strong leadership in mainstreaming climate change adaptation in development planning and management by organizing, with other partners, the LGUs' Summit in March 2011: Mainstreaming Climate Change Adaptation in the Philippines (for Municipal Mayors).

Given the country's vulnerability and experience on extreme climate-related events, the government has been trying to focus its resources and attention on adaptation and disaster preparedness. The Medium Term Philippine Development Plan (MTPDP) for 2004-2010 guided national development programs and referred to climate change adaptation within the context of disaster risk reduction. Climate change adaptation is also addressed in the **10-year National Framework Strategy and Program on Climate Change (2010-2020). The Climate Change Framework**

"aggressively highlights the critical aspect of adaptation meant to be translated to all levels of governance alongside coordinating national efforts towards integrated ecosystem-based management which shall ultimately render sectors climate-resilient (Climate Change Commission, 2010). The authoritative role of LGUs to lead an insistent and proactive climate and disaster resilient development plans/programs is stipulated in the Local Government Code of 1992.

National Climate Change Action Plan



The National Climate Change Action Plan outlines the agenda for adaptation and mitigation from 2011 to 2028 with specific targets and deliverable of each sector of society on how to respond collectively to climate change. The main goal is to build the adaptive capacities of women and men in their communities, increase resilience of vulnerable sectors and natural ecosystems to climate change, and optimize mitigation opportunities towards gender-responsive and rights-based sustainable development. Guided by this goal, the Action Plan hopes to achieve two ultimate outcomes: **1) enhanced adaptive capacity of communities, resilience of natural ecosystems and sustainability of built environment to climate change; and 2) successful transition towards climate-smart development.**

LGUs have to lead the formulation, planning and implementation of climate action plans particularly focusing on the following:

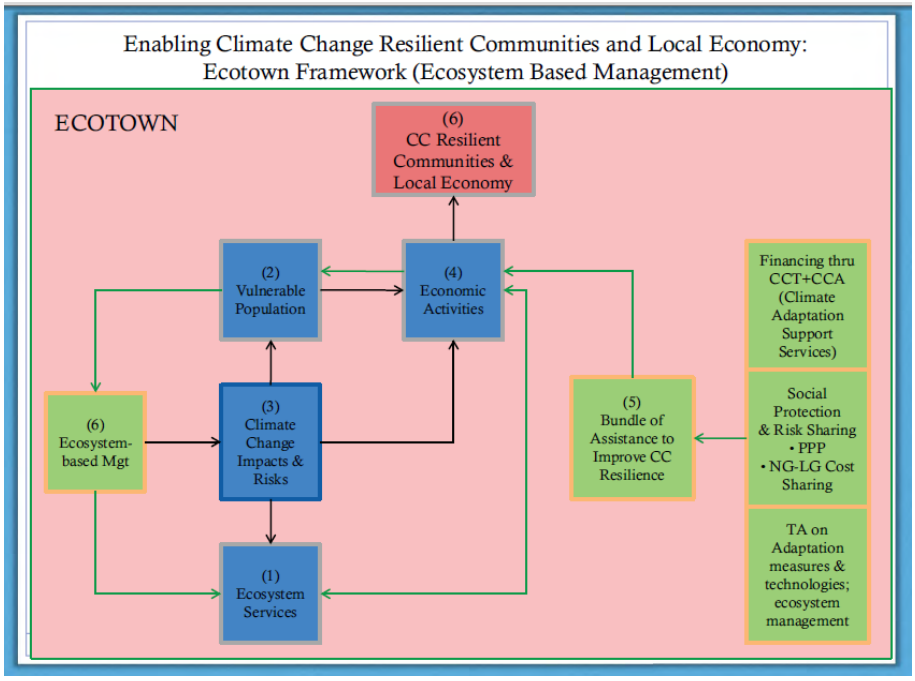
- food security;
- water sufficiency;
- ecosystem and environmental stability;
- human security;
- climate-smart industries and services;
- sustainable energy; and
- knowledge and capacity development.

On **food security**, the Action Plan stressed the need to ensure availability, stability, affordability, safe and healthy food amidst climate change. As for **water sufficiency**, the LGUs have to prioritize the sustainable management of water resources and ensure equitable access. Achieving **ecosystem environment and environment stability** requires enhanced resilience and stability of natural systems and communities.

On **human security**, there should have specific actions to reduce risks of the population from climate change and disasters. Strategies to attain **climate-smart industries and services** include the development, promotion and sustainability of climate-resilient, eco-efficient and environment-friendly industries and services. **Sustainable energy** is achievable according to the Action Plan if sustainable renewable energy and efficient technologies would be adopted as major components of sustainable development. The last identified intermediate outcome of the Action Plan requires enhanced **knowledge on and capacity to address climate change**.

To implement the National Climate Action Plan, municipal and city government must consider climate change as regular function, supported by provincial governments. Barangays shall have direct involvement as well and national government shall extend technical and financial assistance to the LGUs. Monitoring the implementation of the National and Local Climate Change Action Plans is important towards achievement of the goal. Accomplishments of both the national government agencies and LGUs on their respective climate change programs shall also be subjected to regular evaluation.

The Climate Change Commission is currently setting up Ecologically Stable and Economically Resilient Towns (Eco-Towns) as a local implementation mechanism in the National Climate Change Action Plan. Eco-town is a planning unit composed of municipalities or group of municipalities located within and in the boundaries of critical key biodiversity areas (forest, coastal/marine and fishery, or watersheds), highly vulnerable to climate change risks due to its geography, geographic location, and poverty situation. Initial criteria for selecting eco-towns include: location at the eastern seaboard, top ten poorest provinces, top eco-tourism sites and key biodiversity areas.



Five pilot areas were identified and more eco-towns will be established in the countryside in the coming years. Within two years of time frame indicated in the agreement, the project will **review the bio-physical attributes of the selected municipalities in preparation for an ecosystem assessment of its watershed, agriculture, coastal resources and land uses**. The Climate Change Commission shall prepare work plan with technical financial aid to help LGUs enhance existing plans to make it climate-change resilient while LGUs will support in terms of generating data and providing services and facilities in the implementation of the framework.

Mitigation, Adaptation and Development

Mitigation and adaptation as noted earlier are the two main approaches that address climate change and help ensure environmental and economic sustainability as well as poverty reduction. **On the context of biodiversity-climate change linkages, the adoption of biodiversity-based adaptive and mitigative strategies can enhance the resilience of ecosystems and reduce the risk of damage to human and natural ecosystems** (CBD, 2007). The following structures and mechanisms coordinate the mitigation efforts at the global level: UNFCCC; CDM; United Nations Conference of the Parties (UN COP); and Subsidiary Body for Scientific and Technological Advice (SBSTA).

The IPCC Fourth Assessment Report (AR4) notes that **"even the most stringent mitigation efforts cannot avoid further impacts of climate change in the next few decades, which makes adaptation essential."** Adaptation to climate change as stressed in Chapter 1 refers to adjustments in natural or human systems in response to climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. To assist policy-makers develop effective and long-term responses to climate change, it is important to have a systematic and holistic review of climate change implications at early stages since both mitigation and adaptation approaches are interdependent. For instance, it is important to consider carbon sequestration that can produce co-benefits as a mitigation initiative. On the other hand, coastal areas require more adaptation efforts.

Some of the biodiversity-related activities, promoting mitigation of or adaptation to climate change, are as follows (Ad hoc Technical Expert Group on Biological Diversity and Climate Change, 2003):

- **Maintaining and restoring native ecosystems;**
- **Protecting and enhancing ecosystem services;**
- **Managing habitats for endangered species;**
- **Creating refuges and buffer zones; and**
- **Establishing networks of terrestrial, freshwater and marine protected areas that take into account projected changes in climate.**

The **IPCC also recognized the increasing link between climate change and development.** In its AR4, it says that ''The distribution of impacts and vulnerabilities is still considered to be uneven, and low-latitudinal less-developed areas are generally at greatest risk due to both higher sensitivity and lower adaptive capacity; but there is new evidence that vulnerability to climate change is also highly variable within countries, including the developed countries'' (IPCC, 2007). Activities by the International Institute for Environment and Development (IIED) on mainstreaming climate change and on disaster risk reduction show existing efforts that link climate change and development (Huq *et.al.,* 2006).

In a methodological case study analysis conducted by the World Resources Institute, it has addressed how adaptation can be framed in the context of development (McGray *et. al*., 2007). Supported by several technical adaptation studies, the Organization for Economic Co-operation and Development (OECD) has worked on guidelines on how development assistance can take climate change into account (Agrawala and Van Aalst, 2005).

Apparently, the GHG emissions are driven by socio-economic development patterns characterized by economic growth, technology, population and governance. These patterns make the people more vulnerable to the impacts of climate change which affect socio-economic development and thereby contribute in future GHG emissions. While relationships between GHG emissions, climate change mitigation and development have been under intense study (Markandya and Halsnæs, 2002), links between climate change adaptation and development have been progressing more recently (Adger, 2003). **Climate change poses challenges to meet key development objectives requiring adaptation efforts consistent with development priorities** (Sperling, 2003).

