Compendium of Climate Change Vulnerability and Impact Assessment Tools

CLIMATE CHANGE COMMISSION · PHILIPPINES ·

Imprint

The Climate Change Commission, which is attached to the Office of the President of the Philippines, is an independent and autonomous agency with the same status as that of a national government agency. It is the lead policy-making body of the government tasked to coordinate, monitor and evaluate the programs and action plans of the government relating to climate change. It has formulated the National Strategic Framework on Climate Change (NSFCC), and the National Climate Change Action Plan (NCCAP).

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Inventory of Methods for Adaptation to Climate Change Project – GIZ-BMU

Responsible at CCC
Climate Change Office
Rm. 238 Mabini Hall
Malacañang Compound
San Miguel, Manila
Phone: +63 2 735 3069
Email: info@climate.gov.ph
www.climate.gov.ph

Responsible at GIZ
Support to the Climate Change Commission in the
Implementation of the NFSCC and the NCCAP Project
9th Floor PDCP Bank Centre
Rufino corner Leviste Streets, Salcedo Village
1227 Makati City, Philippines
Phone: +63 2 651 5100
www.giz.de

Author
Dr. Tonie O. Balangue

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Abbreviations

ADAPT	Adaptive, Dynamic, Active, Participatory, and Thorough Principles
ADB	Asian Development Bank
Agsys-VACA	Agricultural System Vulnerability and Adaptive Capacity Assessment
AMICAF	Analysis and Mapping of Impacts under Climate Change for Adaptation and Food Security
ARG	Automated rain gauges
ASLR	Accelerated sea level rise
AVVA	Aerial Video-assisted Vulnerability Analysis
B+WISER	Biodiversity and Watershed Improved for Stronger Economy and Ecosystem Resilience Project
BFAR	Bureau of Fisheries and Aquatic Resources
CALABARZON	Cavite, Laguna, Batangas, Rizal, and Quezon
CBDRM	Community-based Disaster Risk Management
CCA	Climate change adaptation
CCC	Climate Change Commission
CCIM	Climate Change Impact Model
CDRMO	Community Disaster Risk Management Organization
CENRO	City Environment and Natural Resources Office
CEP	Coastal Environmental Program
CGSD	Coast and Geodetic Survey Department
CI	Conservation International
CIS	Climate information services
CIVAT	Coastal Integrity Vulnerability Assessment
CLUP	Comprehensive Land Use Plan
CSO	Civil society organization
CVCA	Climate Vulnerability and Capacity Analysis
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
DENR	DENR – Planning and Policy Studies Office
DHI	Danish Hydraulic Institute
DOH	Department of Health
DOST	Department of Science and Technology
DPSIR	Drivers – Pressures – State – Impact – Responses Model
DRM	Disaster risk management
DRR	Disaster risk reduction
DSWD	Department of Social Welfare and Development
EBA	Ecosystem-based Adaptation
EEPSEA	Economy and Environment Program for Southeast Asia
EPZA	Export Processing Zone Authority
FAO	Food and Agriculture Organization
FishVOOLs	Fisheries Vulnerability Assessment Tools and System
FIVIMS	Food Insecurity and Vulnerability Information Mapping System
FSE	FORTRAN Simulation Environment
FSP	Fisheries Sector Program
GCM	Global climate model
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH

ICSEA-CChange	Integrated Coastal Sensitivity, Exposure, Adaptive Capacity for Climate Change
ICZM	Integrated coastal zone management
IDRC	International Development Research Centre
IMEH	Integrated Monitoring and Evaluation System for Health
IPCC	Intergovernmental Panel on Climate Change
IPCC – CZMS	IPCC – Coastal Zone Management Subgroup
IRMES	Intermediate Result Monitoring and Evaluation System
LGC	Local Government Code
M&E	Monitoring and evaluation
MCP	Mainstreaming and climate proofing
MDG-F	Millennium Development Goals Achievement Fund
MENRO	Municipal Environment and Natural Resources Office
MOSAICC	Modeling System for Agricultural Impacts of Climate Change
NEDA	National Economic Development Authority
NEDA-RDCS	NEDA – Regional Development Coordination Staff
NGA	National government agency
NGO	Non-government organization
NNC	National Nutrition Council
NOAH	Nationwide Operational Assessment of Hazards
OECD	Organization for Economic Cooperation and Development
PAGASA	Philippine, Atmospheric, Geophysical, and Astronomical Services Administration
PAWB	Protected Areas and Wildlife Bureau
PCCARRD	Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development
PENRO	Provincial Environment and Natural Resources Office
PHIVOLCS	Philippine Institute of Volcanology and Seismology
PIDSAR	Philippine Integrated Disease Surveillance and Response
PRECIS	Providing Regional Climates for Impact Studies
RBM	Results-based Management
RCM	Regional climate model
REECS	Resources, Environment, and Economics Center for Studies, Inc.
RESILIENT SEAS	Remote Sensing Information for Living Environments and Nationwide Tools for Sentinel Ecosystems in Our Archipelagic Seas
SEAMEO	Southeast Asian Ministers of Education Organization
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SLR	Sea level rise
TURF	Tool for Understanding Resilience of Fisheries
UKCIP	United Kingdom Climate Impacts Programme
UPLBFI	University of the Philippines – Los Baños Foundation, Inc.
USAID	United States Agency for International Development
VA	Vulnerability assessment
VIA	Vulnerability and impact assessment
WLMS	Water level monitoring stations
WMO	World Meteorological Organization

Executive Summary

Recognizing the Philippines' vulnerability to climate change, the Climate Change Commission (CCC), with support from the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), has launched several programs to make the Philippines readily adapted to whatever effects the changing climate will bring to the country. One of the important elements of their programs is the preparation of a compendium of climate change vulnerability and impact assessment tools which can be used by local government units in addressing climate change adaptation (CCA) and disaster risk reduction (DRR) concerns in their respective municipalities. It is envisioned that through this compendium, local governments will be able to integrate CCA and DRR to their respective comprehensive land use plans and physical development plans, among other plans at the local level, and be able to implement such plans with high hopes that climate change impacts and disasters will not bring damaging effects to lives, properties, public infrastructure, economic gains and present and future investments.

Each VIA tool is described according to the outline prescribed by the Global Project on the Inventory of Methods for Adaptation to Climate Change (IMACC).

The outline is composed of the contents:

a) approach/method/tool;

b) detailed description of methodological approach;

c) conditions of method application where stakeholders and institutional set-up (lead agency and others involved) and resources (personnel, expertise, funds, time); and

d) challenges, lessons and recommendations for future application where impact (how far did the application result in improvements in practice), resource intensity of method (need for data, expertise and other support), cost-benefit ratio (potential comparison with other approaches), and potential and recommendations for replication / integration (preferable application areas, conditions for successful application, integration into planning / budgeting processes etc.) were described.

The tools were then classified under thematic areas such as Vulnerability Assessments (VA), Mainstreaming and Climate Proofing (MCP), Monitoring and Evaluation (M&E), and Climate Information and Services (CIS)/Climate Impact Modeling for the users to have an easy grasp of what the tool is addressing. In all, the compendium registered 27 tools/studies in climate change vulnerability assessment and impact assessment developed or conducted by Filipino authors and eight (8) tools/studies developed in other countries.

Only those with published case studies in the web or reports available in some agencies were presented in the case study analysis using the IMACC format.

Introduction

Background

The Philippines is one of the highly vulnerable countries to climate change and its effects, such as floods, typhoons, heat waves, and droughts. Various sectors such as agriculture, coastal and marine, fisheries, forestry and biodiversity, terrestrial and marine ecosystems, health, water and coastal communities, and the human population are directly or indirectly affected by these changes. The productivity and outputs of the forestry, fisheries, agricultural, and marine sectors are altered and the livelihoods, especially of the poor, are put at risk. As many poor communities are located in hazardous areas, their lives are also at stake.

The Climate Change Commission highlights the importance of enhanced vulnerability and adaptation assessments towards achieving the objective of building the adaptive capacity of communities and increasing the resilience of natural ecosystems to climate change. As such, scoping all locally applicable regional and international vulnerability, impact and adaptation assessment tools that can be useful in assessing vulnerabilities of different sectors such as agriculture and fisheries, health and others is necessary.

The scoping and the compendium of vulnerability and impact assessment tools were guided primarily by the development thrusts set in the National Climate Change Action Plan 2011-2028, Philippine Development Plan 2011-2016 and other relevant sectoral plans (e.g. draft CC R&D Agenda).

Objectives

The primary objective of this endeavor is to inventory VIA tools developed in the Philippines as required by the Global Project on the Inventory of Methods for Adaptation to Climate Change (IMACC).

Methodology

The compendium was produced through research in the Internet of literatures on climate change vulnerability and impact assessment tools developed by expert in the Philippines and other countries. VIA tools developed by experts in the Philippines with case studies were the main contents of this compendium. These are presented according to the required outline of the global project on the Inventory of Methods for Adaptation to Climate Change (IMACC).

Each VIA tool is described according to: a) approach/method/tool; b) detailed description of methodological approach; c) conditions of method application where stakeholders and institutional set-up (lead agency and others involved) and resources (personnel, expertise, funds, time) where described according to information presented on the literiatures; and d) challenges, lessons learned, and recommendations for future application, where impact (how far did the application result in improvements in practices), resource intensity of method (need for data, expertise, and other support), benefit-cost ratio (potential comparison with other approaches), and potential recommendations for replication/integration (preferable application areas, conditions for successful application, integration into planning/budgeting processes, etc.) were discussed.

VIA tools with case studies developed in other countries were still retain in this report and are presented as annexes for further readings or references. The IMACC project may drop these studies if not needed. The reason why such studies were annexed to this report is to provide additional information to the Climate Change Commission for a wider reference of VIA tools.

These case studies were not included and described according to the IMACC format for two reasons: a) such studies were not based on Philippines conditions; b) lack of sufficient information where the IMACC outline is satisfied; and c) such studies in other countries may have been reported already in their respective IMACCs.

All the reports on the case studies as published focused on the usual report writing framework where project costs and duration were not reported and that the reports focused mostly on general description of the methodology missing a lot of detailed tasks, data used, and discussions of the results of the study focusing on the findings and recommendations. Also since most of the studies where project base and done for specific objectives, their impacts were not established due to lack of an M&E intended to follow-up their impacts. Because of this, the impacts presented in this report were initial impacts in terms of generating needed outputs of the study.

To augment the information generated from literature reviews, informal interviews were conducted to determine the project duration, project cost, benefits or impacts, and other information relevant to the report. Difficulties were encountered during the interviews. Majorities of the project leaders or staff were too busy and could hardly find time to answer our questions. Also since most of the studies were conducted long time before, some salient information cannot be easily recalled. Information on money matters are highly treasured and not shared perhaps for fear of possible misuse of information that is detrimental to contracting institutions. Furthermore, project personnel are only aware of the technical side of the project while the financial aspect is being handled by the respective accounting offices of the contracted institutions. Project spending by institutions cannot be divulged to others especially "outsiders" like us for reason of security. Impacts of studies are also difficult to ascertain because none of the VIA studies were followed up with M&Es that are supposed to measure the effectiveness and efficiencies of the VIA tools.

Due to the above reasons, BCR,[1] project budget and time spent were described qualitatively or in the case of project budget and time spent, such information were based on figures recalled by the project leaders and staffs and in some cases based on similar projects and past experiences of the author.

In the qualitative descriptions of the BCR of the VIA tools, the following assumptions were used:

a. Since there is no M&E yet of the project, it is difficult to estimate the benefits of the project from its impacts. Thus, the readily available basis for assessing the project's benefit is the potential savings expressed as a percentage of rehabilitation or development cost. The logic is that capturing the totality of the problem is realized when technology is used rather than purely dependent on manual method. In such situation, development cost is more accurate where savings become more achievable. The percentage of savings is based on expert's opinion.

b. Rather than comparing the VIA tool under evaluation to other VIA tools, this study opted to compare it with traditional manual methodology. This is due to the fact that each of the VIA tools presented were conducted under different objectives, situations of application, area scales, degree of methodology or processes, limitations and constraints, and assumptions. It is also difficult to translate the differences into common terms to make them comparable.

c. The point of comparison is always to or with a traditional manual methodology. Traditional manual approach is generally time consuming, laborious and inadequate in capturing the real situation of the study site. Most VIA projects are large in scope, extent and coverage where manual approach could hardly cover the same scope, extent and coverage with acceptable accuracy within a short period of time.

1 BCR and CBR are interchangeably mentioned in this report.

I Vulnerability assessment

I.1. Integration of Climate Change Responses in the Comprehensive Land Use Plans (CLUPs) using SimCLIM: The Case of Quinali Watershed, District 3 of Albay

I.1.a. Entry point into the adaptation process for method application

Albay is one of the provinces in Region 5, Southern Luzon that is within the path of annual typhoons and extreme climatic events. It is sitting within the periphery of Mayon Volcano, an active volcano. Typhoons and extreme rainfall had destroyed several sectors of the province hindering physical, social and economic development. As part of its effort to reduce the impacts of typhoons, extreme climatic events, and volcanic eruptions, the provincial government has implemented disaster risk reduction and climate change adaptation strategies (Cruz, 2010).

One of the important natural resources of the province is Quinali Watershed. It is a source of goods and environmental services that support the social, economic and environmental development of the province. To sustain the gains of the province of Albay and to maintain its growth under a climate change situation, the provincial government recognized the importance of integrating climate change responses to the comprehensive land use and development plan of Albay after testing it first in Quinali Watershed (Cruz, 2010).

The primary objective of the study by Cruz (2010) was to pilot-test the integration of climate change responses to the comprehensive land use plan of the Quinali Watershed. Its secondary objectives were to 1) conduct a vulnerability assessment of the watershed using a computer-aided tool known as SimClim; and 2) recommend climate change adaptation measures in the face of typhoons, extreme climatic events, and disasters that will be brought by the eruption of the Mayon Volcano.

According to Cruz (2010), the use of SimClim in conducting vulnerability assessment was introduced primarily among provincial and municipal land use planners and decision-makers in Albay, and members of the immediate community always affected during disasters. The same process was intended to be repeated in other provinces and municipalities in the country.

SimCLIM is used to describe baseline climates; examine current climate variability and extremes; generate climate and sea-level change scenarios; assess present and future climatic risks; assess present and future adaptation measures; conduct sensitivity analyses; examine sectoral impacts; examine uncertainties; facilities integrated impact assessments.

The tool contains custom-built GIS and can be applied spatially to any geographic area and spatial resolution, from global to local. It also contains site-specific tools for examining time-series climate data and driving site-specific impact models.

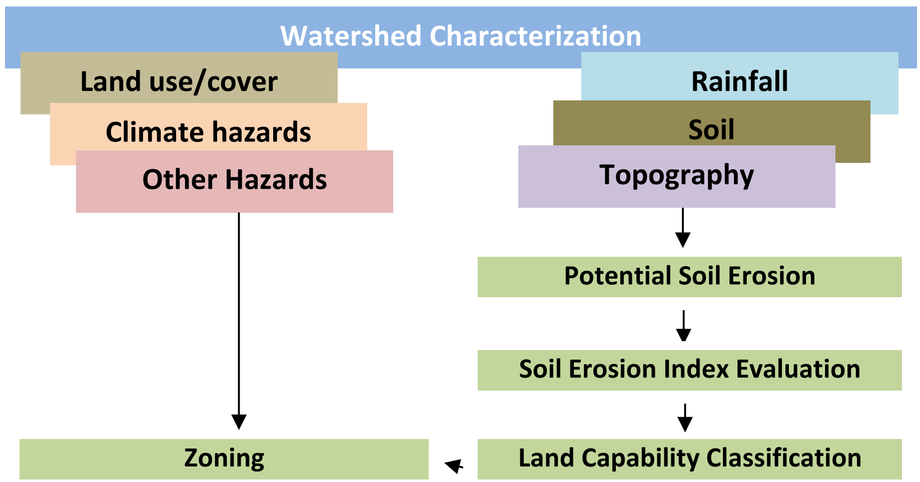


Figure 1. Framework of watershed characterization

I.1.b. The methodological approach

The general approach in a "bird's eye view" is reflected in the conceptual framework. The conceptual framework defined the activities and their inter-relationships with one another as well as the flows of inputs and outputs, information and responsibilities of the actors. The framework (Cruz, 2010) is shown in schematic diagram in the following section.

Inputs: Data and information used for the study

According to Cruz (2010), the major data inputs used in the study are:

1. Data on the current rainfall, temperature, and topography were key inputs in generating the projected rain induced landslide and drought hazard maps

2. Hazard maps, such as mean annual frequency of days with at least 100mm and number of days with maximum temperature of > 35° C

3. Slope map and digital elevation model- showing the different elevations and slopes in an area.

4. Land use map or land cover map –showing the different land uses and land cover.

5. Land capability map- shows the different land management units with classified land capabilities.

6. Existing land use and development plans –refers to comprehensive land use plans and comprehensive development plans.

Outputs of the study

Cruz (2010) enumerated the outputs of the study in map form are:

1. Projected rain Induced landslide map showing several areas that are potentially affected with rain induced landslides.

2. Adjusted drought hazard map –shows the potential areas affected by drought.

3. Soil erosion potential map – shows the areas that may be eroded given future climate change scenario

4. Soil erosion Index – soil erosion translated into erosion index.

5. Adjusted land capability zone map – shows the land capability zones adjusted due to the effect of climate change

6. Adjusted land use map – shows the adjusted land use map considering present period.

7. Adjusted development plan – adjusted by integrating climate change consideration.

8. Other related climate risk map – shows the areas classified as hazard areas or risk areas.

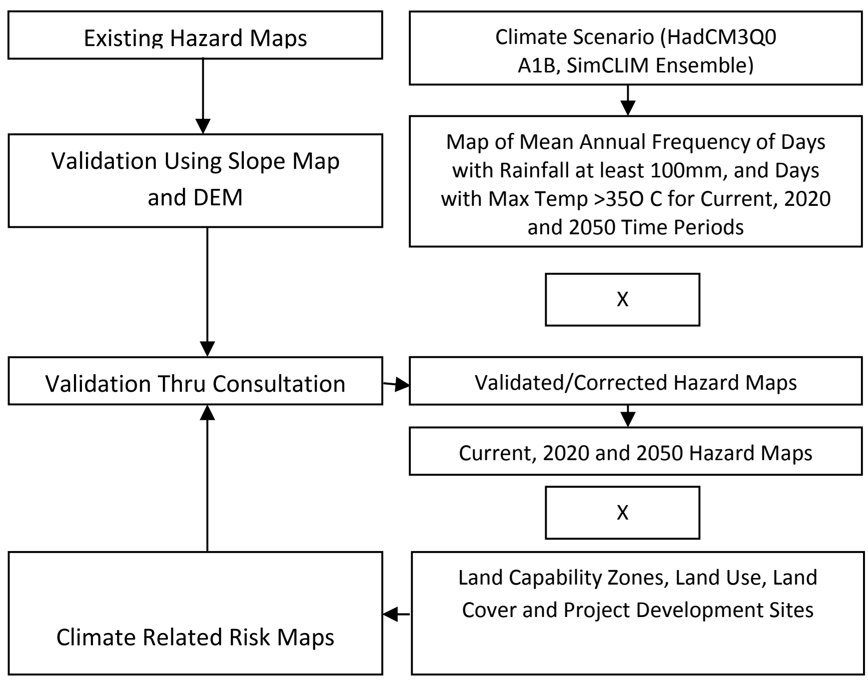


Figure 2. Framework of vulnerability assessment

Process of conducting the study

The activities conducted in the study are based on the integrated framework. According to the report of Cruz (2010), these activities are:

1. Review and updating of all maps about the watershed, particularly land use, land cover maps, topography map (slope map). Updating means integrating on the same maps, the most recent developments in the area capturing all that have changed from the time the maps were originally prepared to the present time. The easiest way to capture the changes is by using the most recent satellite data of the area, doing land over classification analysis and validating this on the ground or by surveying new developments on the ground and adding them into the maps.

2. Review and updating of hazard maps, land capability maps, project development plans. The same process in no. 1 but focused only to hazard maps, land capability maps, and development plans.

3. Projection of climate change indicators (rainfall, temperature, relative humidity) for 2020 and 2050) Given a historical data on the climate change indicators, future values of such indicators are projected to designated periods through the use PRECIS of SimClim.

4. Assessment of the impacts of climate change. Given the future climate change indicators, what would be the effects of these to the hazards, land capabilities, soil erosion, etc.? These are simulated through the use of SimClim.

5. Updating of hazard maps based on the climate change impacts. Projected impacts of climate change are reflected on the hazard maps.

6. Creation of hazard zone maps and non-hazard zone maps. From the updated hazard maps, all are consolidated into one map containing both the hazard zone areas and the non-hazard zone areas.

7. Estimating soil erosion and creation of soil erosion map. Based on projected rainfall under a climate change scenario in the future, how much soil erosion is affected. From these, the different degrees of impact of soil erosion are mapped.

8. Transforming soil erosion map into an erosion index and coming up with a map for soil erosion index

9. Creating the land capability map based on the soil erosion index. On the basis of soil erosion index, the land capability maps are drawn.

10. Preparing or updating the comprehensive land use plan based on the land capability map. On the projected land capability maps, the comprehensive land use plan is prepared considering the impacts of climate change scenarios.

11. Drawing of hazard maps, hazard zone map, soil erosion index, land capability maps for 2020 and 2050, and integration of these to the 2020 and 2050 comprehensive land use plans.

I.1.c. Conditions of method application

For the basic functions, little training is required for users familiar with climate science. Training is advisable for users with limited background in climate change or for those who wish to gain experience with the full functionality of the system.

Stakeholders and institutional setup

The lead agency that spearheaded the implementation of the project was the Provincial Governor Office of Albay, Region 5 in coordination with the UPLB College of Forestry and Natural Resources. The Project was headed by provincial governor. The regional national government offices that collaborated in the implementation of the project were the DENR Region 5, DA Region 5, DAR Region 5 and the MLGU that has jurisdiction over the Quinali watershed.

Resources

The important resources used in the study were:

a. Computer system with GIS capability
b. GIS maps of the watershed
c. SimCLIM software
d. Expertise: Watershed Management Specialist, GIS expert, GPS Surveys and Validation Expert, Research Assistant

Duration and estimated funds used in the conduct of the study

In order to achieve the major objectives of the project, a total duration of 12 months was spent.[2] Originally, the duration was set at 6 months but based on actual phasing due to some necessary adjustments brought by updating of data through actual on-site validation which were restricted by weather, the duration was extended to one year. The project was conducted long time ago which makes it difficult for the Project Leader to recall the specific duration and cost of the different project activities. He added, however, that the since most of the maps on the Quinali watershed were already prepared in digital format, it saved them a lot of time in preparing much needed information in digital form.