While climate change adaptation is essentially linked to development both for the developed as well as the developing countries, the adverse impacts of climate change would potentially affect more developing countries in a number of key sectors, including water resources, floods, droughts, agriculture and coastal zone management. Linkages between adaptation and development occur at several different scales or levels as indicated below (Huq *et.al*., 2006 as cited in Lasco, *et.al*., 2009):

- ***Local level****: The most severely impacted communities in developing countries will be those living in geographic regions most exposed to climatic impacts (e.g. flood-prone and drought-prone areas). As these people are generally poorer than the rest of the population within the country, they need to be targeted with programs providing support for adaptation to climate.*

- ***Sectoral level****: Within countries, the most adversely impacted sectors include agriculture, water resource management, coastal zone management as well as disaster (e.g. floods, cyclones and droughts) management. Policy makers, planners and managers in those sectors need to anticipate the future impacts of climate change in their sectoral planning.*

- ***National level****: At the national level, policy makers will need to take into account potentially adverse impacts of climate change in different sectors and also take policy decisions across different sectors. One important feature of national policy making includes the need to address existing policies (and actions), which enhance (rather than reduce) vulnerabilities to climate change, and remove "maladaptations" to climate change.*

- ***Regional level****: Many climate change impacts will be felt most acutely at the regional level in areas such as West Africa, eastern Africa, southern Africa and South Asia. Regional-level actions (e.g. for river basins or major drought prone areas such as the Sahel) may therefore be most appropriate. The regional level is also the smallest scale (at least at present) at which potential climate change impacts under different scenarios can be effectively modeled.*

- ***Global level**: Actions implemented at the global level will require the global community of nations to act together under the UNFCCC as well as under other development oriented efforts. For example, reaching many of the MDGs may be more difficult due to the adverse impacts of climate change. International cooperation will also be required for the development of innovative financial mechanisms such as insurance and/or the more effective implementation of existing multilateral and bilateral sources of funding. Incorporating climate adaptation into development will require additional financial resources.*

Held in Johannesburg in 2002, the World Summit on Sustainable Development provided a venue to extensively discuss the emerging issues that support the links between climate policy and development. It has taken the issue forward by exploring and developing the concept of "mainstreaming." The concept, which came from development discourses of gender issues, has long been understood as an effective way to ensure gender equity in development policies – mainstreaming of gender issues. Mitigation initiatives such as fuel switch and energy conservation can only be effective when mainstreamed into energy policy. As for adaptation, this link to development under the mainstreaming concept has not appeared clearly until recently (Klein *et. al.,* 2007).

In December 2009, the COP of the UNFCCC failed to determine legally binding emissions reduction commitments for developed countries. The developing countries, on the other hand, have realized their vulnerability to climate change. The situation has given rise to a paradigm shift looking beyond the exclusive emphasis on mitigation. **The simultaneous growth and implementation of mitigation and adaptation strategies, as well as mainstreaming of climate change measures into development planning were recognized as crucial means to face the challenge of climate change** (ADB, 2009; Stern, 2007).

Mainstreaming Climate Change in Biodiversity Planning and Management

IV. Mainstreaming Climate Change in Biodiversity Planning and Management

This chapter, divided into four sub-sections, starts with an account on how the concept of "mainstreaming" evolved through the years after it has gained attention at the World Summit on Sustainable Development. The section on "Main Challenges" highlights the barriers limiting the implementation of projects on the ground to mainstream climate change particularly into development objectives. Following this is a section on "Entry Points and Potential Ways to Mainstream in the Philippines: Focus on Adaptation and Planning" which highlights the approaches and strategies geared towards mainstreaming climate change into biodiversity planning and management. The last section tackles successful initiatives and lessons learnt on mainstreaming climate change.

History

Gleaning from the previous chapter of this guidebook, the concept of "mainstreaming" gained attention at the World Summit on Sustainable Development. From then on, it has been given different description and definition and has not yet been universally defined. Some "mainstreaming" definitions and descriptions include:

- The full integration of climate change adaptation policies into national development programs (Huq *et. al.,* 2003);

- The integration of climate change vulnerabilities or adaptation into some aspect of related government policy such as water management, disaster preparedness and emergency planning or land-use planning (Agrawala and Van Aalst, 2005);

- The integration of policies and measures that address climate change into development planning and ongoing sectoral decision-making, so as to ensure the long-term sustainability of investments as well as to reduce the sensitivity of development activities to both today's and tomorrow's climate (Klein *et. al.,* 2007; Klein, 2002; Huq *et. al.,* 2003; and Agrawala and Van Aalst, 2005); and

- The integration of policies and measures that address climate change into development planning and sectoral decision-making (Persson and Klein, 2008).

Viewed positively as source of many potential benefits, "mainstreaming" was recognized by many supporters including the UNFCCC in the international policy arena. Article 4.1 of the Convention calls for Parties to take climate considerations into account in their development planning, until recently there was little guidance on how to move forward. The Eleventh Conference of the Parties to the UNFCCC (COP-11) held on December 2005 in Montreal adopted a Five-Year Program of Work on Impacts, Vulnerability and Adaptation to Climate Change, which focuses on two themes: 1) impacts and vulnerability, and 2) adaptation planning, measures and actions (Klein *et. al.,* 2007).

Through the implementation of mainstreaming initiatives, adaptation to climate change will form part of or will be aligned with other well established programs, particularly sustainable development planning (Adger *et. al.,* 2007).

By integrating climate adaptation into other development and poverty reduction policies and activities, actions that are contrary to the development goals or so-called 'maladaptation' can be prevented (Huq *et. al*., 2006). It will also reduce the sensitivity of development activities to both current and future climate change. Instead of designing, implementing, and managing adaptation separately from development planning, adaptation can be mainstreamed in order to use the financial and human resources more efficiently (Klein *et. al*., 2008).

In the Philippines, mainstreaming efforts are initially focused on disaster risk reduction and management with the enactment of Republic Act 10121 or the Philippine Disaster Risk Reduction and Management Act of 2010. The law provides guidance for mainstreaming climate change mitigation and adaptation into policies, programs and activities at the national and local levels and integrating DRR and CCA in development, peace and conflict resolution processes. Since very little attention is given on mainstreaming climate change into biodiversity planning and management in the country, this guidebook hopes to promote the issue and assist field, extension, and development workers as well as LGUs and partner agencies in enhancing their roles as agents of biodiversity conservation through a well-mainstreamed climate change issues in biodiversity planning and management.

Main Challenges

What are the challenges in mainstreaming climate change into development planning?

In developing countries, there is still limited number of actual projects on the ground that mainstream climate change particularly into development objectives. This is complicated by the institutional and cognitive barriers that exist (Gigli and Agrawala, 2007; Tearfund, 2006; Yohe *et al*.,2007; Lasco *et. al*., 2009). The slow progress on mainstreaming efforts, despite that a great majority of developing countries are signatories and active participants to multilateral environmental and development agreements, could be attributed to a number of reasons. Some of these reasons are:

- Many developing countries **view climate change as a long-term problem** compared to basic necessities and urgent needs that are perceived as more important, such as food security, employment creation, or pollution (Huq *et. al*., 2006);

- **Policymakers and climate change advocates think in different timescales**. Normally, climate change impacts are projected in decades and centuries while development goals are more immediate, and usually based on the political cycles of elected officials (Lasco *et. al*., 2009);

- **There is still much uncertainty** surrounding the direction and magnitude of climate change at the national and local levels (Lasco *et. al*., 2009); and

- **Short-term funding and competing/conflicting agendas** within governments and donor agencies (ADB, 2005; Agrawala and Van Aalst, 2005; Mirza, 2006).

Persson and Klein (2008) stressed through the following three main points some additional concerns in mainstreaming that are linked with Overseas Development Assistance (ODA):

- **Limited funds for climate change adaptation** in developing countries could be redirected into more general development activities, reducing their effectiveness;

- **Increased focus on climate risks** could divert money from development assistance that is meant to address challenges seen as being more urgent than climate change; and

- Developed countries could **view mainstreaming as an opportunity to free them from their UNFCCC obligation** to provide developing countries with new and additional financial resources for adaptation.

Under the UNFCCC negotiations, the noticeable increasing attention given to adaptation is reflected in the increasing number of adaptation projects under way in many developing countries. However, they **are difficult to scale up and mainstream into national planning and development processes as many of these projects are small stand-alone projects only** (Klein *et. al.*, 2008). One option to push mainstreaming initiatives is to take advantage of the growing donor interest in funding sectoral projects and national level projects, including those addressing policy and governance issues.

What are the challenges in mainstreaming climate change into local development planning in the Philippines?

In terms of mainstreaming climate change in local development planning in the Philippines, there is lack of science-based information on climate change scenarios and impacts at a scale relevant to decision-makers. More often, Local Comprehensive Development Plan and Comprehensive Land Use Plan are formulated in the absence of the National

Climate Change Action Plan. On spatial and sectoral considerations, challenges remain on:

- how and where to redefine buildable areas that would lead to appropriate Zoning Policies;
- how to maximize protective buffer zones;
- how to direct development considering the climate change risks;
- how to measure impact on poverty situation which could be aggravated given the climate change risks to economic opportunities, access to services, and basic infrastructure; and
- how to foresee sectoral opportunities (UN Habitat, 2011).

Entry Points and Potential Ways to Mainstream in the Philippines: Focus on Adaptation and Planning

The Medium Term Development Plan of the Philippines does not explicitly mention adaptation to climate change but **there is a very strong commitment to address the impacts of weather-related hazards which form a viable entry point for mainstreaming**.

Adaptation, as noted earlier in this guidebook, involves adjusting the decisions, activities, and thinking due to observed or expected climatic changes, in order to modest harm or take advantage of new opportunities. In addressing climate change, adaptation is an essential complement to the reduction of GHG emissions (IPCC, 2007).

Based on the global review of climate adaptation initiatives, three general types of adaptation have been suggested (McGray *et. al*., 2007):

- **'serendipitous' adaptation**, which refers to activities undertaken to achieve development objectives that incidentally achieve adaptation objectives;
- **climate-proofing of ongoing development efforts**, which includes activities added to an ongoing development initiative to ensure its success under a changing climate; and
- **discrete adaptation**, which means activities undertaken specifically to achieve adaptation objectives.

From constricted activities aimed specifically to address the impacts of climate change, **adaptation has been broadly viewed to include building response capacity and addressing the drivers of vulnerability** (Klein *et. al.,* 2008). Climate change adaptation and sustainable development, as highlighted in the IPCC AR4 share common goals and determinants (Yohe *et. al.,* 2007). Over 100 adaptation initiatives in developing countries were reviewed and results confirmed that in practice, there is fine line that differentiates these adaptation initiatives with good development (McGray *et. al.,* 2007). This implicates that **climate change adaptation community must work in harmony with the (sustainable) development community to maximize synergies and reduce conflicting activities**. The need to urgently tackle climate change adaptation was reflected in the calls to mainstream it into local, national and international development policies, planning, and activities.

According to Halsnaes and Traerup (2009), there are several implications of applying a mainstreaming approach to the evaluation of climate change adaptation policies. These are:

- Climate change is addressed as a development problem and aspects like human welfare and its various social and human dimensions are linked to environmental issues.

- The issue moves into the domain of multiple sectors including agriculture, water, health, energy and infrastructure.

- The current impacts of climate extremes and disasters and their links to development are the starting points for assessing future climate change impacts.

- There is a need to link climate change impact data and development statistics, which, given uncertainties and data limitations, complicates adaptation studies.

Another perspective was drawn from the environmental policy integration (EPI) literature, wherein the use of procedural, organizational, normative and reframing approaches in adaptation mainstreaming were proposed (Persson and Klein, 2008).

- The **procedural approach involves the introduction of new, or modification of existing, decision-making procedures**. For example, project evaluation through environmental and social impact assessments could be revised to include adaptation to climate risks.

- The **organizational approach involves changes in the structure and staffing of relevant organizations**. Examples of this approach include staff training and awareness, amendments of formal staff and departmental responsibilities, staff rotation, merging of ministries, creation of new ministries and structural changes of budget lines.

- The **normative approach involves high-level (parliamentary and cabinet) commitments to a given issue, in this case the issue of climate change adaptation**. This is a way of clearly communicating political will and energizing action at all levels of government.

- The **reframing approach involves reframing traditional sector activities to enhance appreciation of long-term outcome and conditions for successful mainstreaming**.

To mainstream climate change into biodiversity planning and maangement, is there any potential entry point?

Given the implications and different approaches as discussed above, **climate change adaptation planning in the protected areas sector could be a good entry point for mainstreaming climate change into biodiversity planning and management**. Protected areas were first established to conserve tourist attractions and scenic wonders. In recent years, the underlying principle has evolved to become a foundation of biodiversity conservation and ecological sustainability, as well as an important indicator of world ecosystem health and human condition (CBD, 1992; MEA, 2005).

Why is it important to implement climate change adaptation planning in the protected areas?

It is crucial to implement climate change adaptation planning in the protected areas for a number of reasons:

- climate change is already impacting

protected areas' ecosystems and resources (e.g., the distribution, phenology, and composition of species; landscape physiography; and the provision of recreational opportunities);

- despite efforts to reduce GHG emissions, some level of human-induced change will be realized in the 21st century;

- proactive adaptation will be more cost-effective and efficient in reducing the potential for irreversible impacts, such as species extinctions, and in exploiting probable benefits than reactive responses (Smit *et. al.,* 1999; Burton *et. al.,* 2002; Root *et. al.,* 2003; Parmesan, 2006; Stern, 2007; Thomas *et. al.,* 2006; IPCC, 2007; Herrod and West, 2008; Lemmen *et. al.,* 2008; Pearson and Burton, 2009; Lemieux, 2011).

How do we facilitate mainstreaming?

To facilitate mainstreaming, there is a need of dialogue between climate researchers, concerned community, policy-making authorities and other stakeholders (Mirza, 2006). Furthermore, the shortage of capacities to cope with the challenges of biodiversity and climate change demands **relevant capacity building and development for effective implementation of any mainstreaming initiatives**. Stakeholders currently involved in conservation and the sustainable use of biodiversity are not very keen on considering the threats and opportunities of climate change in their strategies to protect biodiversity. Given that climate change will steer in new risks which could exceed the limits of current adaptive capacity, new forms of adaptation are necessary – a comprehensive approach to adaptation, that is, for mainstreaming to **address a range of stressors and underlying causes of vulnerability, in addition to technological adaptation measures** (Klein *et. al.,* 2007).

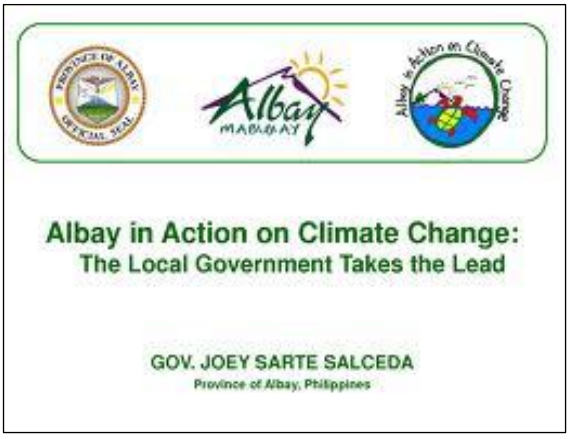
Success Stories and Lessons Learnt

As mentioned earlier, **mainstreaming climate change into biodiversity planning and management in the Philippines still needs a lot of work as there is no literature yet that well documents successful initiative along this line.** Available literatures are mostly focused on a broader scope of the whole climate change issues. While several fora have raised awareness on the issue of climate change and biodiversity, very few studies have been done to actually measure, quantify and valuate the climate change impacts on

biodiversity despite that many potential impacts of climate change have been reported. This section of the guidebook presents some success stories and lessons learnt on mainstreaming efforts in general that could guide future initiatives targeted on biodiversity planning and management.

Gleaning from the experiences of our neighboring countries, the completion of Malaysia's zoning plan for its largest Marine Protected Area (MPA) is one of the recent attempts to mainstream climate change into biodiversity planning and management. From January 30 to February 3, 2012, a team composing of representatives from the Department of Marine Parks and Department of Fisheries in Sabah, Malaysia worked with experts from the United States Agency for International Development (USAID) Coral Triangle Support Partnership (CTSP), the University of Queensland and World Wildlife Fund (WWF)-Malaysia to complete a large scale MPA zoning plan for the proposed 1.02 million hectare Tun Mustapha Park. As one of the first in the world to integrate fisheries, biodiversity, climate change and socio-economic conditions into the MPA design, this zoning plan was created through a ground-breaking set of guidelines developed by CTSP (Green *et. al.*, 2012).

Completing the zoning plan is a step forward in the process of establishing the park as a protected area under Malaysian law. As the largest marine protected area in Malaysia, it is considered globally significant for its rich marine ecosystem that serve as habitat to several threatened marine species such as dugongs and sea turtles. The park, once established, will be included in the region-wide network of the Coral Triangle Marine Protected Area System (Green *et. al.,* 2012).



In the Philippines, the Province of Albay has led the initiatives on climate change mitigation, adaptation, and mainstreaming at the local government level (Lasco *et. al.,* 2013; Lasco *et. al.,* 2008). In October 2007, Albay convened the First National Conference on Climate Change Adaptation in Legaspi City in collaboration with Albay LGUs, DENR Environmental Management Bureau (EMB), the Advisory Council on Climate Change Mitigation, Adaptation and Communication, and the World Agroforestry Centre. The main outcome of the conference is the Albay Declaration on Climate Change Adaptation. This Declaration was adopted to prioritize climate change adaptation in local and national policies, to promote "climate-proofing"

development, and to mainstream adaptation through local and regional partnerships.

The Albay Declaration was signed by the DA, DENR-EMB, Department of Science and Technology (DOST), NEDA, DOE, and the Advisory Council on Climate Change Adaptation, and supported by donor institutions such as the World Bank, UNDP, and ADB. It currently serves as a model framework to mainstream climate change concerns into national and local planning, accounting and budgeting systems, and support initiatives by LGUs, civil society and private sector groups. Under this declaration, the Albay in Action on Climate Change (A2C2) became a pioneering initiative on local climate change mitigation and adaptation.

Included in A2C2 as one of the component programs is a 90-hectare mangrove plantation project located in Manito, Albay and other land use, land use change and forestry (LULUCF) activities. The passage of the Sangguniang Panlalawigan (SP) Ordinance 2007-51 mandated the integration of disaster risk reduction and climate change adaptation in the review and update of its Comprehensive Land Use Plan (CLUP). Throughout the country, the Albay initiative has been replicated by other LGUs. It attests that while climate change is a global issue, local action can contribute in solving not only local but global problems as well.

While the experience of the province of Albay is not specifically focused on mainstreaming climate change into biodiversity planning and management, it is a good example demonstrating the key role that local governments can play in promoting climate change adaptation and in initiating mainstreaming efforts in policies and programs. **It also contributes to biodiversity development planning through the mangrove plantation project and forestry activities**. As part of the A2C2 program, the activities could also serve as another strategic entry point to mainstream climate change into biodiversity conservation planning. Furthermore, emerging lessons from the Albay experience can guide future mainstreaming initiatives in other provinces or cities in the country.

One of the lessons learnt from the Albay experience is **that means of mainstreaming climate change could be most effective at the meso scale administrative level such as a province** (Lasco *et. al.*, 2008). LGUs at the provincial scale can commit resources for climate change adaptation. In the case of Albay, significant finances to mainstream climate change in the Philippines were sourced

from the public and private sectors in no time. In addition, there are **relatively few provinces (73 in the country) as opposed to thousands of municipalities and villages so the ease to mobilize. The political power of the provincial level to warrant action at the local level is also an advantage.**

Another lesson learnt is that **"champions" from meso scale government units could be key to mainstreaming climate change adaptation in developing countries like the Philippines.** Since the Governor of Albay has a very high awareness of climate change issues with regard to sustainable development, he devoted time and shared resources to raise the climate change issue from the provincial agenda to the national development and policy agenda. The Governor exercised **strong leadership in mainstreaming climate change adaptation in development planning and management** which contributed to the success of the projects and programs in Albay.

In mainstreaming climate change into biodiversity planning and management, it is important to consider the **indispensable role of local governments and partners** in shaping and implementing successful adaptation measures that would ensure continuous development while providing safety nets for highly vulnerable ecosystems and social groups.

Sustaining projects and programs through international support is also deemed important. A UNDP-managed joint program on "Strengthening the Philippines' Institutional Capacity to Adapt to Climate Change" (2008-2010) aimed to enhance national and local capacity to develop, manage and administer plans, program and projects addressing climate change risks, and mainstream climate risk reduction into key national and selected local development plans and processes. Biodiversity conservation has been one of UNDP's earliest areas of support in the Philippines and to other countries in the region, as well as one of the biggest, financially. Among others, their work involves: 1) biodiversity inventories and valuation; 2) protected area establishment; 3) enhancement of biodiversity conservation and management practices; and 4) enhanced governance ecosystems (UNDP, 2011).