Accordingly, it took them 12 months to complete the study. Approximately the project fund was apportioned into project staff salaries (49.66%) and the rests for maps validation, travel and transport rental and computers for GIS mapping.

For a watershed which has already most of the information in digital form with the least updating and validation work, the duration and cost of vulnerability assessment entails a total duration of 1 year with a total cost of about PhP1.0 - PhP1.7 million depending on the availability of secondary data.

I.1.d. Challenges, lessons learned, and recommendations

Impact of the project

The result of the vulnerability assessment guided the local government units and the DENR region 5 in the rehabilitation of degraded portions of the Quinali watershed considering that it is an important watershed that provide water for irrigation, domestic water supply to communities and water for industrial uses. Most of the vulnerability maps were used in the preparation of watershed development and management plan for the Quinali watershed.

Resource intensity of method

According to the Project Leader, the available data in digital form were sufficient in achieving the project objectives. Likewise, SimClim is a powerful tool that merged climate change projection capability and GIS capability all in one software. The use of high resolution satellite data is wanting but not necessary.

2 Based on interview with the Project Leader, Chancellor Rex Cruz, UPLB.

Technical people who are knowledgeable on watershed management, climate change, watershed planning are not that many in the region but there are several at the national level. Each municipality or city is advised to develop a team whose main function is to conduct vulnerability assessment to give clear direction to development planning and land use planning.

Cost-benefit ratio

Comparing the method with conventional approach of vulnerability assessment in watershed shows that conventional methods are time consuming and the chance of getting errors is very high because there is no way that the whole perspective of changes in the watershed can be viewed or assessed totally on the ground. In the method used in the study, the use of digital maps which are generally products of satellite data with adjustment on the ground, it is easy to map changes on the ground. Thus, a bird's eye view of the totality of the watershed is attainable with the techniques used in the study. Thus, there is more accuracy on the data and information gathered through the method used compared to data generated through ground surveys.

While the initial investment of procuring SimClim is high plus the cost of using it, it would be more beneficial in the long-run. On this basis, the method used in the study would have higher ratio in favor of benefit than cost. Also, by reducing data gathering errors on the ground, the cost of site development would be cheaper because repetitive activities would be eliminated. Thus, savings which could be used for funding similar activities in other watersheds would be high, thus, beneficial to the province. Approximate benefit cost ratio would be 1.5 to 1.7.

Potential and recommendations for replication or integration

The province that commissioned the study has envisioned the total mainstreaming of climate change and DRR to its development. In fact the leadership was recognized as the first provincial leader who initiated integration of climate change and DRR concerns in its institutional activities to benefit its constituents.

The process has been recommended by the project management to integrate it in the comprehensive land use planning and comprehensive development planning of the province as well as the regional office of the DENR and use the same process in other watersheds within the region.

For the other municipalities in the province and DENR Region 5, a memorandum order requiring their respective planning units to apply the process is necessary.

I.2. Vulnerability and Adaptation Assessment to Climate Change (CC) and Sea Level Rise Using SimCLIM/AlbayCLIM: Case Study in Selected Areas in Albay

I.2.a. Entry point into the adaptation process for method application

AlbayCLIM is a modified version of SimCLIM on which municipal planning development officers in Albay were trained.

I.2.b. The methodological approach

The situation of Albay under climate change is similar to what has been described in the case study on watershed conducted by Cruz (2008). This study on the other hand, focused on the province's coastal municipalities. Similar with other coastal areas in the country, these areas are in the frontline facing typhoons, sea level rise, and storm surges affecting mostly the fishermen in the community.

In line with the goals of the Philippine's National Framework Strategy on Climate Change, (NFSCC), the study aimed to assess the vulnerability of coastal municipalities and the resiliency of natural ecosystems in Albay (Pulhin, Cruz, & Ulrich, 2009).

Finally, the capacity of coastal communities to adapt to climate change was further improved through their active participation in the process of vulnerability assessment and formulation of climate change adaptation strategies.

The beneficiaries of the study were the coastal area communities, the local planners and project implementers.

Pulhin, Cruz, & Ulrich (2009) adopted a framework which integrated participatory approach, rapid rural appraisal, stakeholders' observations, and physical vulnerability assessment based on exposure. Climate change impact modeling was aided with SimClim. The study covered both the impacts of present and future climate change scenario to enable the coastal communities identify and implement the most effective adaptation strategies. The adaptation policy framework in identifying strategies is presented in the following section.

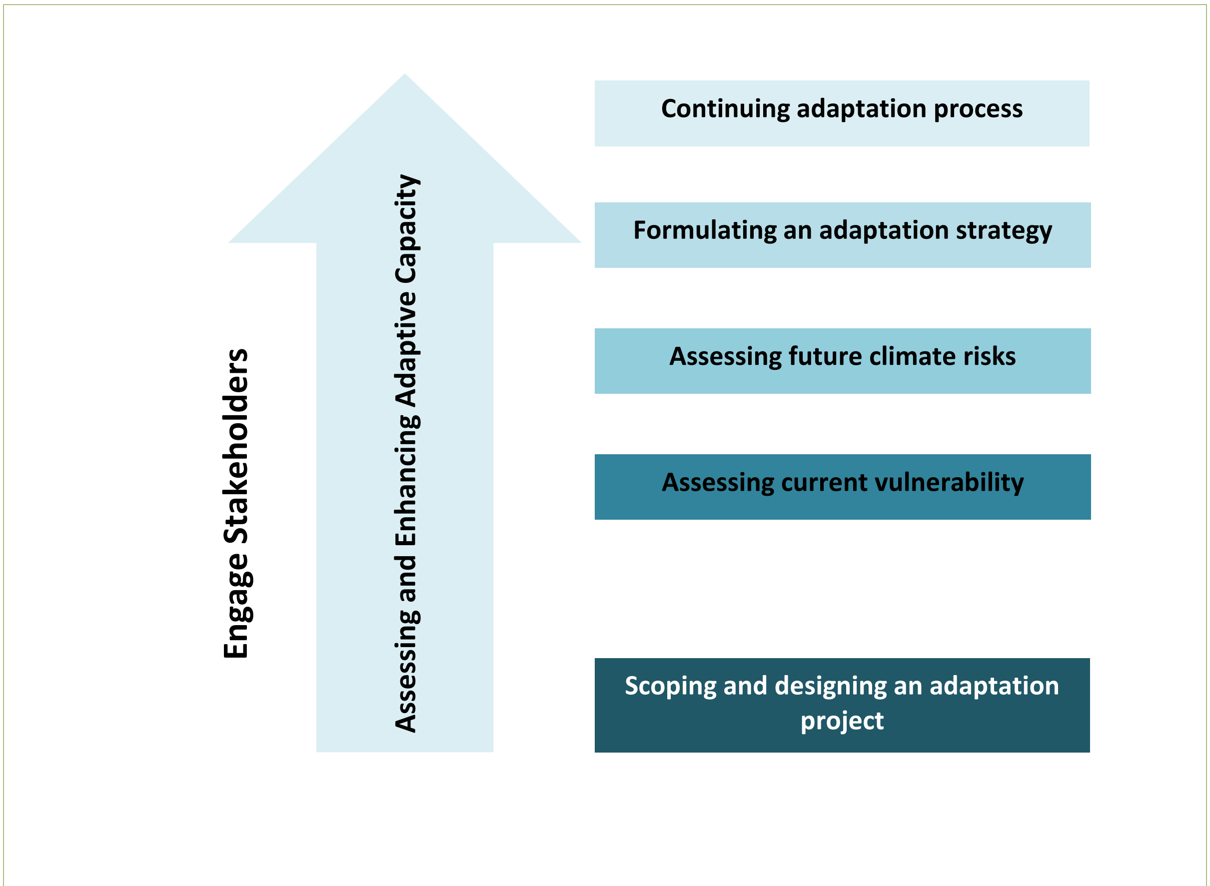


Figure 3. Adaptation policy framework

Source: Pulhin, Cruz and Ulrich, 2009

Inputs: Data and information used for the study

According to Pulhin, Cruz, & Ulrich (2009), the activities and data as key inputs to the AlbayClim included the following:

1. Field reconnaissance. This activity was necessary to have an on-ground observation on what and where the vulnerable areas that were affected by climate change.

2. Secondary data. These data were used as benchmark where the present data were compared. The benchmark or baseline data used were the 1990 precipitation data and mean temperature data.

3. Key informant interview. This activity was conducted to know from the key people of the project sites their observations on the changes in climate and people areas that were hardly hit or affected. Results were inputted into the AlbayClim process.

4. Participatory rural appraisal (PRA) techniques (i.e., FGDs, community mapping, etc.). This involved the people in the affected community where all observed locations of environmental attributes and their conditions were characterized. Results were also inputted into the AlbayClim process.

5. Household survey. This activity was conducted to determine from the households their socio-economic standing, the climate change mitigation or adaptation practices that they implemented during the times of typhoons and other climate change extreme events. Results were inputted into the AlbayClim process.

6. Climate change and sea-level rise scenarios generated using AlbayClim.

Outputs of the study

With all the above data as inputs into the AlbayClim process, the study by Pulhin, Cruz, & Ulrich (2009) produced:

1. Socioeconomic characteristics of the respondents;
2. Biophysical characteristics;
3. Impacts of climate variability and extremes (Agriculture, Forests and Water);
4. Impacts of climate variability and extremes (Health, Properties, Equity, etc.);
5. Adaptation to impacts of climate change; and
6. Future adaptation strategies in San Antonio and Bogtong (Agriculture, Forests and water)

The findings of the vulnerability assessment are presented in the following sections.

Coastal communities

The coastal communities in study sites that were exposed to sea-level rise, typhoons, and storm surges include the following:

In Poblacion 1, Cagraray and Cawayan communities

1. The major livelihood of the residents in these areas affected due to sea level rise were fishing and farming.

2. Forty (40) percent of the 124 survey respondents from Poblacion 1 and Cawayan believed that sea-level is rising in their coastal areas.

3. The impacts of typhoon with storm surges in the coastal communities by sectors were:

   a. On water supply, damage to water pipes and poor water quality
   b. On human health - prevalence of water-borne diseases and flu
   c. Agriculture - washed out crops

d. Fisheries - destruction of fish gears and fish cages, fishing boats
e. Human settlement - destruction of properties and houses

4. Brgy. Cagraray which was protected by mangroves was not affected.

5. Impacts of floods (associated with storm surges, extreme precipitation and runoff) involved the following:

   a. Water Resources - Damage to water pipes; poor water quality;
   b. Human Health - Prevalence of water-borne diseases and flu;
   c. Fisheries - Damage to boats, fish gears and other equipment;
   d. Agriculture - Increased salinity of water in rice fields; Washed out crops;
   e. Human Settlement - Destruction of houses; and
   f. Mangroves - Uprooted mangroves.

Given the above impacts, the adaptation strategies implemented in the barangays were:

- Current Adaptation Practices

  1. Water Resources - Boiling of water
  2. Agriculture - Timing of planting/harvesting activities
  3. Human Health - Provision of medicine, immediate response, monitoring
  4. Fisheries - Boat repair, loans, securing boats before typhoon, finding alternative livelihood
  5. Tourism (boat rental), Boat reconstruction; loans
  6. Human settlement - House reconstruction (concrete and elevated); loans; evacuation of people, livestock and properties before typhoon comes; riprap reconstruction/seawall
  7. Mangroves - Pruning activities before typhoon; reforestation

- Future Adaptation Strategies for Brgy. Poblacion

  1. Medical preparedness
  2. Shrimp breeding
  3. Natural fishing
  4. Limit development in mangrove areas
  5. Strict enforcement of regulations

- Future Adaptation Strategies for Brgy. Cagraray

  1. Population Control
  2. Construction and operations of Health Center with doctors and medicines
  3. Relocation of affected population to higher grounds to avoid sea level rise and floods
  4. Planting of more mangrove species along deforested mangrove areas
  5. Filtration of water for households
  6. Development of other water sources
  7. Boiling water
  8. Gradual adjustment or conditioning of fishermen to the effects of sea-level rise
  9. Construction of a higher and longer sea wall (2m high and 100m long)

Upland communities

On the other hand, the upland communities have difficulty in recognizing the impacts of sea level rise and storm surges because they have no prior experience of the effects. Their adaptation measures focus more on soil erosion and landslide measures to minimize the impacts of heavy rains during typhoons.

Process of conducting the study

According to Pulhin, Cruz, & Ulrich (2009), the vulnerability and adaptation assessment case studies in Albay comprised the following activities:

1. Team mobilization, identification of data needs and data collection;

2. Customization of SimCLIM modeling system for the province of Albay and was named AlbayClim, including:

    a. Description of baseline climate;
    b. Examination of current climate variability and extremes;
    c. Assessment of present and future risks;
    d. Investigation of present and future adaptation;
    e. Projection climate and sea-level change scenarios;
    f. Conduct of sensitivity analyses;
    g. Projection of impacts from climate and sea level change;
    h. Examination of risks and uncertainties; and
    i. Analyses of integrated impacts.

3. Conduct of climate change concepts and use of SimCLIM;

4. Assessment of actual impacts, vulnerability and adaptation; and

5. Dissemination of the assessment results.

I.2.c. Conditions of method application

As described in the process of conducting the study, SimCLIM was customized according to the context of Albay. Municipal development planning officers were trained for this project.

Stakeholders and institutional setup

This is similar to the first study on SimClim. The lead agency was the Provincial Governor Office of Albay, Region 5 in coordination with the UPLB College of Forestry and Natural Resources. The Project was headed by the provincial governor. The regional national government offices that collaborated in the implementation of the project were the DENR Region 5, DA Region 5, DAR Region 5 and the MLGUs that have jurisdiction over the study site.

Resources

The important resources used in the study were:

a. Computer system with GIS capability
b. GIS maps of coastal areas
c. SimCLIM software
d. Expertise: Sociologist, GIS Specialist, Research Assistant

Duration and estimated funds used in the conduct of the study

This study was a parallel project component of the Quinali watershed SimClim application. This was applied in the coastal areas of the province of Albay. The study was conducted in a one year period. There is no information on the exact total project cost. The estimate of this report is that the budget was within the neighborhood of the budget of the Quinali watershed study. Since the project involved KIIs, FGDs and household surveys, it is estimated that the project cost was higher by about 200,000 to 300,000 over that of the Quinali watershed project. Also, the extent, scope and coverage of the project was larger than the watershed vulnerability assessment project.

I.2.d. Challenges, lessons learned, and recommendations

Impact of the project

The project taught the people in the study sites in Albay on the importance of preparing themselves in any events of disaster related to climate change. They were also trained on how to become resilient to disasters by teaching them how to formulate and implement suitable adaptation measures especially those that will ensure the sustainability of their livelihood.

Resource intensity of method

The method used in the project relied mostly on social surveys where information on climate change vulnerability came directly from the people who are at the forefront of disasters. Since they are directly affected, any remedial measures or solutions must be within their capacities instead of relying from the government. Making all the people capable of adapting themselves to climate change to minimize human mortality and damage to property is perhaps one of the ultimate objectives of governance.

To support the process used in the project, the barangay officials may be empowered technically on the conduct of social survey, vulnerability assessment, climate change, and concerns to reduce risks due to disasters brought by climate change and other forms of hazard. Improving their skills along these fields would reduce their dependence from highly trained technical people. This may be attained by training the community officials and some volunteers in the barangays.

Cost-benefit ratio

Strengthening the capability of community officials nationwide and institutionalizing the process of a people-based climate change vulnerability and adaptation assessments will save substantial amount from the budget of all the barangays in the long-run. The savings will not only come from the barangay annual budget but also from potential savings from the livelihood of the people as well as from businesses in the communities. By preparing the people in the event of extreme climate events or hazards, damage to human lives, properties, infrastructure and the environment would be minimized. Thus, the benefit of the method would come from avoided damages, savings of LGUs and savings from the livelihood of the people and businesses in the community. Approximately, the ratio would be more benefits than costs.

Potential and recommendations for replication or integration

Pilot test the method in other areas probably one in Northern Luzon, one in the Visayas and another one in Mindanao. Areas recommended for piloting the project should have both upland and coastal settings and with or without IEC on climate change. This is important to assess the perceptions of the people in both coastal and upland communities and also from those with or without knowledge on climate change. Furthermore, the evaluation on the acceptability of the process of climate change vulnerability and adaptation assessments by the people must also be established to have a basis for recommending it to the LGUs nationwide. Results of the piloting would support budgeting and institutionalization of the process.

I.3. Laguna Lake Basin Climate Change Vulnerability Assessment: A GIS Approach

I.3.a. Entry point into the adaptation process

Typhoons and monsoon rains batter the Philippines several times a year. Stronger typhoons and other extreme climatic events cause devastating damages to communities, infrastructures, food production areas, displacement of families and death of people. To minimize adverse effects of typhoons and extreme climate events in the future, the vulnerability assessment of areas along typhoon path should be known to help government and communities to prepare in case typhoons will come again (REECS, 2009).

The study was conducted in the Laguna Lake Basin. The basin is surrounded by communities and it supports human communities, inland fishery, water production, rice production, electric power generation, and tourism. Unfortunately, the basin is a favorite stopover of most typhoons that passed through central Luzon.

Given the large area coverage of the typhoons and floods, ground assessment approach was impractical considering time and fund constraints. The fastest and least costly approach was to combine simulation, GIS, ground truth method, and experts' and stakeholders' observations.

The study defined vulnerability assessment as the process of identifying which attributes of the basin, aided through GIS, are exposed or at risk to the hazards and impacts of climate change factors such as rainfall, temperature, wind speed and direction and temperature resulting in the reduction of the optimal capacity of the basin's attributes in performing intended functions. It treated sensitivity and adaptive capacity as external factors rather than as integral determinants of the vulnerabilities of the basin.

Economics of climate change impacts, as defined in this study, is limited to the damage cost on the basin attributes due to flood, temperature increase and wind speed.

The main objectives of the study were 1) to assess the vulnerability of the different sectors or attributes of the Laguna Lake Basin, and 2) to inform MLGUs around the Laguna Lake on the potential hazards that may come in the future to the communities within the context of climate change. The secondary objectives were 1) to estimate the economic damage of typhoons, and 2) to formulate adaptation measures to be recommended to the leaders of the MLGUs.

The study was intended for the planners, MLGU government, and environmental and natural resources managers of the Laguna Lake Development Authority, the DENR, and to the vulnerable sector of the population in the different lake-side municipalities.

I.3.b. The methodological approach

The study was guided by the conceptual framework presented in the figure below.

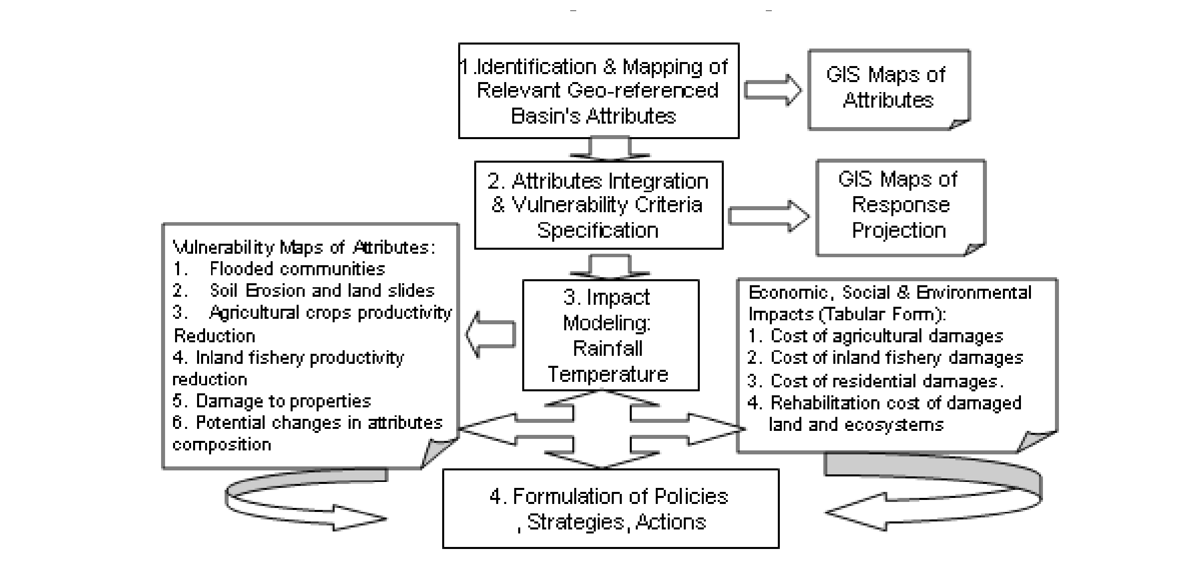


Figure 4. Conceptual framework of the Laguna Lake basin vulnerability assessment study

Source: REECS, 2009

Inputs: Data and information used for the study

Basic digital data on the administrative boundaries of the municipalities in the basin, drainage network, land cover/land use, topography/contour, elevation, slope, and soil type were mapped using GIS. Climate change data such as rainfall, wind direction, speed, and temperature from 1979 to October 2007 were sourced from the Agromet Station of the Rice Research Institute in Los Baños, Laguna. The typhoons in 1970 to 2006 that hit the area were characterized in terms of rainfall, and wind direction, and wind speed. From these typhoons, rainfall data were correlated to flooded areas defined by their elevations.

Which areas will suffer most if in the future the same or even more typhoons and extreme climatic events with higher magnitudes will hit the Laguna Lake Basin? To aid decision in identifying vulnerable areas, the science-based physical responses of the basin attributes on climate change parameters were used as criteria. These are:

1) Drainage network and slopes to establish potential vulnerability to landslides.