The following are UNDP's work on climate change relevant to biodiversity conservation in the Philippines:

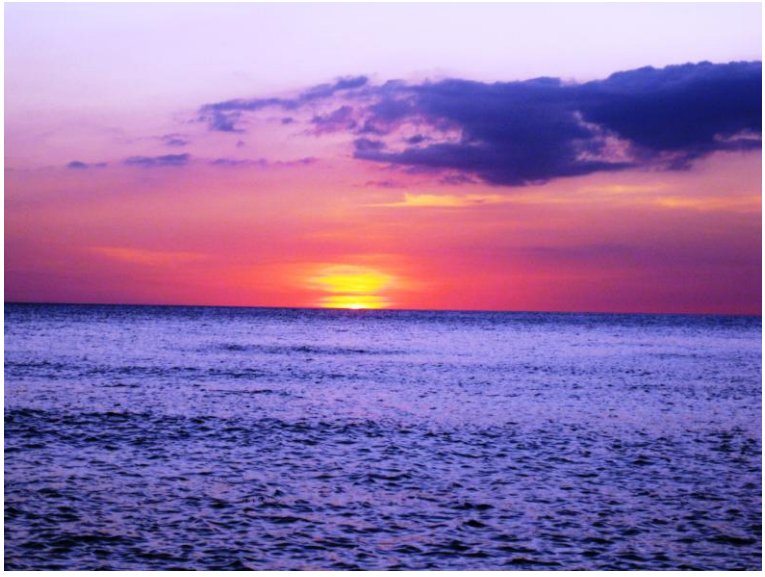
- Generation of data and information such as downscaled climate scenarios for all provinces, which is necessary for vulnerability and adaptation assessments (V&As) and adaptation planning for all sectors;

- Disaster risk reduction using the same risk management approach, and its mainstreaming into local land use and development planning and regulatory processes; and

- Development of appropriate mainstreaming tools and competencies on disaster risk reduction and climate change adaptation

> *To ensure continuous development while providing safety nets for highly vulnerable ecosystems and social groups, local governments, partner agencies, and communities have key roles to play in planning and implementing successful adaptation measures.*

In a study conducted by Bao (2011), he stressed that **the communities and the local stakeholders must be aware of climate change and its impacts to help them mainstream this issue into their regular plans and programs**. Another study emphasized on the importance of mainstreaming climate change into development strategies highlighting the potential mistake of overlooking the welfare of those communities most at risk from climate change (Dasgupta and Baschieri, 2010). Applying to biodiversity planning and management, it is crucial **to prioritize key biodiversity-rich areas and to raise the awareness of the communities and local stakeholders on climate change and biodiversity linkages**.



Opportunities and Direction: Step-by Step Procedures to Mainstream Climate Change in Biodiversity Planning and Management

V. Opportunities and Direction: Step-by-Step Procedures to Mainstream Climate Change in Biodiversity Planning and Management

This section presents the step-by-step procedures on how climate change can be mainstreamed in biodiversity planning and management. It describes vulnerability and risk assessment tools and techniques that can be used to support adaptive management in a rapidly changing climate. Guide questions, worksheets and examples are provided to demonstrate how a suite of tools (e.g., vulnerability assessments) can be used to inform climate change adaptation and biodiversity conservation efforts. The guidebook is designed to allow users to select and combine tools and techniques to enhance the capacity to address threats and opportunities resulting from climate change that are unique to the location and/or sector (e.g., forest management unit or fisheries management zone). Therefore, it is not a prescriptive 'must-do' manual. The process is scalable, given that assessments will be done in different locations and on a variety of spatial scales and will include diverse expertise from many disciplines.

STEP 1 **Set context and build project team**	• Define project/program area, themes and indicators • Engage experts, stakeholders and partners
STEP 2 **Assess current vulnerability and apply future scenarios**	• Describe current sensitivity, exposure and adaptive capacity of the system • Develop and apply future climate scenarios
STEP 3 **Assess future vulnerability and risks**	• Identify future impacts and describe the likelihood of vulnerabilities • Determine areas at higher risks
STEP 4 **Formulate and evaluate adaptation options**	• Identify potential adaptation options • Evaluate options based on economic, social, ecological, technical and institutional factors
STEP 5 **Mainstream adaptation**	• Implement highest priority adaptation options • Monitor action and vulnerabilities over time and modify adaptation options as required

Step 1: Set context and build partnership

Define the scope of the project/program area

As climate change impacts occur across multiple scales, defining the scope of the project or program can vary as follows:

- Local or community, such as a watershed, eco-town, forest management unit, protected area, provincial park, fisheries management zone, coastal zone, or other resource planning areas;
- Provincial or jurisdictional scope; and
- Regional such as eco-region or based on regional boundary.

To encourage a range of interested partners to be involved in the project/program, local level can be a useful scale. If the budget is limited and practitioners need to gain experience in conducting vulnerability assessments, local projects/programs are more feasible. It is important to note, however, that while adaptive management decision-making may happen on a local scale, natural resource managers should think and plan within the context of larger landscapes.

The usefulness of climatic projections for the project/program area is determined by geographic scale. Climate projections are more robust at coarser, broader scales, even with the availability of downscaled climate models (more information on models and scenarios are provided in succeeding steps). It is important to describe uncertainties and to avoid over-interpreting fine-scale projections if vulnerability assessment is conducted on a smaller, local scale (Glick *et al*., 2011). Whether the scope of the assessment is local, provincial or regional, it is crucial to consider the geographic range of the species being examined, and how they might move into or out of the project/program area under future climate scenarios.

What should be considered in selecting the project/program area? This guidebook suggests considering the following factors in selecting the project/program area:

Potential project area	**Boundary delineation (whether it is a political or ecological boundary)**	**Availability and accessibility of data/ information about the area**	**Applicability of climate analysis tool to the area**	**Alignment with existing plans to enable mainstreaming adaptation in future implementation**
Examples:				
Protected area	*Watershed*	*Many available and accessible information about the area*	*Climate analysis tool is applicable to the area*	*Aligned with existing plans*

Identify the themes and potential indicators

What should be considered in selecting themes? Availability of both the expertise and data must be considered in selecting themes. The quality of data should be checked as well. Examples of themes are numbered below:

Themes	**Are there available good quality data?**	**Are there available expertise?**
1. Hydrology (movement, distribution and quality of water)	*Examples:*	
2. Wildlife	*Good quality data but limited*	*Yes, many*
3. Fish and aquatic habitat	*Yes/No*	*Yes/No*
4. Forest		
5. Wetlands		
6. Invasive Species		
7. Species at Risk		
8. Parks and Protected Areas		
9. Others		

Identify and select among the potential indicators those that can be used to focus the assessment. Each theme has many potential indicators. For example, the following can be used in fish and aquatic habitat: distribution and population of fish species in streams, temperature and oxygen regimes in lakes, and habitat availability for fish species. Another example is the change in bird distribution for wetlands theme. Indicators like water quality, water quantity, and stream flow may be used for hydrology theme. For forest theme, indicators such as health, growth and productivity, disturbance regimes, and forest composition, may be considered among others.

The table below may be useful in investigating the themes and indicators used in other assessments. Review possible themes and indicators with researchers and experts. To further narrow down the list of potential themes, the project/program team can rank them based on the most important areas to focus on. This is important in cases where there are too many themes but resources, capacity, or time are limited.

Potential theme	Thematic indicators	Rank of importance for analysis
Examples:		
Fish and aquatic habitat	*distribution and population of fish species in streams*	*2*
	temperature and oxygen regimes in lakes	
	habitat availability for fish species	
Wetlands	*change in bird distribution*	*4*
Hydrology	*water quality*	*3*
	water quantity	
	stream flow	
Forest	*health, growth and productivity*	*1*
	disturbance regimes	
	forest composition	

Identify and engage experts, stakeholders and partners

Vulnerability assessment and implementation of adaptation measures are key steps of the mainstreaming process that **require a set of skills and expertise**. A project/program team can comprise in-house staff of the organization that is leading the project/program, external experts, and other partners/stakeholders (NGOs, LGUs, other government agencies, people's organizations, donor agencies). **The larger the scale, the greater diversity in expert opinion may be required** to undertake a more complex assessment. While members of the project team are expected to have specific roles and responsibilities, a **leader should be assigned to coordinate the project/program**.

This guidebook recommends a participatory, iterative, adaptive management process to enhance partners and stakeholders' understanding of the various actors' perspectives; to develop and solicit more support for adaptation options, targets, and visions; and to strengthen capacity in implementing activities. Where data are limited, indigenous knowledge and local participation can help establish a strong portfolio of local observations – an added value to the process. According to Smit and Wandel (2006), interacting factors and stimuli beyond climate, including political, cultural, economic, institutional, and technological factors could be more recognizable through local participation.

Suggested steps to achieve active participation of stakeholders are as follows:

Key Steps	Guide
1. Identify stakeholders and partners.	1. Make a list of potential stakeholders and partners. They could be individuals, communities, or groups that: - Have an interest in how climate change is considered in biodiversity planning and management - Have access to information, and - Who may be responsible for formal and informal dissemination of knowledge and/or implementation of policies and measures.
2. Foster effective working relationships with stakeholders and communities.	2. Make sure stakeholders and partners understand: - How they are being involved in the process - How they may contribute (their role in the project) or how information they provide will be used - How the vulnerability assessment information can be useful to them - How they can influence decision-making in the process, and - How they can contribute in reducing climate risk
3. Discuss possible models for engagement.	3. Consider the following : - Participation through consultation and giving information - Interactive participation through joint planning - Self-mobilization where stakeholders take the initiative

Step 2: Assess current vulnerability and apply future scenarios

Describe current sensitivity, exposure and adaptive capacity of the system

How do we define vulnerability sensitivity, exposure and adaptive capacity?

Vulnerability is determined by the degree of exposure, sensitivity, and adaptive capacity in a system.

Exposure is defined as the nature and degree to which a system is exposed to significant climatic variations (IPCC, 2001).

Sensitivity is the degree to which a system will respond to a change in climatic conditions. In many cases, sensitivity and exposure can be characterized jointly (Smit and Wandel, 2006).

Adaptive capacity is the ability or potential of a system to respond successfully to climate variability and change (IPCC, 2007). This concept is related to many other commonly used concepts such as coping ability, robustness, and resilience (Smit and Wandel, 2006).

Who will assess vulnerability, sensitivity, exposure and adaptive capacity of the study area?

The project team has to rely on appropriate experts among its members to assess sensitivity, exposure and adaptive capacity. An assessment group can be created for this purpose. This group is expected to use the best available information and approach to conduct the assessment (e.g. previous studies, historic and current climate data, observations, expert judgement, datasets, model outputs, etc.).

How do we assess current exposure and sensitivity?

The following are simple steps that can be used as a guide.

- Gather information that will describe the project/program area's historic climate records and current climate condition;

- Gather information on the observed changes in the project/program area that would show how climate has affected an indicator or an environmental theme on a broader perspective; and
- Rank the current exposure and sensitivity to climate as High, Medium, or Low

How do we assess adaptive capacity?

- Consider ecological adaptive capacity such as agility, flexibility and how changes in temperature cause different genes to be expressed in tree species, dispersal abilities, etc.;
- Look at the human adaptive capacity like the ability to implement planned adaptation measures to cope with changes as a result of economic resources, institutional capacity, infrastructure, technology, etc.; and
- Rank the current adaptive capacity of the system as High, Medium, or Low

It is important to note that non-climatic factors may influence vulnerability assessment of species and ecosystems to climate change. Some human activities for instance may cause stress to a system like population growth and changes demographics, economic shift or diversification, historic and recent land-use changes and zoning, and market fluctuations. By describing the relationships between various species and ecosystems and their vulnerabilities to current climatic and non-climatic factors and stresses, the project starts to build foundation for the assessment of future vulnerabilities.

Professional judgement and expert opinion are useful approaches to help identify the different non-climatic factors that affect the current status of a system. These stresses may be described either qualitatively or quantitatively, whether and to what degree the non-climatic stresses are impacted by climate change. This is the systematic way to recognize the cumulative and synergistic impacts resulting from the interaction between climate change and other factors.

Develop and apply future climate scenarios

In developing scenarios, we need to incorporate projections of future climate that could vary spatially and temporally. If possible, it is useful to also include projections of other non-climatic factors such as population growth and development. Projections range from large scale global climate scenarios showing long-term changes to average temperature, precipitation and other variables, to impact assessments that integrate climate factors in regional or more localized ecological response models.

How are projections being done?

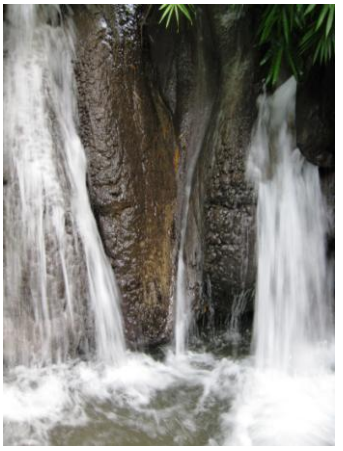
The effect of higher concentrations of GHGs based on increasing amounts of heat trapped in the atmosphere is projected using climate models. Each climate model is unique, is based on different assumptions, and produces somewhat different projections of future climate when provided the same data. For the 2007 IPCC assessment, a total of 24 international centers provided Global Climate Model (GCM) data. IPCC approved 40 scenarios for use in climate change impact and vulnerability assessments. Each scenario has a unique set of assumptions about future social and economic conditions.

> ***Scenarios are not predictions, only possible outcomes***. *The amount of GHG in the future depends on many factors related to global population, human activities, technological development, and the carbon sink/source behaviour of ecosystems. While it is possible to accurately predict the future amounts of GHGs in the atmosphere, climate models would produce different projections.*

For example, let us use one of the more commonly used scenarios, the A2 scenario. Note that current global anthropogenic GHG production exceeds levels used in the business-as-usual A2 scenario (IEA, 2011), and A2 is now considered to be somewhat conservative. A2 scenario anticipates higher GHG levels by 2100, reaching 1,320 parts per million by volume (ppmv) in CO_2 equivalents[2] compared to 915 ppmv for the B2 scenario (Nakićenović and Swart, 2000).

The human population of the world in the A2 scenario reaches 15 billion by 2100 while B2 scenario projects a world population of 10.4 billion people in the same period. Reliance on fossil fuels is also higher in A2 than in the B2 world. Environmental protection, resulting in lower greenhouse emissions is more important in the B2 scenario than in the A2 scenario (Nakićenović and Swart, 2000).

Wherever possible, climate experts in the project team should use the same models, scenarios, and time periods for modeling and reporting on vulnerabilities. Analyses should use at least 30-year averaging periods for GCM output data as recommended by IPCC. Model output is normally calculated according to a number of fixed time horizons (e.g., 2011-2040, 2041-2070, and 2071-2100).



Projections and associated climatic variables should be selected based on relevance to the environmental themes and indicators being studied. Some thematic analyses, however, may require use of projections not

used in other themes. Consider the following in determining the inputs required for the analyses:

- Available climate models and scenarios;
- Required climatic variables (e.g. minimum and maximum monthly temperatures, annual mean temperature, annual precipitation, growing season length in days, etc.);
- Format of climate projection data and information (e.g. maps, table, etc.);
- Preferred projection scale(s);
- Data presentation (e.g. percentage change, incremental change, etc.).

A range of methodologies, from qualitative assessments based on expert and local knowledge, to highly detailed quantitative analyses using science-based methods and ecological models that integrate climate models must be considered in assessing the vulnerability of species and ecosystems to climate change. The table below may be used in prioritizing which methods to be used.

Method	Availability of Information	Quality of Information	Level of Expertise	Time	Budget
Examples:					
Ecological Model: • *Evaluate how climate change variables affect fundamental ecological processes.*	*Readily available*	*Good quality*	*Ecologist*	*Few days*	*P6000*

For quantitative analyses, many types of ecological response model can be used to assess the sensitivity and potential adaptability or resilience of species, habitats, and ecosystems to climate change (Glick *et al*., 2011):

- Conceptual models;
- General characterization models;
- Habitat and occupancy models;
- Physiological models;
- Ecological models; and
- Expert opinion models.

For qualitative analyses, a number of options recommended by UNDP and other organizations can be used to complete the assessment:

- Ranking information in order of importance;
- Identifying critical control points within relationships;

- Quantifying interactions through sensitivity analyses (e.g., through workshops, focus groups and questionnaires);
- Engaging local communities through surveys using structured questionnaires to provide information about observed changes and vulnerabilities; and
- Consulting with scientists and practitioners working for government agencies, industry, academic institutions and organizations.

Step 3: Assess future vulnerability and risks

In Step 2, we assessed current vulnerability and developed scenarios. This time, Step 3 will combine the results of the analyses in Step 2 to develop estimates of future vulnerability and help determine areas at risks.

Identify future impacts and describe the likelihood of vulnerabilities

Using the results of Step 2, work with the technical experts of the project team to rank each indicator's anticipated exposure, sensitivity and adaptive capacity to climate change as High, Medium and Low. Note that the estimates of future adaptive capacity should not include the adaptive measures that will be developed from this mainstreaming process. Repeat the process for existing non-climatic stresses or factors then proceed to an estimation of overall future vulnerability.

Indicator	**Description of future exposure and sensitivity to climate**	**Rank (H-M-L)**	**Description of future adaptive capacity**	**Rank (H-M-L)**	**Description of existing non-climatic factors**	**Rank (H-M-L)**
			Examples:			
Changes in bird species distribution	*Not exposed or sensitive to climate. Its current state, structure or function shows very limited evidence of a relationship to climate.*	*L*	*High tolerance to change and strong ability to adapt to new conditions and stresses*	*H*	*Recent land use change affects the habitat of the bird species*	*M*

How do we estimate an overall future vulnerability?

Continue working with the technical experts and collate rankings from the table above. Based on the collated rankings, assign an overall future vulnerability ranking for every indicator as High, Medium and Low. This exercise will integrate all the scientific information that were synthesized, the experiments that were done and the modeling efforts that were conducted to come up with an overall vulnerability assessment. Expect lively discussions to elaborate on the confidence in the results of the assessments. Approaches to acknowledge and communicate uncertainty should be considered in this part of the project activity.

What is uncertainty?

Uncertainty is defined by IPCC as an "expression of the degree to which a value is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour." Using the IPCC definition, uncertainty can thus be described through quantitative means such as a range of values calculated by various models and/or by qualitative statement like those reflecting the judgment of a team of experts.

It is important to consistently communicate uncertainty across vulnerability assessments completed for the study regardless of the method used. Uncertainty can be reduced over time with inclusion of science and through repeated process keeping in mind that adaptive planning, including vulnerability assessment is an iterative process. Uncertainties should not limit the estimation of vulnerabilities and assessment of risks.

Determine areas at higher risks

How are risks assessed?

The first step is to determine people's perceptions of the adverse effect which involves exploring ways to address the vulnerabilities identified for the projected future climates. Following are some of the questions that can be initially asked:

- Given the limited resources, how can they be deployed to deal with climate compared to other priorities?

> ***Risk*** *is the severity of the consequences of climate change impacts and the likelihood that impacts will occur.*

- Where do we focus the adaptation action?
- Which aspect is more important?

Involve the project team, expert panels, partners, other specialists and all stakeholders, if possible, in the risk assessment. Organize a workshop to conduct the activities in the risk assessment or to validate risk assessment results. The project team should also consider other tools, including quantitative assessments such as cost-benefit analysis that employ a qualitative approach to risk assessment.

Using the table below as a guide, determine potential consequences in several areas such as finance, strategies, operation, environment, public perception, safety, culture, etc for each indicator. Rate the consequences using numerical value for example lowest value being weakest and highest value as strongest factor leading to the decline of a social-ecological system or biodiversity. Next step is to determine and rate the likelihood of the climate change impact occurring using numeral value as well; high value if there is very high probability that the risk will occur in certain number of years and low value if otherwise.

Indicator	**Potential consequence**	**Rating**	**Likelihood of occurrence**	**Rating**
Examples:				
Water quality	*Impact on environment, ecosystems services, or resources requires > 25 years to rehabilitate*	*4 (Major)*	*Very high probability that this risk will occur in the next X years.*	*5 (Almost certain)*

For each indicator, assign a qualitative classification of risk as High, Medium and Low based on the ratings of severity of consequences and likelihood of impacts. The project team is encouraged to use other options to describe risks such as graphs and maps generated through Geographic Information System (GIS). This tool is rapidly developing with a range of applications that is capable of assembling, storing, manipulating, and displaying geographically referenced information (USGS, 1998).