The criteria for determining vulnerability classes are:

Criteria	Class
Slope 0-18%, high drainage density	Low vulnerability
Slope 18-50%, medium drainage density	Medium vulnerability
Slope >50%, low drainage density	High Vulnerability

Source: REECS, 2009

2) Slope and land cover to establish potential vulnerability to soil erosion

Criteria	Class
Slope 0 – 18%, high density forest	Low vulnerability
Slope 18-50%, young forest plantation, coconut and fruit-tree plantations	Medium vulnerability
Slope >50%, grassland, agriculture, residential	High vulnerability

Source: REECS, 2009

3) Drainage network and elevation to establish potential vulnerability to flooding

Criteria	Class
Elevation >30m, high drainage density	Low vulnerability
Elevation 10-20m, medium drainage density	Medium vulnerability
Elevation 0-10m, low drainage density	High vulnerability

Source: REECS, 2009

4) Land cover and temperature to establish potential vulnerability to increases in temperature

Criteria	Class
Forested, temp: 27-29 degree Celsius	Low vulnerability
Agriculture, temp: 29-32 degree Celsius	Medium vulnerability
Built-up areas, Central Business District, temp: 33-37 degrees Celsius	High vulnerability

Source: REECS, 2009

Based on the rainfall of typhoons, the relationships of rainfall to flooded areas defined by elevation were translated into equations to be used in simulating the potential area coverage of flood of the affected areas.

1) Rainfall

TAF = f(R, T, A, D)

Where: TAF = Total area flooded
R – is rainfall reading
T – time of rainfall
A – total area affected by rainfall
D – natural flood draining rate (time)

2) Temperature

T = f(LC, BD, At)

Where: T – temperature
BD – density of built-up area
LC –land cover or land use,
At – area affected by temperature t

These impact models were applied to predict areas or attributes at risk or affected in case climate change variables exceeded normal ranges.

Outputs of the study

1. Vulnerability to flood at 78mm rainfall[3]

The total area flooded by province is shown below.

Province	Hectare	% Area
Metro Manila	16,469	31
Cavite	7,622	14
Laguna	21,102	39
Rizal	8,570	16
Total	53,764	100

Source: REECS, 2009

2. Vulnerability to flood at 382mm rainfall

Province	Area (Ha)	% Area
Metro Manila	31,541.76	31
Cavite	19,259.87	19
Laguna	36,531.89	36
Rizal	13,969.29	14
Total	101,302.81	100

Source: REECS, 2009

3. Vulnerability to wind direction and speed

Metro Manila and the coastal municipalities of Cavite are highly vulnerable to wind. The areas with medium vulnerability are the municipalities of Laguna and Rizal that are close to the edge of the lake. The areas with low vulnerability are the municipalities of Rizal, Laguna, and Cavite that are covered by the mountains located at the northeast to mid-east, south to southeast, south and southwest of the basin, respectively.

4. Vulnerability to temperature increase

The hotter places in the basin are the central business districts, commercial centers, residential areas, and other places that were already covered with concrete structures in Metro Manila, Laguna, Rizal and Cavite.

Metro Manila has a maximum temperature range of 33 to 38 degrees. Portions of Cavite and Rizal province have 29 to 32 degrees. The temperature of portions of Rizal, Cavite, and Laguna ranges from 27 to 29 degrees Celsius.

The low summer temperature in the provinces of Laguna, Rizal, and Cavite is attributed by the relatively wider space of vegetation compared to housing and commercial density in these areas, existence of agroforest and forest ecosystems in Laguna and Rizal, and high elevations of most municipalities in Cavite, Rizal, and Laguna.

5. Rainfall impact on soil erosion

Based on the soil erosion map, the corresponding soil loss deposited to the lake annually is 100.6 million tons a year. On the average, the soil loss per hectare per year is 211.23 tons. This is equivalent to 0.58 ton per day. With high rainfall at 382mm, soil is doubled from 12 million tons of soil loss to 27.17 million tons of soil loss.

3 The definition of flood is any area on the land surface of Laguna Lake basin under water with a depth of more than 30cm receding within 2 hours or more.

6. Impact of wind speed to forest ecosystem

Twenty-one percent of Mt. Makiling forest ecosystem was destroyed by the typhoon with the highest wind speed.

7. Potential impact on rice production of temperature increase

During dry cropping season, the increase in temperature brought a 10% decline of grain yield for every 1 degree Celsius increase in temperature in growing season-minimum temperature in the dry cropping season. This would bring down rice yield in the rice farm areas of Laguna, Rizal and Cavite by 10%.

8. Potential flood impact to population

The total population affected ranges from 10-12 million households and vulnerable.

9. Potential temperature impact to population

In terms of impact of temperature increases to the electricity users in Metro Manila, 92.7% of the household population is expected to have increased electricity consumption during summer with corresponding increase in electricity bills. Increase in electricity consumption means increase in the Carbon Dioxide being emitted to the atmosphere contributing to global warming and climate change.

10. Household income losses based on diverted man-days to cleaning household premises after flood.

The economic losses from the standpoint of the residents are also very high measured in terms of forgone man-days, which should have been used in earning daily wage for the households. Clearing the silt and water deposited inside houses and putting things[4] in order again in the house during typhoon "Milenyo" consumed a maximum of 5 days. The losses of the households in terms of wages are PhP 773 million for the 76mm rainfall to PhP 3.3 billion for the 459mm rainfall.

11. Cost of crop damage due to flooding and strong wind

The costs range from a total of PhP 897 million at 76mm rainfall to PhP 8.6 billion at 459mm rainfall. There are no known areas in Metro Manila that are being cultivated for rice production. Thus, no costs of crop damages were computed. Among the provinces inside Laguna Lake basin, the hard hit in terms of costs of crop damage is the province of Laguna.

12. Cost of palay yield reduction due to temperature increase

The loss for 2 cropping season would amount to PhP 181 million in present value of total revenue from the rice production areas in Laguna, Rizal and Cavite. This assumes that the 2 cropping seasons suffer El Niño.

It is estimated that climate change will have a minimum partial damage cost of PhP 101.6 billion annually considering one strong typhoon and 1 degree Celsius increase in temperature. Its net negative economic impact is PhP 93.7 billion a year. This estimate is a conservative one considering that there was substantial number of climate change impact indicators that were not quantified due to financial and time constraints.

Process of conducting the study

The methodology used in the vulnerability assessment was guided by the conceptual framework. Presented in the methodology are the specific activities conducted in the study. The major processes are:

4 Electric appliances, furniture, books and other household valuables damaged during typhoons were not quantified, therefore excluded in this study.

1) identification and mapping of relevant geo-referenced basin's attributes; 2) attributes integration and vulnerability criteria specification; 3) Impact modeling; and 4) formulation of adaptation and mitigation policies, strategies and actions.

The process is composed of the following activities:

1. Mapping all the basin's attributes using GIS.

   The basin's attributes are topographic divide or the boundary of the basin, vegetative cover, land cover, land uses, drainage network, elevation and slope.

2. Mapping the areas affected by typhoons, floods

   All areas affected by typhoons, floods in the basin.

3. Mapping the areas affected by temperature increase.

   All areas affected by temperature increase.

4. All the maps of the basin's attributes and the areas affected by typhoons were overlaid to identify flooded areas

   All the maps in no. 1 are overlaid with the flooded areas to determine extent of flooded areas to different basin's attributes.

5. All the attribute maps were overlaid with wind direction and speed map to determine the vulnerable areas.

   The basin's attributes are topographic divide or the boundary of the basin, vegetative cover, land cover, land uses, drainage network, elevation and slope.

6. All the attribute maps were overlaid with the temperature map to determine the vulnerability of the basin attribute to temperature increases

   The basin's attributes are topographic divide or the boundary of the basin, vegetative cover, land cover, land uses, drainage network, elevation and slope.

7. Simulation of floods using different rainfall levels of typhoons that passed through the basin.

   a. Typhoon rainfall (mm) = Flooding of a given range of elevations.

8. Calculation of social and economic impacts: a) areas affected and population temporarily displaced during flood and increase in temperature; b) NCR 2007 electricity consumers affected by increases in temperature (other electricity users35 in populated areas of Laguna, Rizal and Cavite were not included due to lack of resources; c) loss of lives and destroyed properties36; d) number of population that were affected with health-related problems37 due to flood and temperature increase in the municipalities in the basin. Potential economic impact indicators used were: a) foregone wages of working population affected during flood; b) increase in cost of electricity during summer38; c) cost of medical treatments39 of population affected by health-related problems due to flood and increase in temperature as well as cost of eradicating the source of health-related problems; d) food production areas affected by flood and cost of crops damaged; e) decrease of rice production and value due to temperature increase; and f) inventory of trees knocked down in the Makiling Forest during typhoons and the value of damaged trees.

I.3.c. Conditions of method application

There is no difficulty in mapping and overlaying the attributes. Mapping can be done manually or through the use of computer with GIS and in impact modeling can be done manually or statistically using computer with excel or statistical software.

In terms of required capacity, any BS graduate familiar with mapping watershed attributes and estimation of CC indicator impacts can properly carry out this approach. If mapping is computerized, training on computer operations and use of GIS is necessary.

The other lessons learned during the conduct of the study are a) climate change vulnerability assessment can be achieved as a social responsibility of concerned private firms through sharing of cost and expertise. If government can provide the GIS maps free of charge then there would be a substantial reduction in the cost of climate change vulnerability assessment project; b) during the presentation of the results of the study to the LGUs, it seemed that the LGUs have no realization on the importance of climate change vulnerability assessment. Thus, an appreciation seminar may be conducted to introduce to them the benefit of having this activity as a requirement for any development plans of their province or municipality and as a tool and its results as inputs to the preparation of comprehensive land use and development plans; and c) anticipated impacts of climate change are known ahead of time giving ample time for the formulation and implementation of adaptation measures.

Stakeholders and institutional setup (lead agency and others involved)

The study was conducted out of the social responsibility of the firm to contribute to environmental management and sustainable development within the context of a lake basin under a climate change condition. It demonstrated the sharing of resources between the company and its manpower to come up with a methodology that would help LGUs in the conduct of climate change vulnerability and adaptation assessment.

Resources

There was only few project staff that conducted the study. The team leader's expertise is forestry with sufficient experience in watershed planning and management and with a working knowledge in resource economics and mapping. He was assisted by a GIS specialist who did most of the overlaying and finalization of maps. The fund that financed the project came from the Resources, Environment and Economic Center for Studies. The project was dependent on digital maps, GIS software, computers and peripherals.

Time and cost used in the conduct of the study

The project duration was 240 days effective work time with a total paid out cost of PhP109, 000 excluding the cost shares of the company and the professional fee of the project leader. Basic GIS maps were procured at the Bureau of Agricultural Research, Department of Agriculture at a very affordable price and subsequent GIS data processing were also conducted by their GIS technical person under guidance of the project leader. The project was designed as a "social responsibility share" of REECS to sustainable development and environmental protection under climate change condition. Thus, project inputs sharing was practiced.

I.3.d. Challenges, lessons learned, and recommendations

Impact of the project

A copy of the project report was furnished to the Bureau of Agricultural Research, DA for potential dissemination to other regional offices of DA. Also, the project output was presented in the annual

conference of the Resources Environment and Economic Foundation of the Philippines, whose members are from different sectors nationwide. Also, the report of the project was translated into policy brief. Several copies were distributed to policy-makers, LGUs, DENR, academe and the private sector. Copies were also furnished to the Laguna Lake Development Authority. After distribution of the policy brief to several government agencies and the private sector, there was no effort conducted to follow up the usefulness of the material. The follow up was constrained by funding. However, even without follow-up, there were many individual professionals that requested copies directly from the Project Leader. This somehow is a measure that in deed the policy brief has some usefulness to other professionals and probably to some institutions.
Resource Intensity of method

One of the data that is of critical importance in the climate change vulnerability and adaptation assessments in a lake basin is the impacts of tropical cyclones to ecosystem, biodiversity and inland fishery in the different parts of the basin. There was no quantification of the impacts on such attributes in all of the typhoons that hit the Laguna Lake basin. The limitation was budget and the need for historical impact data of past typhoons. In case there would be a second phase, the aspects on quantitative impacts of typhoons in these sectors should be studied and integrated into the vulnerability assessment process.

Expanding collaboration among the government agencies and the private sector is encouraged to save on cost. Since all sectors are affected by climate change, everybody should share whatever relevant resources they have in assessing climate change vulnerability and adaptation measures nationwide. The more businesses pouring in resources and government providing counterpart assistance would easily cover the whole country within a reasonable time.

Cost-benefit ratio

The process used in the Laguna Lake Basin and the method used in the Quinali watershed are similar in many aspects. They differ in the use of computer software. Quinali used SimClim while Laguna Lake used ArcView. Simclim is more expensive than ArcView. Assuming other factors are equal in both methods, the procurement price of SimClim is more expensive than ArcView. On this basis, the Laguna Lake approach is cheaper than the Quinali process. Thus, the benefit ratio is better in the Laguna Lake project than in the Quinali watershed project.

Potential and recommendation for replication or integration

The method may be replicated in other lake basin in the country probably in Lake Mainit Basin Caraga region because typhoon is becoming stronger in that part of the country in terms of rainfall and wind speed. It would also be good to expand the impact coverage to include ecosystem, biodiversity and inland fishery.

Lessons learned

The insights from the project are presented below.

Table 1. Insights from the vulnerability assessment of Laguna Lake Basin

Attributes affected	Adaptation policy	Mitigating policy
General recommendations		
1. All attributes	Compulsory mainstreaming of specific sectoral policies corresponding to each attribute into total sustainable development and management plans of the Laguna Lake basin. Congress and Senate are expected to push a law creating financing mechanisms to effect immediate climate change mitigation and adaptation measures.	Same with the adaptation policy

Weather forecasting	Improve forecasting capability by installing accurate instrumentations for predicting, typhoons, rainfall, and other meteorological factors.	Improve forecasting capability by installing accurate instrumentations for predicting typhoons, rainfall, and other meteorological factors.
Specific Recommendations		
1. Low-lying residential areas, which are vulnerable to flooding.	1. Education of local government officials on CC and its effects to enable them prepare for any floods to come.	
	2. Elevate houses based on the highest water surface observed in historical data of floods plus a safety factor.	
	3. Turn floods into opportunities for other types of livelihood to augment foregone livelihood from agriculture.	
	4. Clear major natural waterways. Marshland or wetlands must be maintained as ground water recharge.	
	5. Relocate existing houses in flood-prone areas to higher grounds.	
2. Residential areas, upland for agriculture, and degraded forestlands prone to landslides, soil erosion and excessive surface runoff.	1. Teach residential owners to regularly inspect foundation of their houses to watch on possible soil movements underneath. Drainage system at upper slopes must be checked of obstruction. Proper land care.	
	2. Owners of upland farms must be do soil conservation. Abandoned farms in sloping areas should be turned over to the government for reversion into forest and watershed/ environmental use. Suitable relocation areas must be set aside by government. Existing laws governing conservation, development, management and protection of the uplands must be enforced by concerned government agencies.	
	3. Agricultural lands in sloping areas must be terraced.	

	4. Declogging of water ways.	1. For man-made forest ecosystems, enrichment planting for build-up of biodiversity. Biodiverse ecosystems are stable from climate change impacts according to experts.
	5. Location of residential areas in stable soil in plain to moderately sloping and located in higher elevation site only. Houses should not be constructed in slope beyond 18% to prevent landslides. Firm-up foundation into parent material before constructing houses.	
	6. Landslide-prone areas especially those along rivers and streams in steep slopes must be constructed with ripraps or retaining walls. Water logging in sloping areas must be avoided.	2. Barren forestlands must be planted with species of trees that are deep-rooted. Immediate soil cover such as planting of creepers will prevent soil erosion.
	7. Upland farm owners who do not plan any prescribed minimum number of trees or fruit-trees for food crops, soil conservation, and other purposes must be penalized with the highest reasonable land tax. This will encourage them to develop their areas into agroforest plantations and become productive. Compulsory payment of land tax is important to finance climate change remediation through the forestry sector.	
4. Residential in low-lying areas along the coastal line in Manila bay.	1. Adaptation measures are discouraged. Human lives should not be compromised. Relocation is strongly recommended. 2. Relocate housing especially shanties constructed along the bay. If properties are already privately owned let government come up with a buy-out policy.	
5. Residential areas constructed along creeks and waterways	1. Adaptation measures are discouraged. Human lives should not be compromised. Relocate houses to prevent casualties from flashfloods. There are several clusters of houses in Laguna affected by floods.	

6. Agricultural crops that are sensitive to excess rainfall	1. Let science and research discover new crop varieties that can withstand excessive rainfall and temperature.	
	2. Train people's taste buds for other food crops that can be raised under unusual climatic condition. Shift from rice to root crops, banana, corn, etc.	
	3. Plant during dry season only. Planting during the typhoon season is discouraged.	
	4. Scientific water management in agricultural lands to maintain desired yield of crops under excessive rainfall and temperature.	
7. Residential areas affected by increases in temperature, El Niño and prolonged dry season.	1. For residents in Metro Manila as well as commercial and industrial centers, encourage them to integrate real green parks planted with cultured but big trees designed for the production of oxygen. Backyards should be planted with fruit trees. Open spaces, barren parks, stream banks and roadsides must be planted with forest species to act as oxygen producer and pollutants diffuser.	
	2. Encourage government to capture runoff by constructing series of dams along rivers and creeks as well as water impounding ponds for conserving water to be used during El Niño.	
	3. To reduce use of electricity, provide air exhaust vents to give free flow of air circulation. Prevent aircon use or any electric appliances. The lesser the amount of electricity use the lesser the amount of carbon dioxide released into the atmosphere.	
8. Agriculture: Rice Production affected by temperature increases	1. Discover and plant rice varieties that can withstand temperature increases and without rice yield reduction	
	2. Train taste buds of consumers to other food crops. Grow rice in green houses where watering and temperature is controlled	

10. Large tract of grasslands	1. Shallow ground cover to be provided with creeper-vegetable crops to reduce the impact of rainfall and surface runoff.	1. Assuming that grasslands still have thick soil profile, developed forest plantations both for protection and wood production purposes. Plantations in moderate to high slopes to be used for protection and carbon sequestration while those in areas where the slopes are almost plain to moderate use them for wood production purposes or agroforestry with biofuel species. All grasslands developed into agroforestry, biofuel, and protection forest must be surveyed and titled by the DENR/government for security reasons.
11. Wooded lands	1. Enrich areas by planting biodiverse forest species for carbon sequestration and soil erosion control. Integrate mechanics whether vegetative or structural to reduce soil erosion in the area	1. Brush, grass and other non-tree forest species should be interplanted with indigenous and non-invasive tree species to encourage natural biodiversity enrichment. All areas enriched by the DENR/government must be surveyed and titled under the name of DENR/government.
12. Open forest	1. Improve stocking density of big tree species by either assisted natural regeneration or enrichment planting. Integrate soil erosion control measures to minimize erosion in the area and reduce siltation of the lake.	1. Interplanting of forest tree species with high wood density to improve carbon sequestration potential. Practice soil conservation measures to reduce soil erosion and increase water recharge capacity of the basin to sustain ground water supply.
	2. Protect and manage existing open forest from kaingineros, timber poachers and charcoal makers.	2. Developed and enriched open forest should be surveyed and titled by the DENR/government for security reasons.
13. Closed forest	1. Validate actual forest stands and enrich with biodiverse plant species areas that are inadequately stocked. Protect and maintain forested areas that are adequately stocked.	1. Practice sustained yield management for environmental and watershed goods and services of the forest to protect it from poaching and other forms of deforestation activities. As much as possible all forested areas including forest plantations under the government must be surveyed and titled under the name of the DENR/government for security purposes.

14. Bare soil	1. Provide immediate cover and prevent rebrushing and cultivation to discourage soil erosion by planting creepers-vegetable species.	1. Plant with tree species for carbon sink and environmental protection purposes.

Source: REECS, 2009

The other lessons learned during the conduct of the study are a) climate change vulnerability assessment can be achieved as a social responsibility of concerned private firms through sharing of cost and expertise. If government can provide the GIS maps free of charge then there would be a substantial reduction in the cost of climate change vulnerability assessment project; b) during the presentation of the results of the study to the LGUs, it seemed that the LGUs have no realization on the importance of climate change vulnerability assessment. Thus, an appreciation seminar may be conducted to introduce to them the benefit of having this activity as a requirement for any development plans of their province or municipality and as a tool and its results as inputs to the preparation of comprehensive land use and development plans; and c) anticipated impacts of climate change are known ahead of time giving ample time for the formulation and implementation of adaptation measures.

I.4. Building Capacity to Adapt to Climate Change in Southeast Asia: Household Vulnerability to Climate Change in Selected Municipalities in Laguna

I.4.a. Entry point into the adaptation process for method application

Southern Luzon is one of the regions in the Philippines most frequently visited by climate hazards such as typhoons and its after effects, particularly landslides and flash floods. One province severely affected by these climate events is Laguna. Aware of this situation of the province, the provincial government continues to formulate strategies of coping and adapting to these climate change impacts. In coordination with SEARCA in UPLB, the provincial government recognized the need for building local capacities in terms of conducting vulnerability assessment and enhancement of adaptation options in order to improve the communities' resilience in the face of climate change and its impacts.

Funded by the EEPSEA, this three-year project aims to implement capacity building mechanisms among the LGUs in three Southeast Asian countries – Cambodia, Vietnam, and Philippines – on areas such as conducting vulnerability assessment and formulation of adaptation strategies. In the Philippines, the province of Laguna has been chosen as the project site through the Southeast Asian Ministers of Education Organization – Regional Center for Graduate Study and Research in Agriculture (SEAMEO-SEARCA). Specific study sites involve twelve municipalities in Laguna, namely Sta. Cruz, Los Baños, Calauan, Liliw, Magdalena, Majayjay, Nagcarlan, Pagsanjan, Pila, Rizal, and Victoria. Through the collaboration of the provincial government of Laguna and SEARCA, these towns will be undergoing series of trainings on conducting climate change vulnerability assessment, mapping, and analysis of relevant socioeconomic variables.

In line with the general objective of assessing the vulnerability of households located in twelve municipalities of Laguna, the study specifically aims to (Arias, 2012):

i. evaluate the general vulnerability of households based on the framework Vulnerability as Expected Poverty or VEP, and the Vulnerability Index as a function of hazard, sensitivity, and adaptive capacity approach;

ii. profile the households identified as vulnerable;

iii. identify the level of awareness and perception of the households regarding the impacts of climate change;

iv. determine the level of exposure of the households to different climate hazards and its impacts; and to

v. describe the strategies practiced by households in coping with the effects of climate change.

I.4.b. The methodological approach

The study has applied two main frameworks – 1) VI or Vulnerability Index, and 2) VEP or the Vulnerability as Expected Poverty framework.

Primarily guided by the IPCC framework, the VI in the study was formulated with specific indicators under the main components of vulnerability – hazard exposure, sensitivity, and adaptive capacity, as summarized in the table below.