GIS has the ability to take scattered, confusing data and to represent its spatial relationships in such a way that users can realize new levels of understanding. This tool also combines relational databases with spatial interpretation and outputs are often in form of maps. It provides a powerful and versatile tool to facilitate a fast and transparent decision-making (Manandhar, 2010). It is increasingly being utilised for hazard and vulnerability mapping and analysis, as well as for the application of disaster risk management measures. Below is a sample framework of a climate related risk assessment

using GIS presented at the Training on Climate Smart Protected Area Management Plan in Malaybalay, Bukidnon (Combalicer, 2012).

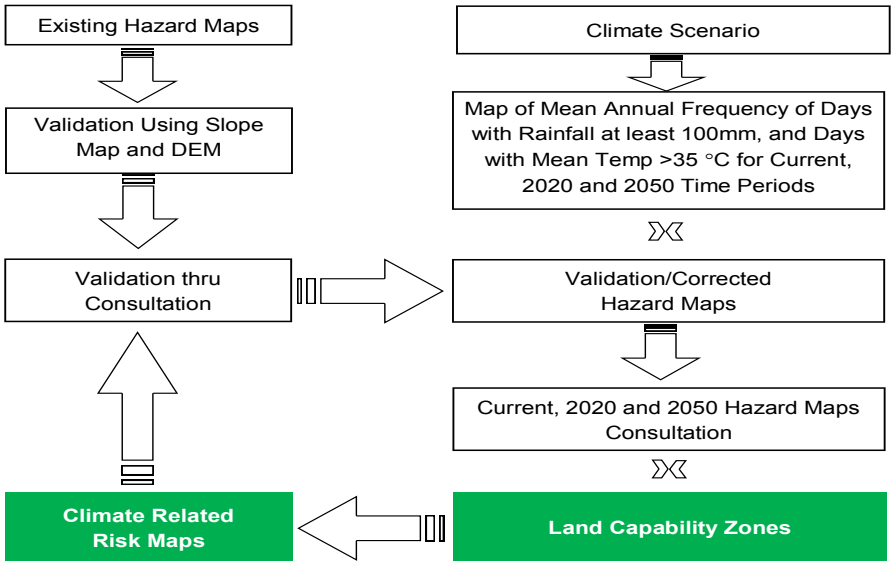


Figure 9. Climate related risk assessment framework using GIS. Source: Combalicer, 2012

After determining and describing the risk, share the findings with key organizations, staff, and decision-makers to raise their awareness of the potential climate impact within their areas of influence and responsibility, to ensure transparency, and to validate results. It is crucial to engage them early in the process to help build support for adaptation planning and implementation. In communicating the findings, the project team should develop impact statements of vulnerability and risk that are appropriate for target government agencies, industry, communities and organizations.

There is a range of communication strategies from workshops and science-policy dialogues to development of briefing notes/policy brief that the project team may explore in different stages throughout the mainstreaming process.

Step 4: Formulate and evaluate adaptation options

The aim of this step is to guide the practitioners and other users of this guidebook in identifying adaptation options that would reduce or eliminate vulnerabilities and risks. In developing adaptation options, the project team should consider a number of factors including desirability, feasibility, practicality, and other important requirements that would help contribute in achieving the goals of the project. Selection and prioritization of a suitable adaptation options in the project are important elements of the mainstreaming process where stakeholders' active involvement are needed.

Identify potential adaptation options

Vulnerabilities and risks come in many forms and so as climate change adaptation options which are site-specific. No single method of generating adaptive responses would be suitable for all mainstreaming process. Every method has its strengths and ultimately, the practitioners decide which method to use depending on available resources and stakeholders' involvement. This guidebook recommends four very broad categories of identifying adaptation options. Generally, these options aim to:

- Eliminate or reduce threats;
- Enhance resilience of species and systems;
- Mobilize people to act; and
- Advance knowledge

In developing a list of adaptation options, it is important to determine the timeframe of implementation whether it is short-term, medium-term or long-term. The table below can be used as a guide in listing potential adaptation options per identified vulnerability/risk.

Vulnerabilities/ Risks	**Adaptation Options**	**Timeframe**
	Examples:	
Introduction of new forest pest	***Eliminate or reduce threats***	
	1. Alter age-class distribution by adjusting rotation age lengths	*Short-term*
	Enhance resilience of species and systems	
	1. Improve tree species diversity	*Ongoing*
	Mobilize people to act	
	1. Implement an outreach program for public to assist in detection	*Long-term*
	Advance knowledge	
	1. Share experience with other local, provincial, and federal agencies/sectors	*Medium-term*

Different approaches can be used in identifying adaptation options. One approach is that the project team conducts a workshop to identify potential adaptation options. The outputs can be presented to the stakeholders for validation. The other approach is to circulate a questionnaire or survey form to the stakeholders to solicit their ideas on potential adaptation options then the project team collate all the inputs to eliminate redundancies, merge similar ideas, and cluster into groups for further evaluation.

Evaluate options based on economic, social, ecological, technical and institutional factors

After coming up with a list of potential adaptation options, the next step is to evaluate and prioritize. The following questions can be used as guide during the assessment:

- How much would it cost to implement the adaptation options? Are there enough resources to cover the cost? Would there be implications in terms of budget allocation and release of funds?
- Is the adaptation option technically feasible? What kind of technical assistance would it require to achieve successful implementation?
- Is the adaptation option institutionally feasible? Are policies and legislation in place to enable the full operation of the selected option?
- What are the likely benefits of the adaptation options? For example, one of the options identified is to increase the tree species diversity within a forest range. This adaptation measure could increase the resilience to climate change by reducing the threat of an insect outbreak in a particular species in that forest ecosystem. The likely benefits are greater ability for populations to shift and increased protection of important ecosystem services.
- Is the adaptation socially acceptable? Are there ways to increase participation? Stakeholders' participation is essential to the success of any mainstreaming process. Therefore, the selected adaptation option should be responsive to the needs of the stakeholders in order to actively engage them in the activities.
- Is the adaptation option ecologically acceptable? The technical experts in the project team should assess the ecological impact of the identified option.

- What is the degree of risk in implementing the adaptation compared to the consequence of not implementing it? Cost-Benefit Analysis, Multi-criteria and Cost-Effectiveness Analysis are tools that can be used to determine this aspect of the evaluation.

Using the above questions as a guide, the project team can come up with evaluation criteria and use ranking method to prioritize.

Step 5: Mainstream adaptation

This is the last step of the process to mainstream climate change into biodiversity planning and management. Once the project team has evaluated the adaptation options, the selected ones are considered for implementation. The essential elements of this step are:

- Monitoring and evaluation;
- Acquiring new knowledge and continuous research; and
- Periodic re-assessments

Implement highest priority adaptation options

Who will implement the adaptation options?

The project team should identify the responsible people for every stage of the implementation process. Particularly for those adaptation options that have fiscal implications, it is important to identify who will fund the activities. The project team should determine the composition of the team who will implement, identify the people who are mainly responsible and those who are expected to provide support.

Where and when to implement?

As early as Step 1, the project/study area has been already defined. As for the best time to implement the selected adaptation options, the project team should establish proper timing. Consider some factors such as onset of rain, dry season, typhoon/storm occurrence and other time element like which months of the year, events to coincide, release of fund, etc.

How to implement?

One approach to implement is by integrating the adaptation options into existing programs. Therefore, it is important to seek opportunities for integration. Another approach is to create new programs as platform of the adaptation measures. New programs should have clear goals, objectives, targets and actions. Sometimes, it is only during the implementation process that key limitations in adaptive capacity are realized so the project team should be flexible to accommodate changes or to modify the plans made.

Monitor action and vulnerabilities over time and modify adaptation options as required

Monitoring is necessary to track the effectiveness of the adaptation options. This also helps in checking the progress of implementation according to the plans. Ensure that the following are considered in the monitoring process or in developing monitoring forms:

- Outputs generated from the process (e.g., new decision-support tools, policy changes, guidebook or guidelines on 'how to', reports and papers that explains the details of the process);

- Outcomes that have been achieved (e.g. formal engagement by the stakeholders in providing inputs in decision-making, integration of climate change considerations during the planning process)

- Actual impacts (e.g., flood early warning system based on a risk assessment that saved "X" lives and minimized property damage up to " X" amount)

- Ecological improvement (e.g., increased in number of species and biological diversity, expansion of mangrove area)

- Elimination or reduction in vulnerability

The project team should ensure that appropriate information is collected to assess the success or failure of the adaptation actions being implemented. Information obtained during the monitoring stage will be useful for future reviews, preparation of progress reports and other information materials for public dissemination, budget requests or reallocation, and policy decisions. By tracking the progress, the project team could easily identify which adaptation options is effective in improving the adaptive capacity of the

system and ultimately in reducing vulnerabilities and risks. It will be easier also to gauge if additional resources are needed and whether the adaptation option is ready for replication in other locations.

Existing programs capable of providing information to help monitor climate change impacts on biodiversity should be recognized and supported. This is to facilitate the integration of existing monitoring programs with climate change monitoring. To maximize the program's effectiveness, efficiencies to monitor climate change and a range of other objectives (e.g., biodiversity and forest health) on the landscape must be enhanced. Align monitoring efforts with important climate change impacts indicators. As gaps are identified during the monitoring process, refer back to the initial assessment and re-evaluate vulnerabilities and risks to guide the updating of necessary adaptation options.

Re-evaluate both the results of initial vulnerability assessments and the identified high priority adaptation options as new information and research on climate change adaptation emerge. Consider monitoring the following particularly in conducting periodical assessment of long-term projects:

- Societal, economic, or political changes since the mainstreaming process began (e.g. how changes in funding, public perception, or political support affect the implementation of adaptation actions);
- Impact of improved scientific findings on the understanding of vulnerabilities to climate change;
- Relevance and accuracy of information related to climate change and biodiversity to inform future decisions.

Change in the focus of priority adaptation options is justifiable as long as it is supported by science-based information and the stakeholders are consulted on the ongoing process. To keep the stakeholders informed of the progress, the following tools may be used: progress reports, press releases, briefing notes, website updates, workshops, science column in a newspaper or community paper, radio interviews, television clips in community channels and other communication media. Besides keeping the stakeholders updated, this strategy can build momentum for ongoing implementation.

References

Ad hoc Technical Expert Group on Biological Diversity and Climate Change. 2003. Guidelines for promoting synergy among activities addressing biological diversity, desertification, land degradation and climate change. Convention on Biological Diversity (CBD) Technical Series No.10. Secretariat of the CBD.

Adger, N. 2003. Social capital, collective action, and adaptation to climate change. Economic Geography 79(4): 387–404.

Adger, W.N., Agrawala, S., Mirza, M.M.Q., Conde, C., O'Brien, K., Pulhin, J., Pulwarty, R., Smit, B. and Takahashi, K., 2007. Assessment of adaptation practices, options, constraints and capacity. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. Van der Linden and C. E. Hanson (eds), Cambridge University Press. Cambridge, UK.

Agrawala, S. and Van Aalst, M. 2005. Bridging the gap between climate change and development. Bridge Over Troubled Waters – Linking Climate Change and Development. S. Agrawala (ed), Organisation for Economic Co-operation and Development (OECD). Paris, France.

Arceo, H., Aguinaldo M.M.S., Aliño, P.M. 2001. An orientation on marine protected areas. Coastal Resources Management Tools. Marine Environment Resources Foundation Inc. The Marine Science Institute, University of the Philippines. The Royal Netherlands Embassy and International Development Research Centre. 45 p.

Asian Development Bank (ADB). 2009. Mainstreaming climate change in ADB operations. Climate Change Implementation Plan for the Pacifi c (2009–2015). Pacific Studies Series. Manila.

Asian Development Bank (ADB). 2009. Proposed loan and administration of grant. Philippine Energy Efficiency Project. Manila.

Asian Development Bank (ADB). 2009. The economics of climate change in Southeast Asia: A regional review. Manila.

Asian Development Bank (ADB). 2005. Climate proofing: A risk-based approach to adaptation. Pacific Studies Series. Manila.

Bao, W. 2011. Climate change and development in mountain areas in China. International Conference on Remote Sensing, Environment and Transportation Engineering (RSETE), 24-26 June 2011.

Bele, M.Y., Somorin, O., Sonwa, D.J., Nkem, J.N., Locatelli, B. 2011. Forests and climate change adaptation policies in Cameroon. Mitigation and Adaptation Strategies for Global Change 16:369–385.

Bildan, L. 2003. Disaster management in Southeast Asia: An overview. Asian Disaster Preparedness Center. Bangkok, Thailand.

Burton, I., Huq, S., Lim, B., Pilifosova, O., Schipper, E.L. 2002. From impacts assessment to adaptation priorities: The shaping of adaptation policy. Climate Policy 2:145–159.

Castillo, T.S. 2010. Philippine milestones on coastal and marine biodiversity management. Department of Environment and Natural Resources (DENR) - Philippines. Global Conference on Oceans, Coasts, and Islands, 3-7 May 2010.

Chakeredza, S., Temu, A.B., Yaye, A., Mukingwa, S., Saka, J.D.K. 2009. Mainstreaming climate change into agricultural education: Challenges and perspectives. ICRAF Working Paper no. 82. World Agroforestry Centre. Nairobi, Kenya.

Climate Change Commission. 2010. National Framework Strategy on Climate Change 2010-2022. Approved and signed during the Commission Meeting on 28 April 2010, Puerto Princesa City, Palawan, Philippines.

Combalicer, E. 2012. Use of GIS in vulnerability assessment. Materials used for the Training Course on Training on Climate Smart Protected Area Management Plan, Malaybalay, Bukidnon, 13 November 2012.

Conservation International (Lead Author); McGinley, M. (Topic Editor). 2008. Biological diversity in the Philippines. In: Encyclopedia of Earth. (eds.) Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment). [First published in the Encyclopedia of Earth 22 August 2008; Last revised: 13 September 2011; http://www.eoearth.org/article/Biological_diversity_in_the_Philippines.

Conservation International, Philippines. 2006. Priority sites for conservation in the Philippines: Key biodiversity areas. Department of Environment and Natural Resources – Protected Areas and Wildlife Bureau (DENR-PAWB) and Haribon Foundation. Quezon City, Philippines, 24pp.

Convention on Biological Diversity (CBD) Secretariat. 2007. Biodiversity and climate change. International Day for Biological Diversity Booklet. Québec, Canada. 44pp.

Convention on Biological Diversity (CBD) Secretariat. 2007. Biodiversity, climate change, and the Millennium Development Goals (MDGs). CBD Factsheet. Québec, Canada.

Convention on Biological Diversity (CBD) Secretariat. 1992. Convention on Biological Diversity. Nairobi: United Nations Environment Programme. http://www.cbd.int/doc/legal/cbd-un-en.pdf.

Dasgupta, A., and Baschieri, A. 2010. Vulnerability to climate change in rural Ghana: Mainstreaming climate change in poverty-reduction strategies. Journal of International Development 22, 803–820. Published online 22 February 2010 in Wiley InterScience. DOI: 10.1002/jid.1666

Department of Environment and Natural Resources – Protected Areas and Wildlife Bureau (DENR-PAWB), United Nations Development Programme (UNDP), Association of Southeast Asian Nations (ASEAN) Center for Biodiversity and Ateneo School of Governance. 2009. Assessing progress towards the 2010 biodiversity target: The 4th national report to the Convention on Biological Diversity.

Department of Environment and Natural Resources (DENR). 1999. The Philippines' initial national communication on climate change. Philippines.

Gigli, S. and Agrawala, S. 2007. Stocktaking of progress on integrating adaptation to climate change into development co-operation activities. Organisation for Economic Co-operation and Development (OECD). Paris.

Glick, P., Stein, B.A., and Edelson, N.A. (Eds.). 2011. Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. National Wildlife Federation, Washington, DC.

Green, A., White, A., and Tanzer, J. 2012. Integrating fisheries, biodiversity, and climate change objectives into marine protected area network design in the Coral Triangle. Report prepared by The Nature Conservancy for the Coral Triangle Support Partnership, 105 pp.

Halsnaes, K. and Traerup, S. 2009. Development and climate change: A mainstreaming approach for assessing economic, social, and environmental impacts of adaptation measures. Environmental Management 43:765–778 DOI 10.1007/s00267-009-9273-0.

Herrod, J. S., and West, J. M. (eds). 2008. Preliminary review of adaptation options for climate-sensitive ecosystems and resources: Final report. US Climate Change Science Program. Washington, DC.

Hilario, F. 2008. Climate change and its potential impacts in the Philippines. Global Earth Observation System of Systems (GEOSS) Symposium on Integrated Observation for Sustainable Development in the Asia-Pacific Region, Mirai-kan,Tokyo, Japan, 14-16 April 2008.

Huq, S., Rahman, A., Konate, M., Sokona, Y. and Reid, H. 2003. Mainstreaming adaptation to climate change in Least Developed Countries (LDCs). International Institute for Environment and Development. London, UK.

Huq, S., Reid, H. and Murray, L. A. 2006. Climate change and development links. International Institute for Environment and Development. London, UK.

Institute for Global Environmental Strategies (IGES). 2008. Climate change policies in the Asia-Pacific: Re-uniting climate change and sustainable development. IGES. Kanagawa, Japan.

Intergovernmental Panel on Climate Change (IPCC). http://www.ipcc.ch

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Parry M.L., Canziani O.F., Palutikof J.P., Van der Linden P.J., Hanson C.E. (eds.) Cambridge University Press. Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: Synthesis report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Core Writing Team, Pachauri, R.K. and Reisinger, A. (eds.)]. Geneva, Switzerland.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007. The Fourth Assessment Report (AR4). Cambridge University Press. Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC). 2007. Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning (eds.)] Cambridge University Press. Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC). 2001. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. J. J. McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., and White, K.S. (eds.). Cambridge University Press. Cambridge, UK.

Intergovernmental Panel on Climate Change (IPCC) Working Group II. 2007. Summary for policymakers. Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report.

Intergovernmental Panel on Climate Change (IPCC) Working Group I. 2007. Summary for policy makers. Contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report.

International Energy Agency (IEA). 2011. "Prospect of Limiting the Global Increase in Temperature to 2ºC Is Getting Bleaker." May 30, 2011. Available from: http://www.iea.org/newsroomandevents/news/2011/may/name,19839,en.html; accessed February 2013.

Jaranilla-Sanchez, P.A., Lasco, R.D., Villamor, G.B., Gerpacio, R., Nilo, G.P. and Villegas, K.L. 2007. A primer on climate change adaptation in the Philippines. World Agroforestry Centre. Philippines.

Kiljunen, P. 2010. Tiedebarometri 2010 (Science barometer 2010). Tieteen tiedotus Ry & Yhdyskuntatutkimus Oy. Finland.

Klein, R. J. T., Eriksen, S. H. E., Naess, L. O., Hammill, A., Tanner, T. M., Robledo, C. and O'Brien, K. L. 2007. Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance. Tyndall Centre Working Paper No. 102. Tyndall Centre. Norwich, UK.

Klein, R. J.T., Huq, S., Denton, F., Downing, T. E., Richels, R. G., Robinson, J. B. and Toth, F. L. 2007. Interrelationships between adaptation and mitigation. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M. L. Parry, O. F. Canziani, J. P. Palutikof and P. J. Van der Linden and C. E. Hanson (eds). Cambridge University Press, Cambridge, UK.

Klein, R. J. T., Kartha, S., Persson, A.,Watkiss, P., Ackerman, F., Downing, T. E., Kjelle´n, B. and Schipper, L. 2008. Adaptation: Needs, financing and institutions. Stockholm Environment Institute. Sweden.

Klein, R.J.T. 2002. Climate change, adaptive capacity and sustainable development. In: Expert Meeting on Adaptation to Climate Change and Sustainable Development, Organisation for Economic Co-operation and Development (OECD). Paris, France.