Table 2. Specific indicators used in the IPCC framework as adapted by the vulnerability study in Laguna

Factor	Indicator	Sub-indicator	Relationship with vulnerability
Hazard	Typhoon	Number of typhoons and tropical depressions in the last 10 years	+
		Numbers of typhoons classified as Signal Number 3 and above in the last 10 years	+
	Flood	Number of flood events experienced in the last 10 years	+
		Highest flood height experienced in the 10 years (in feet)	+
		Longest flood duration experienced in the last 10 years (in days)	+
	Drought	Number of droughts experienced in the last 10 years	+
	Landslide	Number of landslide events experienced in the last 10 years	+
	Flash flood	Number of flash floods experienced in the last 10 years	+
Sensitivity	Human sensitivity	Dependence ratio: ratio of dependent person (below 15 years old and 65 and above) to family size	+
	Livelihood sensitivity	Percent of annual income generated from agriculture, fishery and forestry activities	+
	Infrastructure sensitivity	Ratio of family size to area of weak house	+
		Distance of dwelling unit to nearest body of water	-
	Financial sensitivity	Percent of debt to total income of households	+

Adaptive Capacity	Infrastructure	Average area of permanent dwelling per head	-
	Economic indicators	Income per capita	-
		Amount of remittance per year	-
	Technology indicators	Number of TVs, radios	-
		Number of line phones and cell phones/household	-
		Number of vehicles per household	-
	Social capital indicators	Number of contacts the household can ask for financial help	-
	Human indicators	Number of working household members	-
		Level of education: schooling years that the household head finished	-

The VEP approach, on the other hand, holds that vulnerability is determined by the probability that "households or individuals will move to poverty in the future or fall below a minimum consumption threshold level, given certain shocks" (Chaudhuri, 2003, as cited by Arias, 2012).

Process of conducting the study

The study surveyed 600 households through personal interviews in Filipino medium. The questionnaire used contained questions on the respondents' household information, exposure to climate hazards indicators, adaptive capacity indicators, and their knowledge and perception regarding climate change, adaptation, and impacts such as typhoons and flooding (Arias, 2012).
The study applied two-stage stratified random sampling, in which the population of households was stratified by municipality and its urban-rural classification. Followed by proportionate sampling, a stratified random sample of 600 households was then obtained. Households were selected using a list provided by the LGUs and the Barangay Integrated Development Approach for Nutrition Improvement (BIDANI) in UPLB. Replacement method was applied in cases of refusal or unidentifiable location of respondents (Arias, 2012).

Statistical procedures i.e. mean estimation, standard deviation, and frequency distributions were applied. Significant differences in indicators were determined using t-tests or Analysis of Variance (ANOVA). Relationships between variables were tested using correlation analysis. In order to determine vulnerability, the frameworks of VI and VEP were applied.

Inputs: Data and information used in the study

The inputs to the study include (Arias, 2012):

1) profile of the household respondents

2) vulnerability estimates as defined by VI and VEP approaches, and their comparison

3) profile and characteristics of vulnerable households

   a. relationship between gender and vulnerability
   b. relationship between livelihood and vulnerability
   c. information and knowledge about climate change issues

4) household exposure to hazards

5) hazard impacts

6) damage cost

7) migration

8) adaptation and coping responses

   a. actions taken before a hazard
   b. actions taken after a hazard
   c. expenditure on adaptation

9) assistance needed by households

Outputs of the study

Initial findings of the study (Arias, 2012):

1) 29% of the respondent households are identified as vulnerable based on the VI framework, and 36% based on the VEP

2) Mean estimate for the VI is 0.43, while the mean estimate for VEP is 0.37

3) A positive relationship was found between damage cost and adaptation expenditure. The higher the susceptibility of households to damages, the more likely they are to invest in adaptation.

On the profile and characteristics of vulnerable households:

1) The identified vulnerable households are generally employed the commercial, services, and agriculture sector.

2) Majority are female-headed households

3) A large proportion of the vulnerable households are not aware or without knowledge of climate change

4) Majority believed that their household is "adequately prepared to handle the adverse impacts of climate change" (Arias, 2012)

   a. Preparations include improving the built of their houses, moving the properties up to higher grounds and away from flood waters
   b. Only a small proportion went to evacuation centers
   c. Only a small percentage from the agriculture/fishery/forestry sector took precautionary measures such as flood-resilient farming, availing of crop insurance, early harvesting, and reinforcement of fish/animal pens (Arias, 2012).
   d. About P 1,450 was found to be the average expenditure on adaptation before the hazard, and significantly increased to P 12, 450 after the hazard.

On hazards:

1) Typhoons and floods are found to be the most significant in Laguna, in terms of frequency and proportion of households affected

2) Impacts include damages to properties and livelihood thus the loss of source of income, and negative effects to health including psychological and emotional distress

On the interventions preferred by the households:

The top 5 most preferred interventions of households include: 1) financial assistance; 2) relief goods; 3) information dissemination; 4) medical assistance, and 5) flood mitigation infrastructures and livelihood assistance.

I.4.c. Conditions of method application

Series of trainings for local constituents on vulnerability assessment, local planning, and enhancement of adaptation strategies are still on-going.

Stakeholders and institutional setup

The project is developed by the International Development Research Center of Canada (IDRC) in coordination with the Economy Environment Program for Southeast Asia (EEPSEA) and the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

Resources

The project is being implemented by SEARCA a well known international institution that has adequate expertise on training in any aspects of agriculture, natural resources and climate change. Being an international organization, it has no problem on the expertise it needed to conduct the different training modules. Likewise, in terms of funding, it is funded by IDRC and EEPSEA. Since the budget was not disclosed, it is perhaps similar to the budget of most IDRC and EEPSEA funded projects, which are within the range of PhP500, 000 to PhP1.5 million per project.

The project has a 3-year period and it is still in the first year of implementation.

I.4.d. Challenges, lessons learned, and recommendations

Impact of the project

The initial impact of the project is measured in terms of the awareness of the selected participants on climate change vulnerability and adaptation assessment. There is no concrete impact yet to the communities because the project is still in the capacity building stage.

Resource intensity of method

On the need for data, expertise and other support, there were no indications yet based on the information provided. It is still premature to expand data needs, needs for expertise and requirements for other support.

Cost-benefit ratio

There is no basis yet to determine whether the project has high cost-benefit ratio compared to other methods. It is still premature to gage the benefit of the project. An M&E is important to measure the benefit of the project from the trainees how they will use their learning in the project.

Potential and recommendations for replication or integration

Initial findings according to Arias (2012) are;

1) Focus on adaptation strategies catering to the commercial, services, and agriculture sectors since the identified vulnerable households are employed in these sectors.
2) Formulations of options that are gender-sensitive, since majority of vulnerable households are female-headed.

It is too early to recommend for replication considering that the project is still in its first 6 months of implementation.

I.5. Agricultural System Vulnerability and Adaptive Capacity Assessment (AgSys – VACA)

I.5.a. Entry point into the adaptation process for method application

One of the sectors affected by climate change is agriculture. As the population increases, food production will decline due to drought and flood, leading to food shortage. In such event, farmers become the most vulnerable group due to their lack of access to technology, low income, and lack of sustainable livelihood.

To help the farmers adjust and adapt to the effects of climate change to agriculture, the UPLB Foundation developed a tool for assessing the vulnerability of the agricultural sector and applied this in the provinces of Benguet and Ifugao. Since the farmers are the ones directly affected on the ground, the process of assessing vulnerabilities, formulation of adaptation strategies, and monitoring and evaluation of adaptation activities are better within their hands instead of coming from other professionals. Thus training was integrated into the vulnerability assessment process.

Referred to as the Agricultural System Vulnerability and Adaptive Capacity Assessment or AgSys-VACA, this tool is a simplified community-based approach based on the integration of the most applicable VIA tools including (a) the ADPC Based Disaster Risk Management: Field Practitioners' Handbook, 2004; (b) the CARE Climate Vulnerability and Capacity Analysis (CVCA) Handbook, 2009; and (c) the PRRM Vulnerability and Adaptation Assessment Toolkit, 2009. AgSys-VACA documents climate change-related risks and the adaptive strength in a community-based setting. GIS-assisted integration with climatic and biophysical information in other communities (i.e., barangay, municipality, and region) is possible.

The tool is designed through formulation of the combined science tools and indigenous knowledge (IK) in upland farming of the local communities in Benguet and Ifugao. It is most applicable in assessing the biophysical-related impacts of climate change in the agriculture sector. The availability of the historical data of rainfall, temperature and time of planting, as well as identification of the varieties of the planting stocks are crucial in developing valid interpretations of these variables on the yield of crops.

I.5.b. The methodological approach

This study by the UPLBFI is guided by the principle that building climate change resilient nations or communities depend on the capacity of the national and the local governments to address risks.

The vulnerability and adaptive tool was derived from the historical data of (a) climatic and biophysical characteristics (i.e., weather, rainfall), and the (b) exposure, sensitivity and the adaptive capacity (i.e., cropping calendar, cropping rotation, and selection and varieties of agricultural planting stocks such as rice, corn, potatoes, cabbage, and snap bean.

Thus, the study by the UPLBFI had to achieve two major objectives:

1. To determine the vulnerability and adaptive capacity of the agricultural sector in Benguet and Ifugao; and

2. To provide a basis for planning and prioritizing adaptation measures for the agricultural sector at the provincial, municipal, and community level.

The IPCC framework for climate change vulnerability assessment was used in the study. Additional working principles were integrated to suit the local needs and culture of the stakeholders (UPLBFI, n.d.).

1. Community-based approach – the farmers/communities are the ones directly affected at the ground level and actions are their responsibility to implement on the ground;

2. Based on the framework that climate change vulnerability is the product of the interrelationship among the three indicators: hazard, exposure, and adaptation;

3. That agriculture is a holistic system composed of biophysical, economic, socio-cultural, and political subsystems that are interrelated;

4. Two major components:

    a. Impacts of climate change and other related variables in agriculture; and

    b. Capability of the agricultural system including the farmers to adapt and develop into a more resilient system of production.

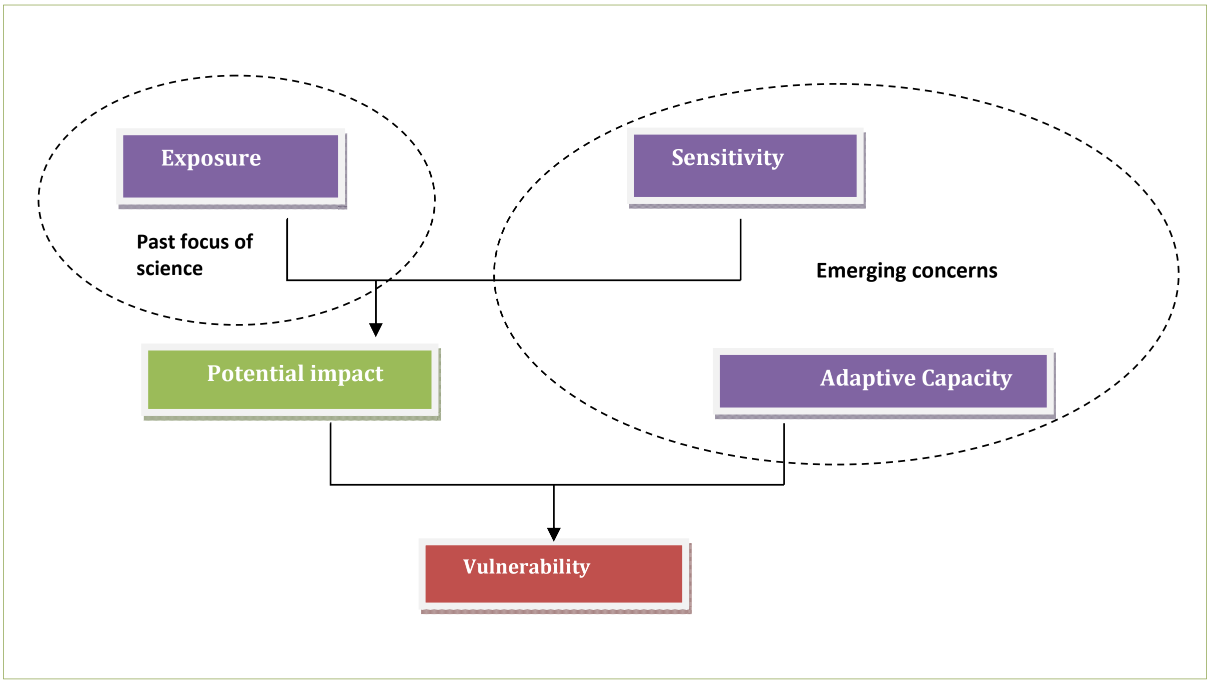


Figure 5. Framework of Agsys - VACA

Source: UPLBFI, n.d.

The diagram illustrates a framework for understanding vulnerability of communities. Climate change results from the abnormalities in climate, which will have different effects on a community and its natural resources. Most significant of these effects are the disasters which could occur as an outcome of the combined exposure, vulnerability, and weak preparedness of a population or community. Each community, as unique entities from one another, will therefore have unique vulnerabilities and adaptive capacities in the face of climate change. Simply put, adaptive capacity to climate change is the system's ability to 1) adjust to climate change, variabilities, and extremes, 2) moderate potential damages, and 3) to take advantage of available opportunities to cope with the consequences.

Inputs: Data and information used for the AgSys-VACA

The study by UPLBFI included the following inputs:

1. Vulnerability and adaptation assessment tools and procedures integrated into one V&A tool known as the Agricultural System Vulnerability and Adaptive Capacity Assessment (Agsys – VACA).

2. Scientifically grounded indigenous knowledge (IK) in Benguet and Ifugao: local knowledge of IPs on weather pattern prediction, planting strategies, topographical and hydrological dynamics of their rice terraces, thus the community's knowledge on adaptive ways in preventing hazards of extreme natural events.

3. Science-indigenous knowledge-based vulnerability assessment tool and adaptation strategies for Benguet and Ifugao uplands, developed through the integration of:

    a. Agriculture variables – systems, interventions, actual experiences, and observations; and
    b. Optimal planting dates of crops.

4. Use of historical weather data in order to project future weather scenarios for 2020 and 2050 in Baguio City

Outputs of the study

UPLBFI was able to produce the following outputs:

1. Selected vulnerability assessment tools for agricultural system.

2. Scientifically grounded indigenous knowledge (IK) in Benguet and Ifugao: local knowledge of IPs on weather pattern prediction, planting strategies, topographical and hydrological dynamics of their rice terraces, thus the community's knowledge on adaptive ways in preventing hazards of extreme natural events.

3. Science-indigenous knowledge-based vulnerability assessment tool and adaptation strategies for Benguet and Ifugao uplands, developed through the integration of:

    a. Agriculture variables – systems, interventions, actual experiences, and observations; and
    b. Optimal planting dates of crops.

4. Use of historical weather data in order to project future weather scenarios for 2020 and 2050 in Baguio City

5. Other findings

   a. The provinces of Benguet and Ifugao are highly vulnerable areas;

   b. Factors that contribute to its vulnerability primarily include its geographic location and high dependence on agriculture in terms of economy and livelihood;

   c. Stakeholders are highly aware of climate change and its hazardous effects especially on agriculture; and

   d. A community level assessment of vulnerability, is more appropriate for the region for its unique agricultural systems and diverse practices, and would most likely lead to determining effective adaptation practices.

Process of conducting the study

Using the framework as a guide, the following lists the three major phases and underlying processes of the UPLBFI study:

1. Pre-assessment and planning phase

   a. Project team organization;
   b. Collection of secondary data; and
   c. Planning and preparation of field work
   d. Training of the farmers/communities on items a – c, above

2. Actual assessment

   a. Training of the farmers/communities on items b to f
   b. Site reconnaissance
   c. Examination of the hazards – types, location, frequency, seasonality, impacts, and magnitude of damage
   d. Examination of vulnerabilities and capacities
   e. Hazard mapping and vulnerability assessment
   f. Identification and assessment of current adaptation measures

3. Post-assessment phase

   a. Training of farmers/communities on items b to c
   b. Systematic analysis and interpretation of results
   c. Monitoring and evaluation of results
   d. Validation of results with the community

I.5.c. Conditions of method application

Agricultural System Vulnerability and Adaptive Capacity Assessment (AgSys-VACA) requires capacity-building trainings for the agricultural sector; consultations with the key stakeholders; secondary data gathering; Focus Group Discussions (FGD); Key Informant Interviews (KII); and Formal Field Interviews.

Stakeholders and institutional set-up (lead agency and others involved)

The UPLB is the agency that conducted the project in Benguet and Ifugao. The cooperators were the farmers in these two provinces.

Resources (personnel, expertise, funds, time)

UPLB has all the needed expertise and personnel especially in the areas of agriculture, agricultural engineering and hydrometeorology, forestry and natural resources. It has no problem with expertise.

Time and Cost Spent in the Conduct of the Study

The time and cost used in the conduct of the study were approximation only. The report did not present the time and cost spent in the study. The time and cost were based on similar activities in agriculture that focused on capability building of farmers. The cost would not differ much considering that the objective is capability building of the farmers in Benguet and in Ifugao in the climate change vulnerability assessment in agriculture in upland areas.

The project's duration is 12 months with a total cost of PhP1.37 million. The bulk of the cost is captured by personal services followed by overhead and travel allowance and per diem.

I.5.d. Challenges, lessons learned, and recommendations

Impact of the project

The transfer of knowledge on climate change vulnerability and adaptation assessments in upland farmers is measured in terms of applied knowledge demonstrated in the improvement of harvests. However, as of this report there was no information whether this was achieved after the project. This makes M&E of any projects on climate change important to track positive and negative impacts.

Resource intensity of method

UPLB being the implementer of the project has no constraint in terms of data on agriculture and expertise on agriculture and training. Since the objective of the project was to transfer skills on climate change vulnerability and adaptation assessments to farmers engaged in upland agriculture, the primary resources needed were knowledge from the different resource persons involved in the training.

Cost-benefit ratio

Just like other projects whose primary objective is to enhance farmers' capability in addressing problems that affect farmers' productivity due to changes in climate, the cost-benefit ratio cannot be established unless there is a subsequent M&E of the activities of the farmers related to their learning in the training.

Potential and recommendations for replication or integration

Benguet and Ifugao are two of the several mountain provinces in the country where indigenous farming practices are being applied by farmers in the famous rice terraces - one of the world heritages. There are other provinces where mountain agriculture is also being practiced. Some of these provinces are Kalinga in CAR and Bukidnon in Mindanao. IPs in these provinces have different indigenous farming practices that may be considered for further studies relative to climate change in case the project is going to be replicated. Perhaps, the IPs have adaptation measures in agriculture that other farmers can learn from.

I.6. Participatory Vulnerability and Adaptation Assessment in Sorsogon City

I.6.a. Entry point into the adaptation process for method application

Sorsogon is one of the provinces of the country that is always affected by typhoons. Its capital is Sorsogon City and this is located along the coastal areas of Sorsogon. The city is threatened by heavy rains, sea level rise, storm surges, and high waves during typhoon. Past typhoons have shown devastating effects destroying houses and infrastructures and causing deaths of people. To minimize the effects of typhoons, sea level rise, storm surges and other extreme climatic events, and to help the people adapt to climate change, there was a need to identify the areas and the sectors that are always affected. This led to the conceptualization of a framework on how to conduct a participatory vulnerability and adaptation assessment for a small coastal city, Sorsogon City in Region V. The study's framework combined IPCC framework for vulnerability assessment and participatory approach through "Learning by Doing Approach" involving several stakeholders at all levels (Mias-Mamonong, 2010).

The study aimed to conduct a participatory vulnerability and adaptation assessment (V&AA) in Sorsogon City using the IPCC framework combined with participatory approach. Planners of local government units at the provincial and municipality levels are encouraged to learn and apply the V&AA process in their respective areas to help the people adapt to the impacts of climate change.

I.6.b. The methodological approach

Sorsogon City worked on its vulnerability through assessments or estimates of its adaptive capacities, sensitivity, and exposure to climate variability and change taking into account IPCC's framework and its Third and Fourth Assessment Reports, the UNDP-Adaptation Planning Framework, Vulnerability and Response Approach (VARA) by the Oakridge National Laboratory, World Bank's Climate Resilient Cities Primer, the UNEP Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies, and the UN-Habitat's Sustainable Cities Programme (SCP) local assessment tools and methodologies (Mias-Mamonong, 2010).

Vulnerability = f (Exposure, Sensitivity, Adaptive Capacity)

Where:

Adaptive capacity - ability of a system to adjust to actual or expected climate stresses, or to cope with the consequences

Sensitivity - degree to which a system is affected, either adversely or beneficially, by climate-related stimuli

Exposure - degree of climate stress upon a particular unit of analysis (long-term change in climate conditions, or by changes in climate variability, including the magnitude and frequency of extreme events (Mias-Mamonong, 2010)

To guide the staff assigned in the V&AA, 7 questions were laid down in each of the three elements of vulnerability (Mias-Mamonong, 2010) indicated in Figure 6.