Lasco, R.D., Pulhin, F.P., Jaranilla-Sanchez, P.A., Garcia, K.B. and Gerpacio R.V. 2008. Mainstreaming climate change in the Philippines. Working Paper no. 62. World Agroforestry Centre. Philippines 23p.

Lasco, R.D., Pulhin, F.B., Sanchez, P.A., Villamor, G.B. and Villegas, KA.L. 2008. Climate change and forest ecosystems in the Philippines: Vulnerability, adaptation and mitigation. Journal of Environmental Science and Management 11(1):1-14.

Lasco, R.D., Delfino, RJ.D., Pulhin, F.B., and Rangasa, M. 2008. The role of local government units (LGUs) in mainstreaming climate change daptation in the Philippines. AdaptNet Policy Forum 08-09-P-Ad, 30 September 2008. Center for Initiatives and Research on Climate Change and Adaptation. http://albaycirca.org/, http://albay.gov.ph,www.albaydecalration.we.bs/, www.nccca.we.bs

Lasco, R.D., Pulhin, F.P., Jaranilla-Sanchez, P.A., Delfino, RJ.D., and Garcia, K.B. 2009. Mainstreaming adaptation in developing countries: The case of the Philippines. Climate and Development 8 (2009) 1–17 DOI 10.3763/cdev.2009.0009 # 2009 Earthscan ISSN: 1756-5529 (print), 1756-5537 (online) www.earthscanjournals.com

Lavides, M.N. (ed). 2010. Impacts of climate change on biodiversity. A Technical Assistance Report submitted by Haribon Foundation to ASEAN Center for Biodiversity. ASEAN Center for Biodiversity, Los Banos, Laguna, Philippines.

Lemieux, C.J., Beechey, T.J., Scott, D.J., Gray, P.A. 2011. The state of climate change adaptation in Canada's protected areas sector. The Canadian Geographer/Le G´eographe canadien 2011, 55(3): 301–317 DOI: 10.1111/j.1541-0064.2010.00336.x. C _Canadian Association of Geographers/L'Association canadienne des g´eographes.

Lemmen, D.S., Warren, F.J., Lacroix, J. and Bush, E.(eds). 2008. From impacts to adaptation: Canada in a changing climate. Ottawa, Canada.

Leveque, C. and Mounolou, J. 2003. Biodiversity. John Wiley. New York.

Manandhar, B. 2010. Flood plain analysis and risk assessment of Lothar Khola. A thesis submitted in partial fulfillment of the requirements for the Degree of Master of Science in Watershed Management, Tribhuvan University, Institute of Forestry, Pokhara, Nepal.

Markandya, A. and Halsnæs, K. 2002. Climate change and sustainable development – Prospects for developing countries. Earthscan. London, UK.

McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J. and White, K.S. 2001. Climate change 2001: Impacts, adaptation, and vulnerability. IPCC, Cambridge University Press. UK.

McGray, H., Hammill, A. and Bradley, R. 2007. Weathering the storm options for framing adaptation and development. World Resource Institute.

Millennium Ecosystems Assessment (MEA). 2005. Millennium ecosystems assessment synthesis report: Strengthening capacity to manage ecosystems sustainably for human well-being. http://www.millenniumecosystmassessment.org

Millennium Ecosystem Assessment (MEA). 2005. Ecosystems and human well-being: Biodiversity synthesis. World Resources Institute. Washington, DC.

Merilo, A.G.D. 2001. GHG mitigation strategies: The Philippine experience. Workshop on Good Practice and Measures. Copenhagen, Denmark.

Mertz, O., Halsnaes, K., Olesen, J.E. and Rasmussen, K. 2009. Adaptation to climate change in developing countries. Environmental Management 43:743–752 DOI 10.1007/s00267-008-9259-3. Springer Science+Business Media LLC. USA.

Mirza, M. 2006. Mainstreaming climate change for extreme weather events and management of disasters: An engineering challenge. 1-4244-0218-2/06/$20.00. Institute of Electrical and Electronics Engineers. USA.

Nakićenović, N. and Swart, R. (Eds.). 2000. Emissions Scenarios: A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.

Parmesan, C. 2006. Ecological and evolutionary responses to recent climate change. Annual Review of Ecology, Evolution, and Systematics 37: 637–669.

Pearson, D., and Burton, I. 2009. Adapting to climate change in Ontario: Towards the design and implementation of a strategy and action plan. The Expert Panel on Climate Change Adaptation Report to the Minister of the Environment. Queen's Printer for Ontario. Canada.

Persson, A. and Klein, R.J.T. 2008. Mainstreaming adaptation into Official Development Assistance (ODA): Integration of long-term climate concerns and short-term development needs. http://web.fu-berlin.de/ffu/akumwelt/bc2008/papers/bc2008_71_Person-Klein.pdf

Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA). 2011. Climate change in the Philippines. Report funded under the MDGF-1656 Strengthening the Philippines Institutional Capacity to Adapt to Climate Change. Quezon City, Philippines.

Racelis, D.A. 2010. SEARCA professorial chair lecture presented at the SEARCA Agriculture and Development Seminar Series (ADSS) on 11 May 2010. http://beta.searca.org/searca/index.php/news/93-expert-recommends-mainstreaming-cca-in-philippine-forestry-

Root, T.L., Price, J.T., Hall, K.R., Schneider, S.H., Rosenzweig, C. and Pounds, J.A. 2003. Fingerprints of global warming on wild animals and plants. Nature 421: 57–60 DOI 10.1038/nature01333.

Rudebjer, P., Baidu-Forson, J., Van Schagen, B, Jarvis, A., Staver, C. and Hodgkin, T. 2008. Agrobiodiversity and climate change: What do students need to know? Paper presented at the 2nd ANAFE International Symposium on Mainstreaming Climate Change into Agricultural and Natural Resources Management Education: Tools, Experiences and Challenges, Capital Hotel Lilongwe, Malawi, 28 July-1 August 2008.

Smit, B., Burton, I., Klein, R.J.T. and Street, R. 1999. The science of adaptation: A framework for assessment. Mitigation and Adaptation Strategies for Global Change 4: 199–213 DOI 10.1023/A:1009652531101.

Smit, B., and Wandel, J. 2006. Adaptation, adaptive capacity and vulnerability. Global Environmental Change 16(3): 282-292.

Somorin, O.A., Brown, H.C.P., Visseren-Hamakers, I.J., Sonwa, D.J., Arts B., and Nkem, J. 2011. The Congo Basin forests in a changing climate: Policy discourses on adaptation and mitigation (REDD+). Global Environmental Change. DOI 10.1016/j.gloenvcha.2011.08.001.

Sonwa, D.J., Nkem, J.N., Idinoba, M.E., Bele, M.Y. and Jum, C. 2012. Building regional priorities in forests for development and adaptation to climate change in the Congo Basin. Mitigation and Adaptation Strategies for Global Change 17:441–450 DOI 10.1007/s11027-011-9335-5.

Sperling, F. (ed.). 2003. Poverty and climate change –Reducing the vulnerability of the poor through adaptation. African Development Bank (AfDB), Asian Development Bank (ADB), UK Department of International Development (DFID), European Commission – Directorate General for Development (EC-DG), Bundesministerium Für Wirtschaftliche Zusammenarbeit (BMZ) or the German Federal Ministry for Economic Development Cooperation, Netherlands' Directorate-General for International Cooperation (DGIS), Organisation for Economic Co-operation and Development (OECD), United Nations Development Program (UNDP), United Nations Environment Program (UNEP) and the World Bank. USA.

Stern, N.H. 2007. The economics of climate change: The stern review. Cambridge University Press. http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_Report.cfm.

Tearfund. 2006. Overcoming the barriers: Mainstreaming climate change adaptation in developing countries. Tearfund, UK.

Thomas, C.D., Franco, A.M.A. and Hill, J.K. 2006. Range retractions and extinction in the face of climate warming. Trends in Ecology and Evolution 21(8): 415–416 DOI 10.1016/j.tree.2006.05.012.

United Nations Development Program (UNDP). 2011. Perspectives on Biodiversity and Climate Change. Plenary Session III: Biodiversity Conservation Initiatives and Partner's Perspectives. Renaud Meyer Country Director. International Conference on Biodiversity and Climate Change. 1-3 February 2011. PICC, Manila, Philippines.

United Nations Framework Convention on Climate Change (UNFCCC). 2012. Feeling the heat. http://unfccc.int/essential_background/feeling_the_heat/items/2918.php.

United Nations Habitat. 2011. Philippine national climate change legislation and national-local action. Resilient Cities 2011, 2nd World Congress on Cities and Adaptation to Climate Change, Bonn, Germany, 4 June 2011.

United States Geological Survey (USGS). 1998. http://www.usgs.gov/research/gis/title.html

Villarin, J.R.T., Loyzaga, M.A.Y., and La Viña, A.G.M. 2008. In the eye of the perfect storm: What the Philippines should do about climate change? Professorial Lecture.

Wasseige C., Devers D., deMarcen P., Eba'a Atyi R., Nasi R., Mayaux Ph. (ed.). 2009 Congo Basin Forests -State of Forests 2008. Pp 209–221. Office des publications de l'Union Européenne.

World Agroforestry Centre. 2007. Local initiatives for climate change adaptation strategies in Albay, Philippines. Policy Brief, December 2007. First in a series on tropical forests and climate change adaptation strategies.

World Bank. 2010. A strategic approach to climate change in the Philippines. Sustainable Development Department. East Asia and Pacific Region.

World Bank. 2008. Biodiversity, climate change, and adaptation. World Bank. Washington, D.C., USA.

World Bank. 2006. An investment framework for clean energy and development: A progress report. World Bank. Washington, D.C., USA.

World Bank. 2006. Mountains to coral reefs. The World Bank and Biodiversity. World Bank. Washington, D.C., USA.

World Bank. 2006. Scaling up marine management: The role of marine protected areas. World Bank. Washington, D.C., USA.

Yohe, G. W., Lasco, R. D., Ahmad, Q. K., Arnelli, N. W., Cohen, S. J., Hope, C., Janetos, A. C. and Perez, R. T., 2007. Perspectives on climate change and sustainability. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M. L. Parry, O. F. Canziani, J. P. Palutikof and P.J. Van der Linden and C. E. Hansin (eds). Cambridge University, Cambridge, UK.

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