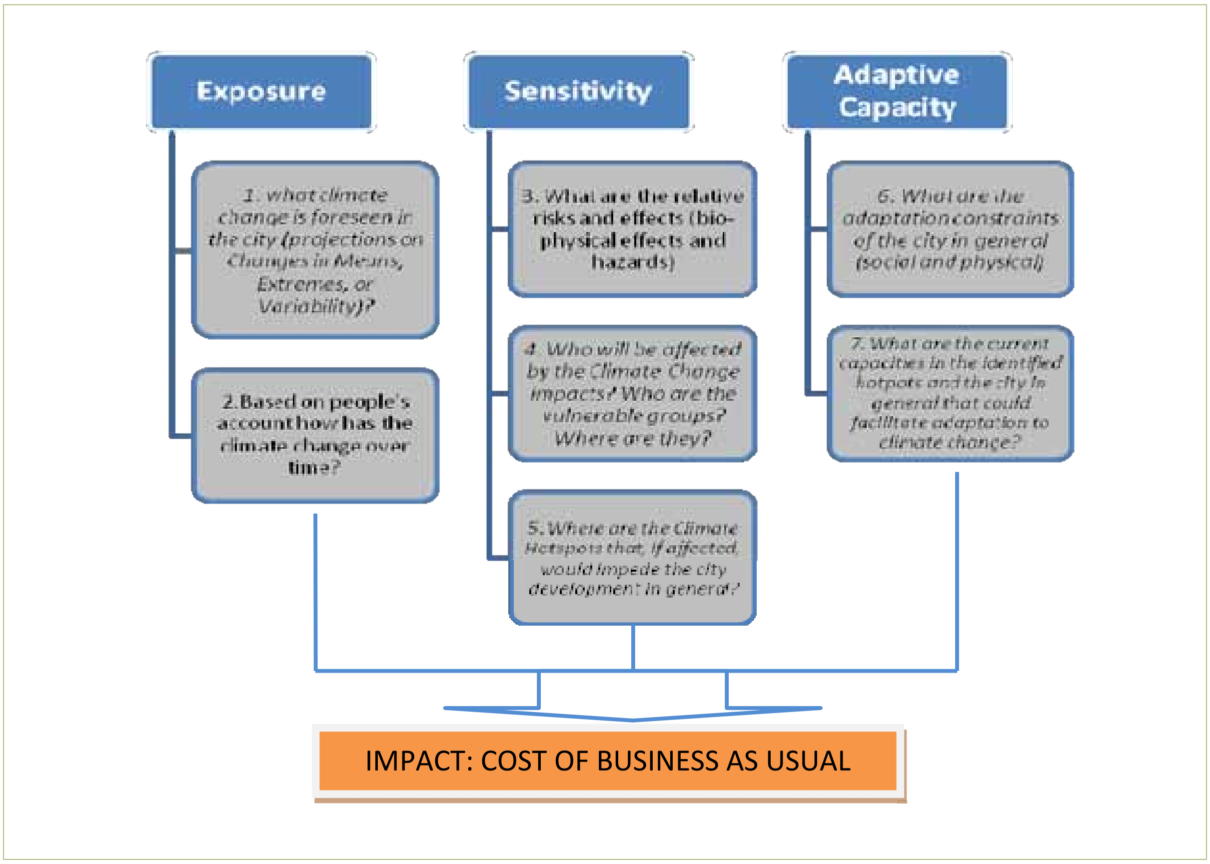


Figure 6. Conceptual framework of the participatory vulnerability assessment study in Sorsogon

Source: Mias-Mamonong, 2010

Answers to the basic questions above resulted in adaptation options that eventually led to the city's sustainable development.

Inputs: Data and information used in the study

Mias-Mamonong (2010) summarized the inputs used in the study in Table 3.

Table 3. Inputs in the participatory vulnerability assessment study in Sorsogon

Assessment factor	**Key data needed**	**Purpose**	**Possible source/s**
Climate Change Exposure (current and future)	a. Climate data (e.g. cyclones, droughts, flooding	- Show trends, and possibly indicate how CC is manifesting locally	- Nat'l/Local observation
	b.Climate scenario/ projections (local/ national/ global	- Show as adequately as possible what can be expected at the locality over the next 10, 30, 50 years or by end of century.	
		- Validate exposure to threats of CC bio-physical effects	- IPCC Global Projections; Regional Projections; National CC communications
	c. Impact reports previous disasters		- City Reports
			- FGDs with communities
Climate Change	a. Hazard Map/s - Identify bio-physical - City/National effects of Climate Change, Government (e.g. drought, flooding, releases landslide, cyclones, etc.)		
Sensitivities			
	b. Socio-economic - To show who will be - FGDs with profile affected given current and communities/		
	future condition community survey results		
Adaptive Capacity	a. Socio-economic profile	- Validate the thresholds of people at risk	- City Data/survey results
	b. Key Physical characteristics	- Present resources and conditions	- City Data
	c. Land Use Plan	- To present spatial information for comparison to with the	
			- City Comprehensive Land Use Plan

Source: Mias-Mamonong et al. 2010.

Other relevant data needed for the impact projections are listed below:

1. The observed anomalies in Philippines' climate from 1951-2006 are enumerated below according to climate indicators (Mias-Mamonong et al, 2010):

    a. Increase of 0.6104 degrees Celsius in observed annual mean temperature;
    b. Increase of 0.3742 degrees Celsius in observed annual maximum temp;
    c. Increase of 0.8940 degree Celsius in observed annual minimum temp;
    d. Increased number of hot days and warm nights;
    e. Decreased number of cold days and cool nights;
    f. Increase of annual mean rainfall and rainy days
    g. Increase in inter-annual variability of onset rainfall;
    h. Average of 20 cyclones cross the Philippine Area of Responsibility where 8-9 make landfall each year - an increase of 4.2 in frequency for the period of 1990-2003

2. Regarding climate change scenarios in 2020 and 2050, PAGASA issued the following climate change projections for the Philippines (Mias-Mamonong et al).

    a. The mean seasonal temperatures are expected to rise by about 0.90C to 1.40 degrees Celsius by 2020 and 1.7-2.4 degrees Celsius by 2050.
    b. Projection of seasonal temporal rainfall variation is largest (-35 % to +45%) during the six month period from March to August.
    c. Projection of seasonal temporal rainfall variation is less (-0.5 % to +25%) during sixth months from September to February.
    d. The highest increase in rainfall during the southwest monsoon season, which is from June to August, is likely in Region 01 (44%), Cordillera Autonomous Region (29%), Region 03 (34%), Region 04 (24%) and Region 05 (24%) in 2050.
    e. The model indicated that climate change will probably lead to an active southwest monsoon in Luzon and Visayas with future increases in rainfall that is more pronounced in June to August, and becoming greater with time.
    f. The drier seasons of March-April-May will become drier still, while the wetter seasons of June-August and September-November become wetter.

Process of conducting the study

According to Mias-Mamonong (2010), the following activities were as follows:

a. Establishment of strong foundation and support both from technical staff of Sorsogon city as well the LGUs:

    - Training and leveling off among Local Executives together with the Key Technical Staff regarding the fundamental concepts, facts and issues on climate change
    - Related all these to Sustainable Development
    - Formation of a City's Technical Working Group (TWG), from the different disciplines to ensure objectivity in terms of data collection and analysis

b. Identification of scope and objectives of the evaluation and assessment process

    - Data collection is triangulated such that both the quantitative (i.e., hard facts gathered through climate change indicators) as well as the qualitative (people's accounts and realities) are determined and explored.
    - To some extent, focus is directed to the first-hand experiences and realities of the locals regarding the variability and effects of climate change

c. Use of other methods and tools such as Key Informant Interviews and Focus Group Discussion in order to identify appropriate Key stakeholders ideal for the entire VA process.

   - Key stakeholders are crucial in multi-sectoral consultations, workshops and data sharing.
   - Use of projections released by the Philippine Geophysical and Astronomical Services Administration through the PRECIS modeling system of the Hadley Centre

d. Under the element Sensitivity, the following factors are required:

   1. Relative risks and effects
      a. Bio-physical effects
      b. Hazards

   2. Affected population
      a. Vulnerable groups
      b. Location of these vulnerable sector

   3. Climate Hotspots
      Adaptive Capacity
      1. Adaptation constraints of the City
         a. Socio-economic
         b. Physical

      2. Existing capacities
         a. Identified Hotspots
         b. Sorsogon City

   - The sensitivity factors of the city which were identified revolved around the socio-economic and physical elements in the area. Based on the data collected, 43 percent of the poor families are escalated to a much higher risk category, given their socio-economic status, i.e., limited resources and assets and their living in disaster prone areas. Added to the risks of these communities is the lack of improved and updated proper information as well as existing participation in planning and decision making activities, although the locals are already aware of the hazards from extreme events such as super typhoons and storm surges, having had experienced these calamities over decades.

e. Systematic evaluation of city exposure, sensitivity and adaptive capacity using the above data and information

f. Evaluated and enhanced adaptation options based on projections to formulate short and long term development plans, multi-sectoral initiatives as well as partnership among LGUs.

g. Identification of potential institutional partners such as academic institutions, NGOs, Communities, and business sectors, together with their corresponding roles in Climate Change and Disaster Risk Reduction initiatives in Sorsogon City was likewise achieved.

h. Identified required trainings and workshops for all the stakeholders such as the City Local Government Unit of Sorsogon, academe, business sector, and community-based organizations.

The needed training courses were:

- Orientation training on climate change
- Training workshop on DRR and vulnerability assessment
- Best practices on CDM and VER including processes and guidelines in developing related projects

- Training on GIS application and maintenance
- Training and exposure trip on adaptation projects
- Training on documentation, monitoring and evaluation

i. Corroboration of data and projects from PAGASA using the PRECIS modeling system and the accounts of local people in the area, together with the key technical staff from government offices and agencies who conducted the monitoring activities, are crucial in completing the assessment process.

j. Involvement of the stakeholders in potential changes in terms of natural and social setting especially due to variability of temperature (i.e., mean) and precipitation.

I.6.c. Conditions of method application

Specific conditions of method application were identified in the study:

- Participation of the LGU and local stakeholders is tantamount not only to ensure full cooperation from all concerned offices and department, but also to facilitate sharing of information and data.

- Compliance and implementation to the programs and projects are likely once the local stakeholders' cooperation and their sense of ownership to decisions and other action plans emphasized and taken into account.

- This approach is site-specific. The key elements included in the case study namely: (1) City's exposure, (2) Sensitivity, and (3) Adaptive Capacity were evaluated in the context of this small coastal community in the country.

- As such, the characterization of social and physical sensitivities was dependent on the conditions of the site. Moreover, changes in mean temperature, precipitation, sea level, occurrences of climate extremes such as droughts and tropical cyclones are specific to the city, if not the region.

- Other data requirements include projections and trends based on the national data provided by the PAGASA using PRECIS modeling system.

- Data and projections from PAGASA regarding the trends on annual mean, maximum, minimum temperature; number of hot days and warm nights; number of cold days and cool nights; annual mean rainfall and rainy days; inter-annual variability of onset rainfall; number of cyclones in the country were required to establish the vulnerability of the city through the PRECIS modeling system of the Hadley Centre, used by the Philippine Geophysical and Astronomical Services Administration through the PRECIS modeling system of the Hadley Centre

- To determine the exposure of the city to climate change, data on temperature, relative humidity, rainfall, periods or weather patterns are also gathered.

- Data requirement to evaluate the Exposure to climate change and variability were based on projections about changes in means, extremes, or variability.

- Assessment questions regarding this element include the following data sources:
  i. What climate change is foreseen in the city?
  ii. Based on people's account, how has the climate changed over time?

In terms of capacity building, trainings on several concepts and skills such as climate change, training workshop on DRR and vulnerability assessment, exposure trip on adaptation projects, documentation, monitoring and evaluation are necessary.

This participatory vulnerability assessment approach is developed by the UN Habitat – Philippines.

I.6.d. Challenges, lessons learned, and recommendations

No literatures describing the above concerns.

I.7. Climate Change Impacts and Responses in the Philippine Coastal Sector: Application of Aerial Video-assisted Vulnerability Analysis

I.7.a. Entry point into the adaptation process for method application

The Philippine's coastline is 32, 400 km and it is one of the longest in the world. It has 1050 coastal municipalities nationwide out of the total 1,500 municipalities of the country. The coastal zone has several resources that are providing livelihood to coastal communities through coastal lowland farming, fishing and tourism (Perez, Amadore, & Feir 1999). Furthermore, they added that there were about 50 million people living in coastal areas that are at risk from natural hazards, extreme climate, sea level changes, storm surge, riverine flooding and depletion of marine and coastal ecosystems. Accelerated sea level rise is the major threat of coastal communities.

Also at risk are the mangrove ecosystem and marine ecosystem. Mangroves act as physical barrier to storm surges and tsunami. It also protects the seas from land-based pollution. Through its root system, it stabilizes sediment, reduces force of sea wave energy, and serves as habitat of marine and terrestrial flora and fauna (Perez, Amadore, & Feir (1999).

Vulnerability of corals arises from increase in sea surface temperature, sedimentation and deforestation, physical alteration from coastal construction, destructive fishing, coastal tourism, and pollution and nitrification from agricultural and industrial wastes. These are further aggravated by climate change (Perez, Amadore, & Feir, 1999).

Philippine Country Study conducted by Perez, Amadore, & Feir (1999) aimed to demonstrate an aerial video approach of performing vulnerability assessments and evaluation of adaptation measures on coastal resources due to accelerated sea level rise with the Manila Bay coastal zone as the pilot area. Moreover, the study aimed to achieve the following secondary objectives:

1) determine the effects of accelerated sea level rise on the coastal ecosystem and socio-economic conditions of Manila Bay;
2) design responsive actions according to its potential costs and benefits
3) develop a long-term coastal zone management plan;
4) disseminate the application of study processes in other parts of the country; and
5) influence the Philippine policies with responsive actions and adaptation plan to counter the country's vulnerability to sea level rise.

The national policy making body, the coastal MLGU leaders and planners, the Bureau of Fisheries and Aquatic Resources, coastal communities, and fishermen were the target beneficiaries of the study.

I.7.b. The methodological approach

The study applied the framework of IPCC Common Methodology which consist of 7 steps: 1) delineating the study area and specification of ASLR scenario, 2) inventorying the study area characteristics, 3) identifying relevant development factors, 4) assessing physical changes and natural system responses, 5) formulating response strategies and assessments of their costs and effects, 6) assessing the vulnerability profile and interpretation of results, and 7) identifying needs and plans of action. However, due to gaps in gathered information, these steps were only loosely followed (Perez, Amadore, & Feir, 1999).

Inputs to the study

According to the authors, the data and information used in the study are:

1. Delineated and physical, social and economic characteristics of the study area and specification of ASLR scenarios

   Manila Bay:
   - Located in western midsection of Luzon, adjacent to the densely populated, and highly urbanized and industrialized city proper
   - One of the country's top economic drivers in terms of industry, commerce, agriculture, aquaculture, and tourism
   - One of the oldest fishing grounds and center of trade and transportation in the country, beginning from pre-Spanish era:
   - Second most productive fishing ground, following the Visayas region
   - North and south harbors are home to both international and domestic shipping industries
   - Low SLR, set at 0.3 m; High SLR, set at 1 m; and worst case scenario – 2 m SLR

2. Study area physical environment characteristics
   - 190 km long coastline
   - Sea level range: -0.475 m to 0.529 m
   - Groundwater level range: 50-150m below sea level
   - Dry season: December to May; wet season: June to November
   - Average of 5 cyclones every 3 years pass the area

Resource profile of the study area: Manila Bay

- Living ecosystems as fishery resources: rivers, mangroves, sea grasses/sea weeds, coral reefs, and swamplands
- Majority of its approximately 131 rivers suffer from improper dumping of wastes
- 2 types of mangrove forests: natural secondary growth, and reforestation
- Mostly found in Bulacan, Cavite, and Bataan
- Mangroves harvested for firewood and domestic uses
- Majority of mangrove areas are converted into fishponds (Bulacan-Pampanga areas)

Economic profile

- Population: 264 coastal barangays with about 800,000 households (NSO, 1990)
- In Tarnate, Cavite, private groups, i.e. Puerto Azul own the coral reefs and oversees exploitative fishing activities such as trawling

Industry profile

- 26,802 registered establishments in 30 coastal municipalities (DTI)
- Two major establishments: CALABARZON and Export Processing Zone Authority (EPZA) – opened up thousands of employment opportunities in the area
- CALABARZON project included: port development, roads and highways, industrial support projects, urban and rural development, agriculture, and environmental management
- Current challenges to coastal communities: environmental degradation, unequal distribution of resources and opportunities, apathy and low environmental awareness, illegal and destructive fishing methods, poor household health and sanitation

Base maps

- Maps with a scale of 1:10,000
- Other maps obtained from the Coast and Geodetic Survey Department (CGSD)

Outputs of the study

Perez, Amadore, and Fier (1999) reported that their study was able to produce the following outputs in a relatively short period of time. These are:

Aerial video survey results

- Presence of several coastal environments:
- Brushland/industrial environment in southern Bataan
- Agro-aquacultural environment in Bataan-Pampanga coasts
- Aquacultural and urban environment in Bulacan and Northern Metro Manila
- Highly urbanized Metro Manila and its shoreline devoid of natural vegetation
- Tourism and agro-aquacultural environment of Cavite
- Natural environment of southern Cavite
- Erosion in Bataan coasts; and beach areas in Cavite, could be due to sand quarrying; and in some abandoned fishponds in Bulacan
- Shoreline changes in Manila-Cavite areas
- Squatter areas in river deltas of Bataan, Bulacan, and Metro Manila
- River outlets to the bay from Pampanga and Bulacan are heavily silted with lahar deposits
- Extreme ends of the bay in Mariveles, Bataan and Maragondon, Cavite are identified as forested
- Rice fields of Cavite are mostly located near-shore, while the agricultural lands of Bataan and Bulacan are used as fishponds
- North shores are characterized have muddy substrate, while the south shores have sandy substrate
- Shoreline changes brought by urban development through: development of residential subdivisions in Parañaque, CCP Complex in Pasay, and the development of coastal roads in Las Piñas-Cavite

Vulnerability to accelerated sea level rise

- Shallowing of nearshore areas from erosion and siltation, slash-and-burn farming, and destructive waste disposal in the coastal areas
- In the long run, infrastructure development and land reclamation projects lead to siltation in the nearshore areas
- Mangrove forests, corals, and sea grasses are destroyed by human activities:
- Conversion into fishponds, saltbeds, rice paddies; and even into residential, commercial, and industrial purposes
- Overexploitation for timber use, firewood, and tanbarks
- Mining activities; dumping of mine tailings and solid wastes
- Destruction of coral reefs due to increased siltation, water turbidity, and temperature
- Destruction of seagrass beds due to agricultural cultivation and mining

The results of the vulnerability analysis as reported by Perez, Amadore and Fier (1999) are summarized below:

- Coastal areas along the bay such as Cavite (Cavite City, Noveleta, Kawit, Imus, and Bacoor), Las Piñas, Parañaque, Malabon, Navotas, and Bulacan (Hagonoy and Malolos) may face 1m sea level rise by 2100;
- At 2m SLR – even inland areas and those near river banks will be affected; and
- Other areas such as Malabon, Navotas, and Bataan (Limay and Orani) are also found to be vulnerable to gradual SLR.
- Endangered areas under different SLR scenarios, year 2100

Sea level rise scenario (m)	Area to be inundated (ha)
0.3	2090
1.0	5555
2.0	8905

Source: Perez, R.T., Amadore, L.A., & Feir, R.B. (1999)

- Projected population to be affected by 1m SLR, year 2025

Place	1990*	1995*	2025**
The Philippines	62,049,000	68,614,000	143,096,245
Cavite	230,506	257,706	658,762
Metro Manila	429,600	510,794	1,443,228
Bulacan	130,000	140,790	227,166
		Total	2,329,156

*Based on NSO data
**Based on computer models from the Commission on Population, UPPI
Source: Perez, R.T., Amadore, L.A., & Feir, R.B. (1999)

Process of conducting the study

In deriving the outputs, Peres, Amadore and Fier (1999) recapped the activities that they performed. These are:

1. Delineation of the study area and specification of ASLR scenarios-Manila Bay. Also, included is the setting up of SLR scenarios at low SLR, set at 0.3 m; High SLR, set at 1 m; and worst case scenario – 2 m SLR

2. Inventory and characterization of study area. This covered the physical environment, coastal resource profiling, economic resource profiling, industry profiling,

3. Aerial videotaping through helicopter flying and using the technique of Leatherman et al. called Aerial Videotape-assisted Vulnerability Analysis (AVVA), a method used for assessing the implication of land use into sea level rise. To guide the aerial videotaping maps were acquired. These are base maps with a scale of 1:10,000 and other maps obtained from the Coast and Geodetic Survey Department (CGSD). The helicopter was flown from Bataan to Cavite and back at 75 m altitude. Still photos and an 8mm video coverage were taken during the flight.

4. Ground truth measurements conducted in identified spot heights, in which spacing depended on nature of terrain and the heights and positions of spot heights plotted in survey forms.

5. Identification of needs and actions based on the results of the vulnerability analysis done through aerial and ground truthing. Appropriate responses depended on site-specific conditions, costs, land use, and coastal infrastructure. In setting the needs and actions, the following were considered:

    a. Costs of response strategies
    b. Relocation of people and infrastructures
    c. Adoption of policies and laws restricting habitation and investment in vulnerable areas
    d. Public education about the coastal environment for the government and people
    e. Flood protection projects to address flooding brought by ASLR
    f. Further research on coastal processes, and rational use of coastal resources, i.e. mangrove forests, coral reefs, and artificial coastal protection
    g. Dislocation of people and changes in their livelihood or danger of "environmental refugees"
    h. Enhancement of coastal zone management plans by addressing sea level rise, through: management of shoreline flood plain hazards for the protection of life and property including evacuation planning.
    i. Prevention of salt water intrusion through conservation of fresh water;
    j. Preservation of public access to and regulation of coastal recreation areas;
    k. Conservation of wetlands, estuaries, and near-shore habitats; and
    l. Planning the sustainable development of natural resources, i.e. ground water, sand, and corals

6. Formulation and recommendation of adaptation measures covering sea level rise, policy and institutional implementation arrangement.

I.7.c. Conditions of method application

The tool engaged airborne methodology where a helicopter was used to fly over the site for assessing its condition. Video scenes were taken and transcribed into useful forms. The approach is appropriate to be implemented by the Philippine Airforce to perform climate change vulnerability assessment in coordination with the DENR and LGUs for technical assistance.

I.7.d. Challenges, lessons learned, and recommendations

Several recommendations in addressing sea level rise alongside corresponding policy interventions are noted below:

Addressing sea level rise

- Long-term planning in the context of ICZM practices
- Integrated coastal zone management (ICZM) – a collaborative governing process which integrates coastal zone development and management with environment and socio-economic goals through participation of the community and all coastal zone stakeholders.
- Allocation of environmental, socio-cultural, and institutional resources are aimed towards conservation and sustainable multiple use of coastal zones
- Levels of vulnerability and sustainability will be the basis of assessing the need to integrate climate change in ICZM
- Government actions:
    - o Fisheries Sector Program (FSP):
        – Mangrove reforestation in 12 priority bays through contracts with private companies
    - o Coastal Environmental Program (CEP)
        – Modified FSP into a community-based coastal resource management

– 12 pilot areas, 1 in each region, were selected to implement CEP
– Community leaders are trained to manage cooperatives and people's organizations, and to develop a management plan, taking into account the 5 components of the program:

1. Habitat conservation and management
2. Protection of endangered species
3. Monitoring and control of coastal pollution
4. Inventory/assessment of coastal resources
5. Applied research and special projects

- The Local Government Code (LGC) of 1991 or RA 7160
    - o LGUs are empowered to plan and implement development programs or projects within their areas, without waiting for the initiative of national government
    - o Under LGC, coastal resource management is a primary responsibility of LGUs

Proposed policy intervention

- Assessment of current practices on crisis management, in relation to climate change
- Awareness raising on climate variability and change, through:
- ICZM legislation and implementation, including land use planning
- Institutionalization of mangrove development and protection
- Reservation of potential recreational and tourism coastal areas
- NIPAs should include wetlands, swamps, and marshes

Institutional vehicles for implementation and role of stakeholders

- Involvement of coastal stakeholders in the development and implementation of ICZM as they serve as source of political will which initiates community action
- Involvement of community groups, i.e. fisherfolk and their families, coastal zone workers, community leaders, etc. in the daily ICZM tasks, such as: monitoring of stream water quality, clean-up activities, monitoring discharges from coastal zone activities, watershed management, and adoption of sustainable mangrove reforestation and sustainable fishing techniques.

Impact of the project

After the project no reports were published where impacts of the use of the tool were presented. Thus, there was no basis in assessing its impacts.

Resource intensity of method

Personnel and expertise may be limited to people in the Philippines Airforce. Lack of expertise may be augmented by DENR, NAMRIA and other government agencies with relevant capability.

Benefit – cost ratio

There is no basis in the assessment of the benefit and cost of the project. Probably beneficial in estimating area affected. Degree of damages may be well measured on the ground rather aerial. The cost of flying over an area to get video footages may be expensive, thus, resulting in a net cost rather than benefit.

Potential and recommendations for replication or integration

Replicate the methodology accompanied with a time and motion study and cost analysis in selected areas, probably in areas where there are receding shorelines.

Mainstreaming and climate proofing

II

II.1. Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in Subnational Development and Land Use/Physical Planning: The Case of Surigao del Norte

II.1.a. Entry point into the adaptation process for method application

No single place in the Philippines is exempted from the hazards due to climate change and disasters. Anywhere, anytime, typhoons or any extreme climatic events may strike. Two laws were promulgated to prepare the country in any climate change and disaster situation. These laws are the DRR Law and the other is the Climate Change law. All local government units are required by these laws to integrate into their comprehensive land use plan and comprehensive development plan strategies to address DRR and CCA concerns. NEDA the primary office responsible in formulating strategies in development and land use planning recognized the importance of having a tested methodology for mainstreaming DRR and CCA into the physical land use and development planning of every municipality in the country.

The study's primary concern was to demonstrate a methodology integrating DRR and CCA into the comprehensive land use planning and comprehensive development planning in one of the provinces in Mindanao, the province of Surigao del Norte (NEDA, 2008). Since most of the municipal planners nationwide are not yet familiar on the processes of operationalizing DRR and CCA, the study had showed how DRR and CCA starting from vulnerability assessment to formulation of mitigation and/or adaptation strategies can be mainstreamed into the comprehensive land use plan and comprehensive development planning of every MLGU in the country (NEDA 2008).

All municipal planners were targeted to benefit from the study. Using the processes for vulnerability assessment was expected to make all land use plans, DRR and CCA compliant.

II.1.b. The methodological approach

The study used the IPCC framework on vulnerability assessment.

Inputs: Data and information used in the study

The urgency of preparing all LGUs and communities nationwide due to climate change and disaster related hazards was one of the primary considerations of the team in search of useful data and information vital for the study compelled the team to utilize secondary data available from the different NGAs of the government. Thus, first of their agenda was to list all NGAs that have authority over climate change and disaster-related hazards and coordinate with these agencies for assistance (NEDA, 2008). These agencies including the types of data that they can provide are summarized in Table 4.

Table 4. Type of data used in the mainstreaming study in Surigao del Norte

Geologic hazards	Responsible agency	Hydrometeorological hazard	Responsible agency
Earthquake-related: Ground shaking, liquefaction, subsidence landslide, debris flow, fault rupture, tsunami	PHIVOLCS	Extreme rainfall, tropical cyclone, storm surge, tornado, thunderstorm, flood (riverine floods, cloastal floods, flashfloods), drought (low river flows, agricultural, domestic water supply, groundwater), sea level change	PAGASA
Volcanic activities: Ballistic projectile, pyroclastic flow, lava flow, steam explosion, ashfall, debris avalanche, sector collapse, lahar, volcanic gas	PHIVOLCS	Rain-induced landslides, ground subsidence/ settlement, coastal and inland erosion and aggradations	MGB
Others: Sinkhole formation Gound subsidence			

Source: NEDA, 2008

Corrected digital hazard maps were preferred over printed maps to facilitate data processing. A sample of the hazard map (rain-induced landslide) that the team prepared using GIS is shown below.

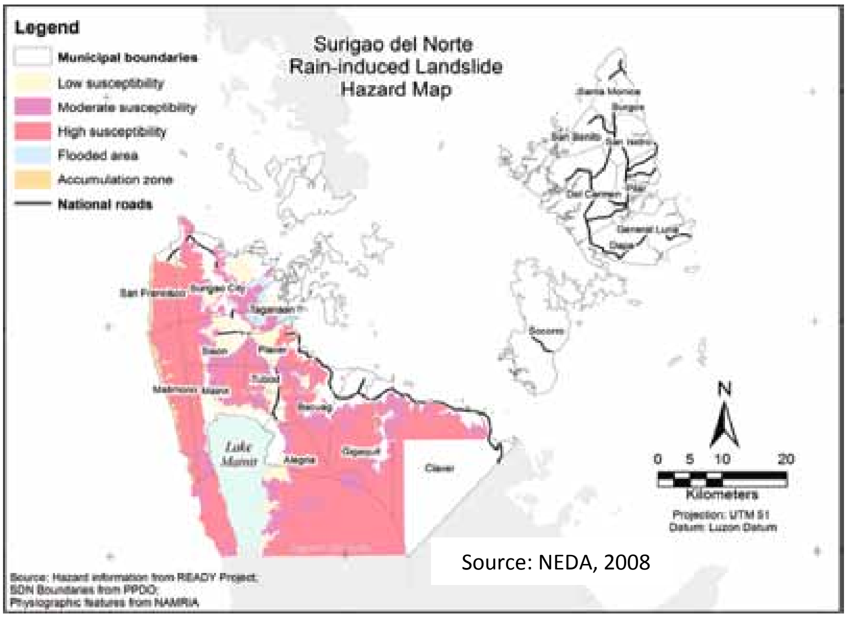


Figure 7. Rain-induced landslide hazard map of Surigao del Norte

Other hazard maps were produced using the same mapping process. Such maps were intentionally excluded from this report to save on space. Interested reader(s) may contact the author.

Outputs of the study

Based on the report by NEDA (2008), the outputs of the study were processed data presented in tabular form and digital maps. The outputs were products of several processes and activities that were firmed up and validated through experts' and stakeholders' consultations. It is important to note that information should be estimated by specialists in their own fields. For instance, hazards' frequencies and return periods, say of earthquake, require complicated mathematical and statistical formulas that only the experts are knowledgeable of. Taking this as a crucial ingredient of planning ensures proximity of projected scenario to reality (NEDA, 2008). The results of the study are presented in tabular form are shown in the following sections.

a. Types of hazard, origin, frequency of occurrence and return periods.

Origin	**Hazard**	**Hazard occurrence frequency**	**Return period**
Geologic	Earthquake-related		
	Earthquake-induced landslide	4.9 – 6.1 (Frequent)	5
	Ground shaking	6.2 – 6.9 (Likely)	13.4
	Ground rupture Liquefaction	>7.0 (Rare)	51.4
	Volcanic eruptions	Frequent	300 and below
		Likely	Above 300-600
		Rare	Above 600
Hydrometeorologic	Rain-induced landslide	Frequent	5
	Storm surge	Likely	25
		Rare	100
	Floods	Frequent	≤10
		Likely	>10

Source: NEDA, 2008

b. Inventory of hazards in the study area

Hazard	Available Map	Hazard Description Susceptibility/Proneness	
		Levels	Areas covered
Rain-induced landslide	MGB	HSA (with accumulation zone)	San Francisco Malimono Alegria
		MSA	Sison (southeast)
		LSA	Surigao Placer

Source: NEDA, 2008

c. Affected population

Municipality/ city	**Barangay**	**Land area**	**Population**	**Pop. density (person/ sq. km)**	**Affected area**			**Potentially affected population by event**		
					HSA	MSA	LSA	Frequent	Likely	Rare
Surigao City	Talisay	16.32	1823	111.70	0.00	0.00	0.00	0.00	0	0
	Mat-i	11.30	4304	380.88	4.09	2.97	0.73	1557.80	2689.01	2967.06
	Taft (Pob.)	1.17	16917	14,458.97	0.12	0.26	0.00	1735.08	5494.41	5494.41
	Cabong-bongan	3.53	608	172.24	0.93	0.30	0.40	160.18	211.86	280.75
	Punta Bilar	0.72	830	1152.78	0.37	0.30	0.00	426.53	772.36	772.36
Municipality B	...									

Source: NEDA, 2008

d. Affected property

Municipality/ city	Land use	Land area (km^2)	Unit property value (Php/sq km)	Affected area			Value of affected property
				HSA	MSA	LSA	
Surigao City	Agricultural land 6	8.11	3,159,727	8.11			25,625,385.97
	Agricultural land 7	0.46	3,159,727	0.46			1,453,474.42
	Agricultural land 8	7.14	3,159,727		7.14		22,560,450.78
	Agricultural land 9	1.97	3,159,727			1.97	6,224,662.19

Source: NEDA, 2008

e. Fatality

Municipality/ City	**Barangay**	**Pop. Density**	**Potentially affected population**			**Factor for fatality**			**Consequence in terms of Fatality**		
			Frequent	**Likely**	**Rare**	**Frequent**	**Likely**	**Rare**	**Frequent**	**Likely**	**Rare**
Surigao City	Cabong-bongan	170.82	158.86	210.11	278.44	3.30×10^{-5}	6.60×10^{-5}	1.00×10^{-4}	0.0052424	0.0138673	0.027844
	Mat-i	314.60	1,286.71	2,221.08	2,450.73	6.60×10^{-5}	1.33×10^{-4}	2.00×10^{-4}	0.0849229	0.2954036	0.490146
	Taft (Pob.)	16,935.90	2,032.31	6,435.64	6,435.64	1.00×10^{-4}	2.00×10^{-4}	3.00×10^{-4}	0.2032310	1.2871280	1.930692

Source: NEDA, 2008

f. Property damaged

Municipality /City	**Land Use**	**Land Area (km^2)**	**Unit property value (Php/sq km)**	**Potentially affected property**			**Factor for property damage**			**Consequence in terms of property damage**		
				HSA	**MSA**	**LSA**	**Frequent**	**Likely**	**Rare**	**Frequent**	**Likely**	**Rare**
Surigao City	Agricultural land 6	8.11	3,159,727	25,625,385.97			0.17	0.33	0.50	4,292,252.15	8,520,440.84	12,812,692.99
	Agricultural land 7	0.46	3,159,727	1,453,474.42			0.08	0.17	0.25	119,911.64	243,356.97	363,368.61
	Agricultural land 8	7.14	3,159,727		22,560,450.78			0.33	0.50		7,501,349.88	11,280,225.39
	Agricultural land 9	1.97	3,159,727			6,224,662.19			0.25			1,556,165.55

Source: NEDA, 2008

g. Risk estimates

Barangay	Hazard Occurrence	Consequence in terms of fatality	Return Period	Probability of occurrence (inverse of return period)	Risk of fatality (Persons/Year)
Taft	Frequent	0.2032310	5	0.20	
	Likely	1.2871280	25	0.04	0.20590
	Rare	1.9306920	100	0.01	0.05792
Mat-i	Frequent	0.0849229	5	0.20	
	Likely	0.2954036	25	0.04	0.04726
	Rare	0.4901460	100	0.01	0.01470

Source: NEDA, 2008

h. Risk on property damage

Municipality Subareas	Hazard Occurrence	Consequence in terms of property damage	Return Period	Probability of occurrence (inverse of return period)	Risk of property damage (Php/Year)
Surigao City, Agricultural land 7	Frequent	119,911.64	5	0.20	
	Likely	243,456.97	25	0.04	38,953.11
	Rare	363,368.61	100	0.01	10,901.06
				Total	49,854.17
Surigao City, Agricultural land 8	Frequent		5	0.20	
	Likely	7,501,349.88	25	0.04	
	Rare	11,280,225.39	100	0.01	338,406.76
				Total	338,406.76
Surigao City, Agricultural land 9	Frequent		5	0.20	
	Likely		25	0.04	
	Rare	1,556,165.55	100	0.01	15,561.66
				Total	15,561.66
Surigao City, Built-Up3	Frequent	5,857,020.00	5	0.20	
	Likely	11,714,040.00	25	0.04	1,874,246.40
	Rare	17,571,060.00	100	0.01	527,131.80
				Total	2,401,378.20
Surigao City, Built-Up4	Frequent		5	0.20	
	Likely	41,987,988.20	25	0.04	
	Rare	62,981,982.30	100	0.01	1,889,459.50
				Total	1,889,459.50

Source: NEDA, 2008

i. Risk scores and ranked

Municipality	Risk Scores			Municipality scores	Priority
	Fatality	Built-up areas	Agricultural areas		
Alegria	2			2	Priority
Bacuag	2		2	4	High priority
Malimono	3	2	2	7	Urgent
....nth municipality					

Source: NEDA, 2008

j. Evaluated risks

Hazard	Risk Evaluation		Implications
	Risk Estimates and High-risk Areas	Vulnerabilities	
Single or multi-hazard	Number of fatalities and costs of damages to properties Ranking and prioritization of areas at risk	Examples: Urban center is located in a high-risk area Poor condition of roads and bridges	Implications to land use and physical framework i.e. identification of alternate transport routes, or rehabilitate existing ones

Source: NEDA, 2008

k. Vulnerable areas and implications

Hazard	Risk Evaluation		Implications
	Risk Estimates and High-risk Areas	Vulnerabilities	
Flooding	Brgy. Poblacion in Bacuag – most susceptible to all four hazard types; Estimated fatality = 1 or more out of 10 persons, to 1-10 fatalities out of 1000 persons/year. The rest of the barangays, both rural and urban, are also exposed to the hazards. Estimated property damage from flooding: Claver – PhP 6.6 M Bacuag – PhP 6.1 M Gigaquit – PhP 2.8 M About 8.22 sq km of agricultural areas are prone to flooding 198.94 sq km are highly susceptible to rain-induced landslide Coastal communities are prone to flooding and storm surge	Low-lying agricultural areas are prone to flooding. They require adequate drainages to minimize overflow to the urban areas. Each of the three municipalities has areas susceptible to flooding, as well as to storm surge. Areas ideal for mixed farming and agroforestry, particularly in Claver, are susceptible to rain-induced landslides.	Disasters can have a drastic effect on the economic conditions of the area, with impacts that would extend to livelihoods such as rice farming, coconut, aquaculture, and mining. Claver may not be able to achieve a large town status due to its susceptibility to flooding, hindering potential investments. Major impacts of also include loss of income for families whose main livelihoods include farming and mining-related activities.

Source: NEDA, 2008

l. Measures addressing risks

Risk	Strategies			
	Risk avoidance;	**Risk reduction**	**Risk sharing**	**Risk retention**
Infrastructure risks	Relocation of structures in high-prone areas	Strengthen hazard-resisting capacity of structures	Develop alternate location for key functions	Take no action
Social and cultural risks	Prohibit occupancy of hazardous buildings	Identify needs of various population groups	Promote incentives for homeowners, renters	Prepare shelter plans
Economic risks	Development of business retention and job placement programs	Diversify income sources	Shared responsibilities between government and private/business sector	Special funds for lost revenues
Natural resource/ environmental risks	Elimination of sources of pollution	Launch clean-up efforts	Greater shared responsibilities of IPs in the management & protection of forests	Take no action

Source: NEDA, 2008

Process of conducting the study

The activity flowchart of the study by NEDA (2008) is presented in the following figure. Sub-activities like calculations of required indicators are briefly described in this section.

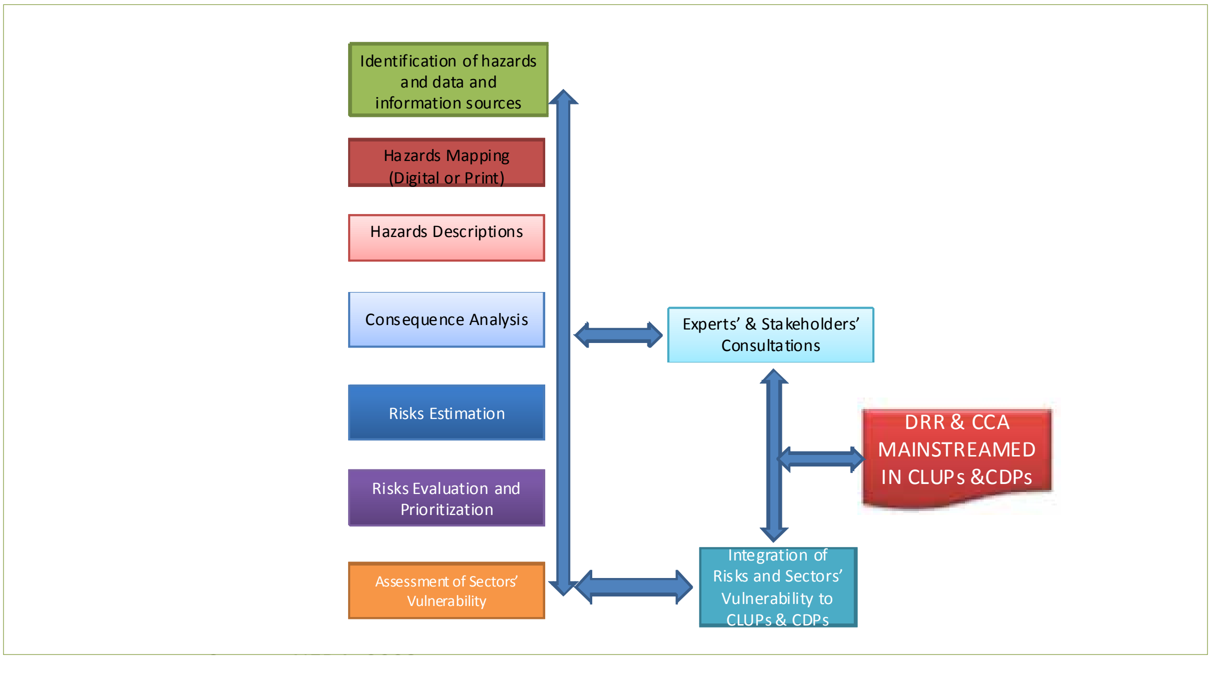


Figure 8. Activity flowchart of mainstreaming DRR and CCA

Source: NEDA, 2008

Estimates of return period for earthquake-related hazard events were based on the peak ground acceleration (PGA), also called g value, and the earthquake zone generator, or zone. The g values and the source of earthquakes were obtained in the PGA Amplitude Map. Assigning return periods for volcanic eruptions was based on the activity level and location of volcanoes (in relation to susceptibility level). Active volcanoes are those with historical records of eruptions within the last 600 years. Potentially active volcanoes are those that appear young in structure but with no historical record of eruptions. Inactive volcanoes – that have no historical record of eruption in the last 10,000 years (NEDA, 2008).

Hydrometeorologic hazards are defined as estimates of return period for rainfall were based on the Rainfall Intensity Duration Frequency (RIDF) tables. Such data can be provided by the Hydrometeorological Investigation and Special Studies Section, Flood Forecasting Branch of PAGASA (NEDA, 2008).

a. Consequence Analysis

Consequences in terms of fatality– how many will likely die – and the cost of property damage – how much damage will be incurred per each hazard event will now be identified, by multiplying the PAP and PApr with the factors (NEDA, 2008).

This process involved estimating the consequences in terms of the elements at risk: fatality and property damage.

Estimating fatality was represented by:

$$C_F = P_{AP} \times F_F$$

C_F = consequence in terms of fatality per hazard event (fatality/event)
P_{AP}= potentially affected population
F_F= factor for fatality (multiplier from 0 to 1 representing the fatalities based on the total potentially affected population as an outcome of a hazard event)

Estimating property damage was represented by:

$$C_{PrD} = P_{APr} \times F_{PrD}$$

C_{PrD} = consequence in terms of property damage per hazard event (fatality/event)
P_{APr}= potentially affected population
F_{PrD} = factor for property damage (for estimating the proportion of properties damaged by a hazard event)

Risks estimation

This phase aimed to estimate the risk of hazards in terms of fatality and property damage.

Estimating risk of fatality is represented as:

$$R_F = P \times C_F$$

R_F = risk of fatality (fatality/year)
P= probability of occurrence of hazard event (difference between reciprocal of return periods of two incremental hazard events)
C_F= consequence in terms of fatality per hazard event

Estimating risk of property damage is represented as:

$$R_{PrD} = P \times C_{PrD}$$

R_{PrD} = risk of property damage (PhP/year)
P= probability of occurrence of hazard event (difference between reciprocal of return periods of two incremental hazard events)
C_{PrD} = consequence in terms of cost of property damage per hazard event

Risks in terms of fatality and property damage can be computed using the data on return periods (from the hazard inventory) and the data on estimated fatality and property damage per hazard event (from the consequence analysis). This procedure will be repeated for other types of hazards.

b. Risks evaluation and prioritization

This phase aimed to identify the areas which should be given priority based on risk estimates; and assess the vulnerability of various sectors in these identified priority areas. Risk prioritization score for each municipality will be obtained by using the data on estimated risks of fatality and property damage. Estimated risk values will have corresponding scores, as indicated in the risks of fatality (NEDA, 2008).

To be able to prioritize the risks of fatality, criteria for doing so were established for risks evaluation and prioritization as shown in the following table.

Risk Levels		**Risk Score**	**Acceptability/ Action needed**
Description	F		
High risk to very high risk	10^{-2}	Urgent	Highly intolerable; Needs extensive investigation and implementation of options; Can be expensive
			Moderately intolerable; Needs detailed investigation, planning, and implementation of options;
Moderate risk	10^{-5} to 10^{-2}	High priority	Intolerable; Needs further investigation, planning, and implementation of options
Very low risk to low risk	10^{-5}	Low priority	Tolerable; Existing plan is implemented to maintain/reduce risk

For determining priority scores based on property damage, the NDCC framework of calamity in the Philippines was adopted as the basis of thresholds.

c. Assessment of Sector Vulnerability

In assessing the vulnerable sectors, criteria were also defined. The criteria are shown in the following table. Map overlays were conducted to classification and describe the vulnerable areas.

Map Overlays	Risk Issues (Risks and estimates)	Explanation-description (Vulnerabilities)
Single or multi-hazard	Numbers of fatalities, and costs of property damage Ranking and prioritization of at-risk areas	Vulnerability of high risk or priority areas (description of vulnerabilities of population and properties)

Source: NEDA, 2008

d. Mainstreaming the results of risk and vulnerability assessment results in planning

All the risks and vulnerability results, including the processes were recommended for the integration of DRR and CCA into the land use and physical framework plan (NEDA, 2008). As a result, all comprehensive land use plans and comprehensive development plans of all municipalities due for revision and updating were encouraged to use the process in order to mainstream DRR and CCA into their plans to attain sustainable development.

II.1.c. Conditions of method application

Stakeholders and institutional setup

The project was implemented by NEDA. Being an office attached to the Office of the President of the Philippines, it is the national lead office in economic development planning at the macro level. The government agencies that cooperated with NEDA in various forms of assistance are the PAGASA, DENR-MGB, and PHILVOCS. PAGASA's role is in the provision of weather or climate data and return periods of tropical cyclones, El Niño and la Niña, DENR-MGB for its hazard maps and PHILVOCS for its fault line and earthquake maps and return periods of events.

Resources

NEDA had no problems with personnel and expertise assigned and implemented the project with assistance from experts from the different government agencies and consultants. Also, funds were not a problem.

Duration and estimated funds used in the conduct of the study

The study was under the MDGF 1656 where climate change vulnerability assessment by sector was contracted to institutions with contract cost ranging from PhP2, 000,000 to PhP3, 000,000 for a period of 1 year. The climate change vulnerability assessment for health was part of the MDGF 1656 where it was contracted with a total budget of PhP3, 000,000. It is possible that the pilot project in Surigao had more or less similar amount of contract cost. Area wise, assuming that 3 million was the contract cost for Surigao Del Norte, which is province wide, the cost becomes lesser per unit area.

II.1.d. Challenges, lessons learned, and recommendations

Impact of the project

The piloting of the project was intended to generate experience and judgment on the workability of the process for climate change and disaster risk assessment and mainstreaming of these to the comprehensive land use and development planning of every municipality. Thus, lessons and experiences, effective and efficient processes and methods gained from the piloting the project were already introduced by NEDA to make the planning process compliant to DRR and climate change.

Resource intensity of method

Judging from the numerous indicators used in the process of vulnerability assessment, there was a dearth of data on the different hazards and their measurable impacts and sensitivities which are important inputs to derive a science-base vulnerability assessment. The computational requirements are data dependent which should be made available to make the formulas sensible and useful for the vulnerability assessment process. Also for all hazards, the return periods and probabilities of occurrences are necessary inputs to the process.

Cost-benefit ratio

Comparing the method used in this study with other methods shows that this approach is more expensive on a per project basis because of the so many quantitative variables that will have to be determined. However, considering the many information given by this method and the degree of data and information accuracy assuming that the formulas are correct, the cost becomes cheaper which means that it has a higher benefit to cost ratio. Also, one factor that saved a lot of fund is the data sharing from other government agencies. The other consideration that makes this method cheaper compared to other methods is when the total cost is expressed per unit area. Assuming a total contract cost of PhP3 million scaled down to a per hectare basis shows that this method has the least cost compared to others.

Potential and recommendations for replication or integration

The project is worth replicating in other provinces to have more information useful for its evaluation and probably for further refinements if possible. Also, if budget warrants, time and motion studies and fund utilization studies be integrated in the replication projects. Likewise, after using the methodology, impact studies to gage the benefits of the method must be conducted.

III Monitoring and evaluation

III.1. Integrated Monitoring and Evaluation System for Health

III.1.a. Entry point into the adaptation process for method application

The DOH developed the Philippine Integrated Disease Surveillance and Response (PIDSAR DOH Administrative Order 2007-0036 dated October 2007) system before climate change gained importance as a major consideration in development and governance. It was used by the DOH in detecting and treating diseases that occur anywhere in the country. It was a reactive system instead of a proactive surveillance system. In most cases human disease carriers in far and inaccessible places without health hospitals/clinics remained untreated, thus serving as a disease vector. To totally get rid of diseases such as malaria and dengue, it is advisable for DOH and PHOs to continuously monitor areas suspected as an abode of such diseases.

The objective of the study was to design and M&E system that will cater to CC-related diseases by improving PIDSAR to conform to climate change concerns. Disease prevalence was increasing due to rainfall, temperature, relative humidity and solar radiation extremities. PIDSAR was modified to make it capable of monitoring diseases as well as climate change indicators at the same time so that effective preventive, treatment and control measures or collectively, adaptation measures together with needed resources may be prepared ahead of time.

The study was intended to give the DOH and LGUs an alternative monitoring and evaluation tool for climate change related diseases.

III.1.b. The methodological approach

The information provided by DOH on M&E was the PIDSAR and M&E systems of other NGAs like DENR, DA, DSWD, etc. and from the M&E of the International Federation of Red Cross and Red Crescent Societies. These M&Es monitor climate change adaptation and climate change programs. Part of the input is a matrix containing the activities, sector to be assessed, CC-related diseases and Reference M&E of other NGAs and international organizations. This matrix gave the team possible reference materials useful for designing an integrated M&E system for the health sector.

Framing the IMEH involved the setting up of definition of terms necessary in vulnerability assessment, identifying the sectors to be assessed considering climate change, identification of climate change-related diseases and the structures of other monitoring and evaluation systems being implemented by national government agencies as well as international organizations. The table in the following section presents the details of the elements that were taken into account when the IMEH was formulated.

Table 5. Conceptual framework of the integrated monitoring and evaluation system for health

Activity	Assessment Sector	Climate Change-Related Diseases	Reference M&E of NGAs and International Organizations
Vulnerability (based on IPCC definition)	Individuals, families, communities, environmental conditions (health and sanitation in families, family garbage disposal system, community waste management system, presence of open canals, stagnant water), Pathogen/Disease Vector	Dengue, Malaria, Leptospirosis, Cholera, Typhoid	
Adaptive capacity (based on IPCC definition)	Individual economic status, Household economic status, National and local policies on health, Health systems and infrastructures, Community participation, Local government assistance		
M&E systems			DOH PIDSAR, CCC National Framework Strategy on Climate Change (NFSCC) under the Climate Change Act, PAGASA weather monitoring system, LGU monitoring and evaluation system, DENR Results Monitoring and Evaluation System, DA M&E, DAR M&E, DOST M&E, DTI M&E, NEDA M&E, NSO M&E, International Federation of Red Cross and Red Crescent Societies, United Nations Development Program's (UNDP) Global Environment Facility.

Source: Lorenzo et al. 2011

Also, before formulating the revised PIDSAR, the team set a working principle or criteria to guide them in designing the integrated M&E system. The principles and criteria are summarized in Table 6.

Table 6. Criteria in designing the integrated M&E system for health

Sources	Principle/factor/Criteria
Climate Change Commission (NFSCC)	Assessment of the vulnerability of the health sector to climate change
	Improvement of climate-sensitivity and increase in responsiveness of public health systems and service delivery mechanisms to climate change
	Establishment of mechanisms to identify, monitor and control diseases brought about by climate change; and improved surveillance and emergency response to communicable diseases, especially climate-sensitive water-borne and vector diseases
DOH	Improvement of existing surveillance system being implemented
	Cost effective
	Technologically compatible
NEDA	Consistency with UNFCC and UNDP requirements
	Within affordability of the national government
	Improvement of existing M&E system in DOH
LGU	Consistency with DOH requirements
	M&E system within skills of provincial health officers, rural Health units and barangay health centers officers.
	M&E system within LGU budget allocation
Project Team	Effectiveness in validating policies, programs, and projects impacts on the changes and improvements in the situation of affected groups
	Simple, provide quick findings, cost-effective and transparent operations, implementers' roles (accountabilities and responsibilities) well defined.
	Useful for decision-making at all levels, effective feedback mechanisms
	Few but relevant and practical indicators to measure in the field
	Annual M&E operations plan formulated and implemented by LGUs and PHOs.

Source: Lorenzo et al. 2011

The other input data were monitoring and evaluation principles, responsible actors, and levels, relevant tools, indicators collected, and indicators to be added. These are shown in Table 7.

Table 7. Other inputs to the integrated M&E

Monitoring and Evaluation Principles	**Actors / Levels**	**Tools**	**Indicators Collected**	**Indicators to be added**
Tracking of Implementation of Policy, Programs and Projects	*Policy*: DOH *Field level effectiveness*: RHUs, local governments	PIDSR aggregate report incorporated into the Field Health Service Information System (FHSIS) annual morbidity report	Health status statistics, health services coverage, notifiable diseases	Environment / climate indicators
Build on Existing Surveillance System by Integrating Environmental Data Collection	Enabling policy: DOH & DOST *Data analysis*: National, regional and provincial Health Offices	Yearly report showing correlations between notifiable diseases and environmental factors	Same as above	Correlation statistics
				Capacity building needs on data analysis at different levels
Promote transparency and demonstrate clearly-defined accountabilities and responsibilities.	Enabling policy: DOH *Field level application*: Regional, Provincial, City and Municipal levels	Yearly summaries that can be readily attributed to weekly, monthly, and quarterly reports	Health systems statistics	PAGASA providing data services on climate parameters to health system operators
Systematic communication and/or sharing of results across different levels	ALL levels	Reports, bulletins, press releases, radio broadcasts	Capacity building strategies for personnel of DRUs/ESUs; Availability of communication systems	Contact details of relevant media outlets and of health offices in various levels
Prudent selection of relevant and practical indicators	DOH, NDCC and Related Agencies	DAOs and other related policy issuances	Measures of usefulness of indicators	
Systematic review and development of the M&E system every 3 years	Enabling policy: DOH Inputs for system modification: All levels	M&E framework for the health sector	Results of periodic assessments	
M&E operations plan formulation and implementation	*DOH*: for integration into overall DOH annual operations plan	DOH annual operations plan	Budget for M&E	

Source: Lorenzo et al. 2011

Outputs of the study

The primary output of the study, according to Lorenzo, et al. (2011) is the revised PIDSAR in a diagram flowchart shown below.

The added features of the PIDSAR are the following:

1. Monitoring of climate change indicators
2. Monitoring of climate change disease impacts to vulnerable sectors
3. Monitoring of the effectiveness of adaptation measures applied

Details of the revised PIDSAR are summarized in the "DashBoard" matrix in the following page. The "dashboard" contains vulnerable areas to be monitored, indicators at 3 levels, monitoring unit by level, monitoring frequency and responsible agency.

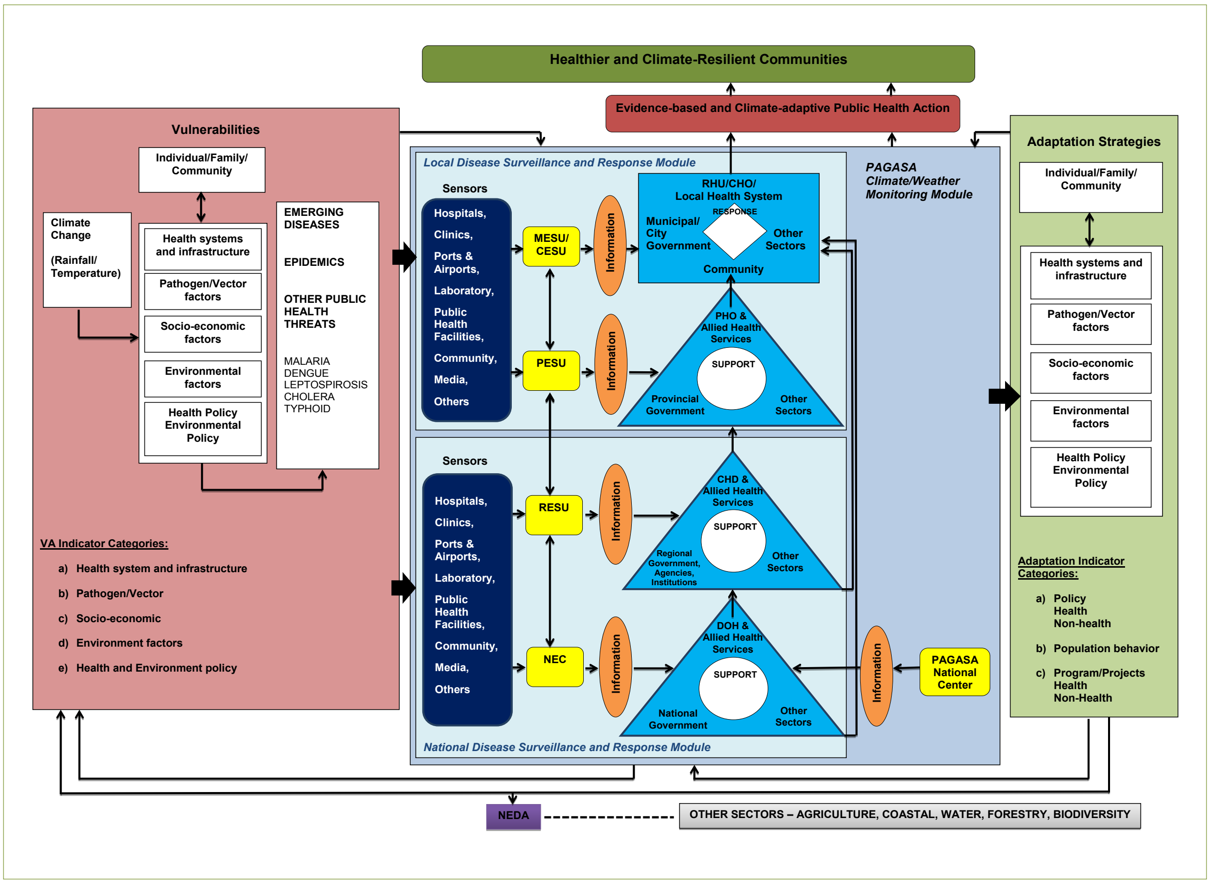


Figure 9. Flowchart of the revised PIDSAR

Source: Lorenzo et al. 2011

Table 8. Dashboard matrix of the revised PIDSAR

	DASHBOARD INDICATORS	**FIRST LEVEL INDICATORS**	**SECOND LEVEL INDICATORS**	**THIRD LEVEL INDICATORS**	**MONITORING LEVEL (B-Barangay, M-Municipal, P-Provincial, N-National)**	**MONITORING FREQUENCY (D-Daily, W-Weekly, M-Monthly, Q-Quarterly, A-Annually)**	**POSITION / AGENCY**
I. Climate & Environmental Parameters	CLIMATE CHANGE EARLY WARNING	% increase beyond rainfall threshold			P	D	NDCC with PHO
		% degree increase above temperature threshold			P	D	NDCC with PHO
II. Public Health and Health Service Interventions	EARLY DISASTER RESPONSE	increase in public awareness (say additional 10% of population)	Community participation in disaster preparedness projects & activities	Implementation of adaptation strategies	M	M	RHU/ BHS
		Functional disease surveillance system	Prevalence of diarrhea	Proper waste disposal: -% of HH with sanitary toilets % of HH with clean source of water % of HH with proper garbage disposal % of establishments with sanitary permits	M,P	W, M	SI-RHU PHO
			Number/% of (+) malarial smears	Active case finding: no. of probable cases	M,P	W	MHO-RHU PHO
			Number/% of validated dengue cases	Active case finding: no. of probable cases	M,P	W	MHO-RHU PHO

	DASHBOARD INDICATORS	FIRST LEVEL INDICATORS	SECOND LEVEL INDICATORS	THIRD LEVEL INDICATORS	MONITORING LEVEL (B-Barangay, M-Municipal, P-Provincial, N-National)	MONITORING FREQUENCY (D-Daily, W-Weekly, M-Monthly, Q-Quarterly, A-Annually)	POSITION / AGENCY
		Increased control of infectious disease	Incidence of diarrhea	Proper waste disposal: % of HH wit sanitary toilets % of HH with clean source of water % of HH with proper garbage disposal % of Establishments with sanitary permits			
			Implementation of programs on integrated vector management	Implementation of decanting activities	M	W	SI-RHU
	ACCESS TO PRIMARY HEALTH CARE	Increased diagnosis of malaria thru microscopy & rapid diagnostic test	Number/% of (+) malarial smears	Active case finding: No. of probable cases	M,P	W,M	MHO-RHU PHO
		Increased treatment of malaria	% of malaria cases treated	Availability of 1st-line and 2nd-line drugs	M,P,N	W,M	MHO-RHU PHO DOH
		Increased diagnosis of dengue cases	% of validated dengue cases	Active case finding: No. of probable cases	M,P	W,M	MHO-RHU PHO
		Increased access to treatment of diarrhea	% of diarrheal cases treated	% of HH with sanitary toilets % of HH with clean source of water % of HH with proper garbage disposal	M,P	W,M	MHO-RHU PHO

	DASHBOARD INDICATORS	FIRST LEVEL INDICATORS	SECOND LEVEL INDICATORS	THIRD LEVEL INDICATORS	MONITORING LEVEL (B-Barangay, M-Municipal, P-Provincial, N-National)	MONITORING FREQUENCY (D-Daily, W-Weekly, M-Monthly, Q-Quarterly, A-Annually)	POSITION / AGENCY
				% of Establishments with sanitary permits Nutrition status of under 5 children			
III.Environmental and social determinants of health	ENVIRONMENTAL HEALTH AND SAFETY	Integrated vector management	% of Provincial, city and municipal governments engaged in vector management	Existing and functional programs found in LGUs on integrated vector management	B,M,P	Q	CHO, PHO
		Effective Sanitary Programs	% Increase in awareness on sanitary programs	% of HH with sanitary toilets % of HH with clean source of water % of HH with proper garbage disposal % of Establishments with sanitary permits % decrease in food and water borne diseases	B, M, P	Q	SI- RHU PHO
IV. Health System and Infrastructure	INTEGRATED NATIONAL PROGRAM ON CLIMATE CHANGE	Stakeholder engagement:Existing partnerships of DOH with other CC-related institutions (government and private)	Existing framework and plan Existing working groups on CC	Outputs to collaborative work and projects brought about by existing partnerships	N N N	Q A A	USEC- DOH DOH NEDA DOH LGUs

	DASHBOARD INDICATORS	FIRST LEVEL INDICATORS	SECOND LEVEL INDICATORS	THIRD LEVEL INDICATORS	MONITORING LEVEL (B-Barangay, M-Municipal, P-Provincial, N-National)	MONITORING FREQUENCY (D-Daily, W-Weekly, M-Monthly, Q-Quarterly, A-Annually)	POSITION / AGENCY
		Presence of funding for the CC program at the national level % of health facilities (hospitals, health centers, Barangay stations, clinics) with adaptation programs and are emergency and disaster preparedness					
	CC RESEARCH AND DEVELOPMENT	Research and development agenda % of funds/ grants in R&D for CC Funds raised and utilized for collaborative projects on CC at national and provincial levels	% of research proposals funded	Outputs/ Completion of researches funded	N	A	DOH CC related agencies NEDA

Source: Lorenzo, et al., 2011

Process of conducting the study

The activities undertaken during the development of M&E framework for health are shown in the flowchart below. This study by Lorenzo et al. (2011) is a part of the vulnerability assessment project earlier presented as separate case study on vulnerability assessment.

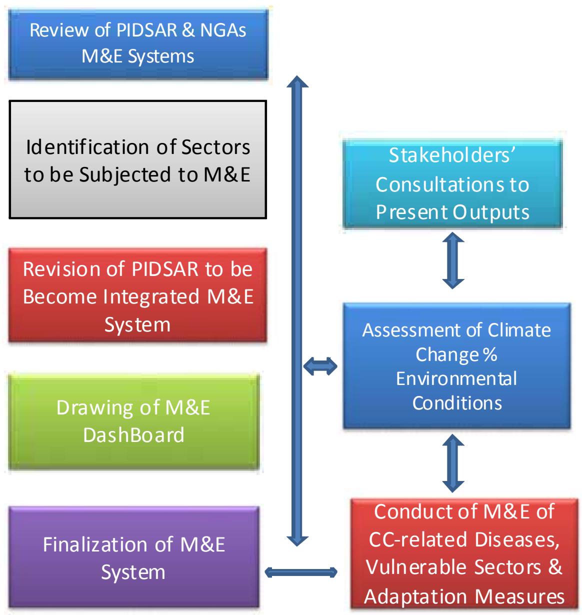


Figure 10. Activities undertaken during the development of M&E framework for health

Source: Lorenzo et al. 2011

III.1.c. Conditions of method application

The implementation of the modified PIDSAR relies on the close coordination among the LGU-PHOs, DOH and PAGASA. The role of PAGASA is to provide climate change information in advance to the LGU and DOH so that both can schedule their monitoring activities in the vulnerable areas. Through the barangay network of each municipality, the barangay leaders are the ones directly in contact with the community people. Thus, they are the ones who can identify in their respective barangays those that are inflicted with all types of diseases including those that evolved out of changing climate in their areas. The ability of the barangay monitoring officers to immediately convey observed disease cases in their community to the PIDSAR group determines the actions to be carried out to address such diseases.

Due to the need to diagnose the correct diseases, those in the modified PIDSAR group are highly specialized medical doctors equipped with sufficient experience and knowledge on how to cure, prevent and control such diseases.

Since most of the rural areas are not readily accessible to motorized land transport system, the PIDSAR members should be provided with suitable mode of transport for their mobility in the barangay.

For fast exchanges of information among the LGU, DOH and PAGASA a fast and reliable communication system should also be put in place and operational at all times especially during harsh climate and environmental condition.

Stakeholders and institutional setup

DOH is the lead agency in the implementation of PIDSAR in coordination with the LGU-PHOs. The barangay health workers may serve as the network of the LGU-PHOs in monitoring cc-related diseases in their respective barangays.

Resources

The barangay health workers may serve as the "ear and eye" of the residents affected with cc-related diseases. Funds may come from the regular appropriation of the PHOs at the provincial level.

III.1.d. Challenges, lessons learned, and recommendations

The application of the modified PIDSAR has not been followed up after integrating climate change dimension. There is no follow up study to evaluate the effectiveness of the PIDSAR in monitoring diseases particularly in the rural areas. Challenges may still arise in covering inaccessible areas.

Impact of the project

There has been no M&E on the impact of the modified PIDSAR. Thus, there is no basis for assessing its impacts.

Resource intensity of method

Manpower at the provincial down to the community level is vital.

III.2. MDGF 1656: Conduct of Climate Change Vulnerability and Impact Assessment Framework, Development of a Monitoring and Evaluation Framework/System, and Compendium of Good and Innovative Climate Change Adaptation Practices for the Health Sector

III.2.a. Entry point into the adaptation process for method application

In the whole spectrum of climate change impacts from floods, droughts, landslides, destroyed biodiversity, lack of food and water, including their combined factorial impacts altogether are received by humans and animals which at the bottom of the impact spectrum affect human and animal health. Amongst the climate change impact receptors, health is the most vulnerable. Recognizing the importance of health, the national government pursued impact assessment of the health sector to identify its vulnerabilities so that adaptation measures at all levels will be implemented.

NEDA, in cooperation with the Institute of Health Policy and Development Studies (IHPDS) – NIH of UP Manila, the Health Sciences Center of the UPS, and the Resources, Environment, and Economics Center for Studies (REECS), has joined expertise to address the vulnerability assessment of the health sector under the NEDA MDGF 1656.

The objectives of the study were to: a) construct a climate change vulnerability and adaptation framework; b) develop impact models and assess what would it be in 2020 and 2050 in terms of climate change related-diseases; c) determine the cost impacts in 2020 and 2050; d) search on local adaptation measures of cc-related diseases to be transformed into a compendium; and e) improve the current monitoring and evaluation system of the DOH.

The DOH, PHOs, rural health workers, and the people in general were the targets of the study. Also, policy makers and the LGUs were expected to benefit from the results of the study by coming up with CC-compliant policies and health governance strategies at the LGU levels.

III.2.b. The methodological approach

The conceptual framework of the study is shown in schematic diagram in the following page.

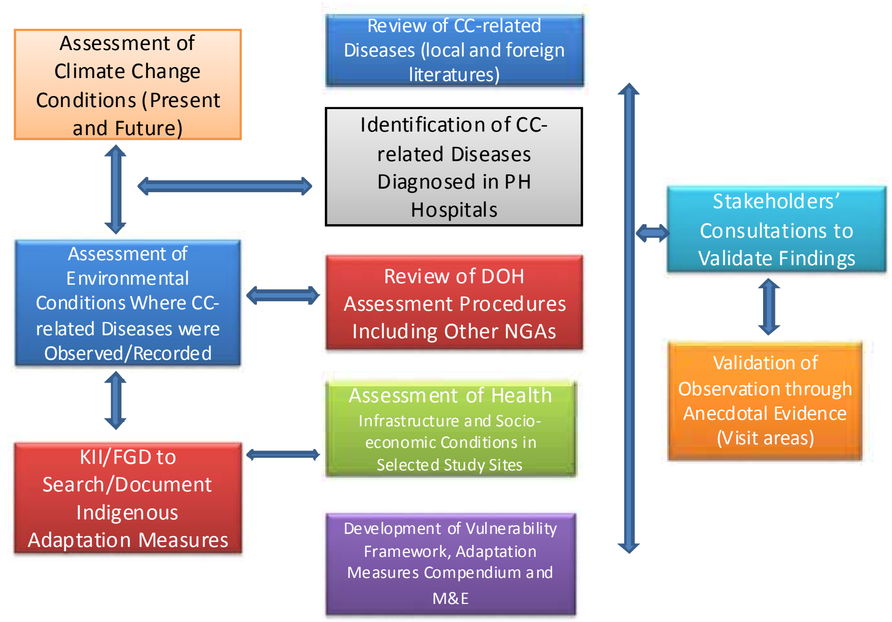


Figure 11. Conceptual framework of MDGF 1656

Source: Lorenzo et al., 2011

Inputs: Data and information used for the vulnerability assessment

Since NEDA was the lead agency in the climate change vulnerability assessments of the sectors covered under MDGF 1656, it coordinated with several NGAs and LGU-PHOs for assistance in terms of providing data and information to the team.

1. PAGASA provided the following data sets:

a. Rainfall
b. Temperature
c. Relative humidity
d. Solar radiation

2. DENR provided information on ecological characteristics of the following ecosystems that can probably contribute to CC-related diseases:

a. Coastline
b. Watershed
c. Topography
d. River ecosystem
e. Forest ecosystem

3. DENR, LGU, HLURB shared their data on the status and conditions of,

a. Solid waste management
b. Human settlement
c. Land use classification

4. NSO, DOH, LGU provided data on individual/family/community level demographic characteristics of selected study sites according to the following parameters:

a. Extreme age (very young and very old population)
b. Presence of indigenous population/communities
c. Access to safe water supply
d. Access to sanitation facilities
e. Access to health care insurance
f. Individual susceptibility (immune system, genetic predisposition, pre-existing diseases)

5. DOH, PhilHealth provided data on health system and infrastructure

a. Accessibility
b. Facilities and human resource capabilities
c. Ability to respond to emergencies and disasters
d. Availability of functional emergency/disaster preparedness plan
e. Monitoring and disease surveillance capacity
f. Forecasting and risk management capabilities regarding health impacts of climate change

6. DOH, PHO provided data on pathogen/vector factors

a. Pathogen/vector reproduction patterns
b. Presence of breeding sites
c. Location of breeding sites vis-à-vis community sites
d. Accessibility of preventive technology (i.e. vaccines, vector control)

7. Socio-economic factors (NSO)

a. Community and family income
b. Educational attainment
c. Awareness of climate change impact on health
d. Access to health care facilities
e. Health insurance coverage
f. Allocation of resources (local and national) to address CC vulnerability (health system and infrastructure)

Outputs of the study

The outputs on vulnerable sectors are summarized in the following table.

Table 9. Outputs on vulnerable sectors

Vulnerability Indicator	Dengue	Malaria	Leptospirosis	Cholera	Typhoid
Individual, family, community	Young and old ages that are exposed outdoor activities during dawn and dusk with poor sanitary practices and facilities, low immune system, poor hygienic practices, no access to sanitary water, and lack of health facilities are highly vulnerable.	All ages with poor sanitary practices and facilities, low immune system, poor hygienic practices, no access to sanitary water, lack of health facilities are highly vulnerable.	All ages, families, communities exposed in flood-prone areas where population of rats and animals are high are highly vulnerable.	All ages where water systems are easily contaminated with septic waste leakages during floods are highly vulnerable.	All ages foods and water taken are spoiled and contaminated are highly vulnerable.
Health systems and infrastructure	Highly vulnerable are those that have no access to clinics and hospitals and drug stores including other important medical facilities.				
Pathogen/vector factors	Communities and households environment that have no proper sanitation, no waste management system, presence of canals and water bodies that are habitat of pathogens and vectors are highly vulnerable.				
Socio-economic factors	Highly vulnerable are the poor sector of the population. Those that are below poverty income threshold level and cannot afford doctor's treatment as well as medicines.				
Environmental factors	Highly vulnerable are communities close to bodies of stagnant water, unsanitary environment, lack of waste management system, temperature, rainfall and relative humidity favoring the growth of pathogens and vectors.				
Health/environmental policy	Highly vulnerable are communities and families not covered by policies on the regular monitoring and treatment of diseases and maintenance of a sanitary environment.				

Source: Lorenzo et al. 2011

Output on adaptation practices are summarized in the following table.

Table 10. Outputs on adaptation practices

Adaptation Practices	**Dengue**	**Malaria**	**Leptospirosis**	**Cholera**	**Typhoid**
Individuals and Family					
Use of treated or untreated mosquito nets.	Proper use of nets at the right time and right place	Proper use of nets at the right time and right place			
Provision of screens and sealing of holes in houses	Prevent entries of mosquitoes	Prevent entries of mosquitoes			
Cleanliness of immediate household's surroundings	Removal of waters in containers inside and outside the house	Removal of breeding grounds of mosquitoes inside and outside the house by practicing proper waste disposal	Elimination of damp areas conducive for rat's habitat. Clean drainage system most often to prevent breeding grounds of rats		
Water, sanitation and good hygienic practices				Source out water for drinking that are safe or free from contamination. Sterilize water before drinking. Store foods properly avoiding contacts with probable carriers of cholera. Practice sanitation and good hygiene in the family.	Same as cholera

Consciousness on good health maintenance	Early diagnosis and treatment of climate change-related diseases.				
Maintenance of pets at home that can reduce growth of vectors and pathogens	Breeding of larvivarous species of fish		Maintenance of cats that feed on rats		
Barangay or Community					
Presence of active barangay health workers.	Report suspected cases to hospitals for immediate diagnosis and treatment	Microscopists for malaria only for immediate diagnosis and treatment of climate change-health related diseases	Report cases of suspected infected persons for treatment	Refer cases to hospitals for diagnosis and treatment	Refer cases to hospitals for immediate diagnosis and treatment
Decanting	Spraying pesticides that are not toxic to human being		Destroy rats and breeding grounds and habitat		
Provision of a centralized clean water sources that are well protected and maintained whole year round				Spring development; Prevention of water source contamination by sealing potential entry of pathogens/vectors.	
Community ordinances: zoning and resettlement of high risk groups or informal settlers.	Resettlement in dengue-free zones.	Resettlement in malaria free zone.	Resettlement in elevated and non-flood prone areas.	Remove sources of water contamination or resettlement contaminated groups.	
Proper waste management system at community level	Removal of wastes that promote growth of pathogens/vectors; cleaning of water ways		Eliminate breeding grounds of rats	Removal of sources of contamination; location of water sources away from sewage/waste damping areas. dengue	Prevent sources of pathogens/ vectors coming from waste/ sewerage areas.

Presence of manned and active health workers in BHCs.	Regular diagnosis, treatment and referrals/endorsement to hospitals that can treat diseases.				
Information and Education Campaign at the Community Level	Barangay Health Centers with regular information campaign activities for the barangay population regarding prevention adaptation measures of all diseases				
Health systems and infrastructure					
Presence of a network of complimentary hospitals complete with laboratory, medicines, and medical facilities within the province where costs of diagnosis and treatments are affordable.	Conduct thorough diagnoses and treatments of infected persons.				
Health care system	Philhealth card necessary for each family				
Holistic health maintenance projects	Fourmula-1, Vaccination, PIDSAR, etc.	Fourmula-1, PIDSAR, malaria treatment medicines, etc.	Fourmula 1, PIDSARS, leptospirosis treatment medicines	Fourmula 1, PIDSAR, cholera treatment medicines	Fourmula 1, PIDSAR, typhoid treatment medicines
Pathogen/vector factors	Dengue	Malaria	Leptospirosis	Cholera	Typhoid
Innovative practices to eliminate vectors and pathogens.	Solar insecticide capture and destroy		Rats trapping	Floating Toilet Device	Floating Toilet Device
Regular spraying of chemicals that are non- toxic to human beings to eliminate pathogens and vectors inside and outside the house.	Regular and simultaneous spraying that kills mosquitoes and other insects, fungi and other pathogens in all houses and breeding grounds in a barangay.		Regular and simultaneous decanting by barangay level.		
Elimination of growth factors and habitat.	Cleaning of water ways, streams and other water bodies, and proper sanitary practices at the household level.		Cleaning of canals; removal of rat habitat and wastes.	Avoid food spoilage by refrigeration and maintenance of clean and safe water sources.	

Socio-economic Factors	Dengue	Malaria	Leptospirosis	Cholera	Typhoid
Health subsidies in vulnerable communities or barangays.	Subsidies to all vulnerable families in the form of free or affordable health card.				
Provision of livelihood and income generating projects to increase income of vulnerable communities.	Planting, processing and marketing of medicinal plants proven to strengthen immune system; manufacture and marketing of decanting and trap gadgets; production and marketing of insect repellants; production, breeding and marketing of pets that feed on insects and rats.				
PPP for clean and safe water system				Replace old water system vulnerable to contamination	Replace old water system vulnerable to contamination
Environmental factors	Dengue	Malaria	Leptospirosis	Cholera	Typhoid
Forestation	Planting and management of integrated forest plantations that drive away mosquitoes	Planting and management of integrated forest plantations that drive away mosquitoes	Planting of forest species that attract rats from residential areas.		
Establishment, maintenance and management of sanitary landfills.	Eliminates breeding grounds of insects, pathogens and vectors.		Eliminates breeding grounds of rats.	Eliminates breeding grounds of insects, pathogens and vectors.	
Periodic cleaning and declogging of waterways, streams and rivers to allow waterflow continuously.	Breeding grounds of mosquitoes in stagnant water are destroyed.		Flowing stream prevents deposition of wastes for rat food.	Clean and declogged waterways also washout pathogens and vectors that live on stagnant water.	
Health/ environmental policy	Dengue	Malaria	Leptospirosis	Cholera	Typhoid

Policy on the integration of health and climate change education in primary and secondary education	Education on the prevention of dengue at home and in school	Education on the prevention of malaria at home and in school	Education on the prevention of leptospirosis	Education on the prevention of cholera	Education on the prevention of typhoid
Climate risk proofing policies	Adoption and implementation of adaptation measures for climate change-related health problems in all DOH projects				
Policy on mandatory coverage of population for health care system	Full coverage in highly vulnerable areas.				
Policy on Strengthened Provincial Disaster Coordinating Council	Creation of a sub-council on disease-related disaster prevention and management				
Disaster preparedness policy.	Nationwide capacity building of people on disaster preparedness brought about by climate change-related diseases.				

Source: Lorenzo et al. 2011

The vulnerability and adaptation assessment framework for health developed by the study team being recommended to be adopted by the DOH, PHOs and health workers are indicated in schematic diagram shown below.

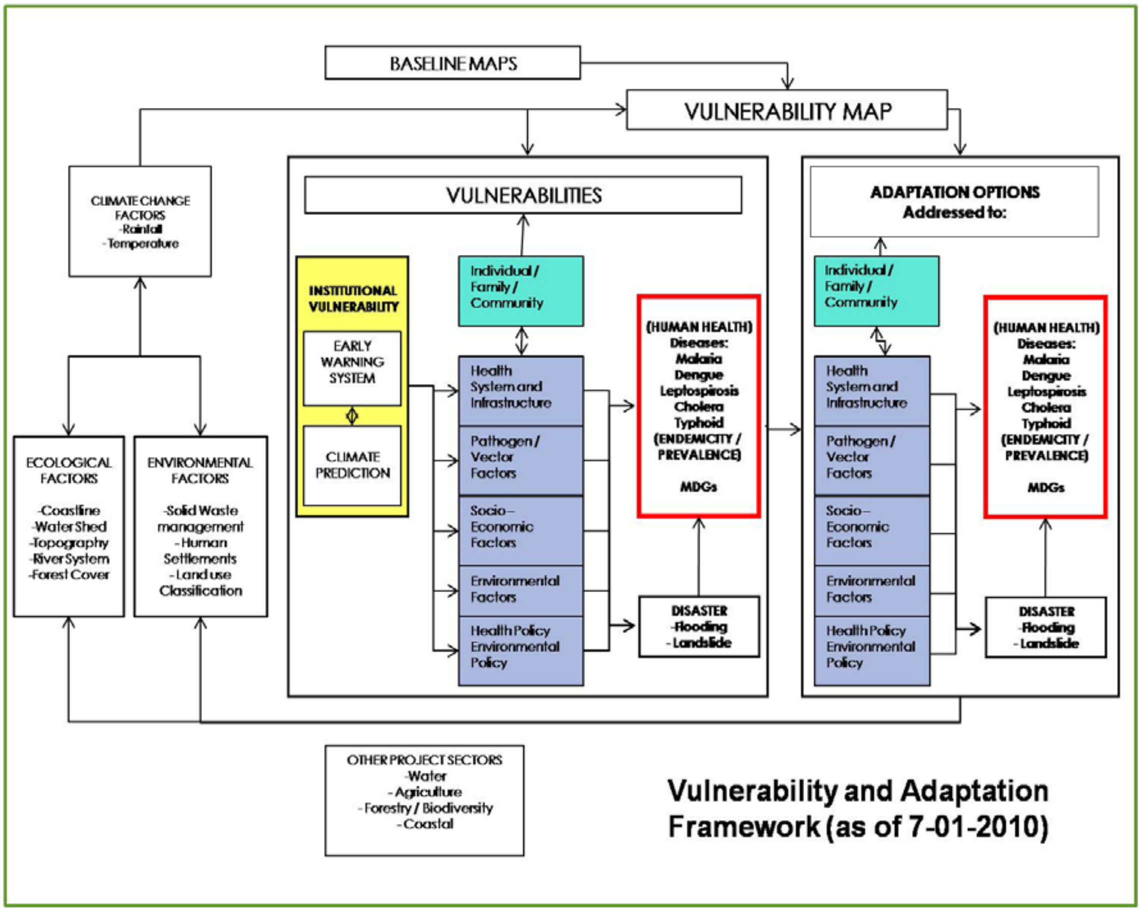


Figure 12. Framework of vulnerability assessment and adaptation

Source: Lorenzo et al. 2011

Based on the framework in schematic diagram drawn in the framing section of the study, the activities that were conducted in the assessment of areas vulnerable to climate change in terms of diseases according to Dr. Lorenzo, et al (2011) are:

a. Review of reports on diseases reported by the PHOs to the DOH.

b. Coordination and consultations with health and climate change stakeholders. The data and information needed from the different NGAs are summarized in the following table.

Table 11. Other inputs from NGAs

Source	**Type of Data**	**Source**	**Type of Data**
Climate change indicators (PAGASA)	Rainfall Temperature Relative humidity Solar radiation	Ecological factors (DENR)	Coastline Watershed Topography River ecosystem Forest ecosystem
Environmental factors (DENR, LGU, HLURB)	Solid waste management Human settlement Land use classification	Demographic (NSO, DOH, LGU)	Extreme age (very young and very old population) Presence of indigenous population/communities Access to safe water supply Access to sanitation facilities Access to health care insurance Individual susceptibility (immune system, genetic predisposition, pre-existing diseases)
Health System and Infrastructure (DOH, PhilHealth)	Accessibility Facilities and human resource capabilities Ability to respond to emergencies and disasters Availability of functional emergency/disaster preparedness plan Monitoring and	Pathogen/Vector factors (DOH, PHO)	Pathogen/vector reproduction patterns Presence of breeding sites Location of breeding sites vis-à-vis community sites Accessibility of preventive technology (i.e. vaccines, vector control)

	disease surveillance capacity Forecasting and risk management capabilities regarding health impacts of climate change		
Socio-economic factors (NSO)	Community and family income Educational attainment Awareness of climate change impact on health	Socio-economic factors (NSO	Access to health care facilities Health insurance coverage Allocation of resources (local and national) to address CC vulnerability (health system and infrastructure)

Source: Lorenzo et al. 2011

c. Selection of study sites. The selected areas were:

1. Tanay and Teresa in Rizal
2. Brooke's Point, Palawan
3. Alaminos and Bolinao in Pangasinan
4. NCR for disease impact modeling

Their disease incidence data on dengue, malaria, leptospirosis, cholera and typhoid were utilized in the study and also for generating local adaptation measures.

d. Mapping all factors/indicators and overlaying all the factor/indicator maps
e. Identification and classification of health vulnerabilities
f. Presentation and consultations with the DOH and PHOs regarding the results of the vulnerability assessment
g. Graphical and statistical modelling of climate change disease incidence
h. Economic impact determination of climate change related diseases
i. Formulation of adaptation measures addressing the vulnerable sectors
j. Presentation of the results of vulnerability assessment and adaptation measures to the DOH, NEDA, LGUs and other NGAs.
k. Finalization of results by integrating the suggestions and comments of the stakeholders.

To select the best adaptation measures, the team developed a simple scoring system shown in the following matrix.

Disease/ Adaptation Measure	Practicability of implementation		Cost-effectiveness		Within policy/ program		Safe to family members		Impacts to the environment		Total	
Impact Rating	+	-	+	-	+	-	+	-	+	-	+	-
Dengue												
a. Adaptation 1												
b. Adaptation 2												
Malaria												
a. Adaptation 1												
b. Adaptation 2												

Source: Lorenzo, et al., 2011

III.2.c. Conditions of method application

The framework allows for a comprehensive and holistic approach to studying the impact and interrelationship among climate, climate change-related variables, the environment and the health sector. The framework identified interrelated factors that are beyond medicine. Due to this, it would be advisable for the medical professionals assigned in vulnerability assessment of the health sector to be trained on the inter-related subsystems defined in the framework. The vulnerability assessment team at the municipal level should also be equipped with important hardware and software to facilitate processing of health vulnerability assessment, adaptation measures evaluation and disease impact modeling.

Reference organizations for this framework include the Institute of Health Policy and Development Studies – National Institute of Health, University of the Philippines – Manila; the National Economic Development Authority (NEDA); and REECS.

In terms of hardware and software, the team should have a computer, printer and essential accessories equipped with GIS and statistical software. A set of computer system is worth PhP75,000 plus a GIS software worth PhP30,000 to PhP275,000. Statistical software is worth PhP50,000 – PhP100,000. Furthermore, the vulnerability assessment team for health at the provincial level should have at least a total budget of PhP1.977 million for a 12 month study exclusive of their salaries and wages in the PHOs. The budget of the team that did the vulnerability assessment for the health sector was PhP2,000,000.

III.2.d. Challenges, lessons learned, and recommendations

Impact of the project

Since the completion of the project there was no report whether the DOH has already institutionalize the process of VIA in the health sector at the central office or at the provincial office.

Resource intensity of method

The VIA tool required a lot of data from the sectors identified in the framework. It requires different expertise from the health sector, environment and natural resources sector, food sector, water sector, and the weather/climate sector. All these sectors contribute to the data requirement of the tool.

Cost-benefit ratio

The avoidance of diseases due to climate change means good health of the people, high productivity, and high savings on the part of government. This will lead to a higher benefit over cost.

Potential and recommendations for replication or integration

The methodology used in assessing the vulnerability of the health sector may be used now by other municipalities, which have not prepared yet their vulnerability assessment.

III.3. Framework of Intermediate Result Monitoring and Evaluation System (IRMES) of the Department of Environment and Natural Resources (DENR) for the B+WISER Project

III.3.a. Entry point into the adaptation process for method application

The biodiversity and watersheds of the Philippines are under threat by anthropogenic activities aggravated further by climate change. Biodiversity and watersheds provide benefits in forms of goods and environmental services that the Philippines needs for sustainable national development. Biodiversity is a source of food, medicine and a place for ecotourism that generate benefit for the people and the government. Watersheds, on the other hand, produce water that propels electricity, provide irrigation water, water for domestic and industrial uses, minimize floods and performs other ecological services. To ensure that investments poured by the government and international aid organizations are put in the right place, in the right activity giving the right results as expected, an M&E is a must.

The Biodiversity and Watershed Improved for Stronger Economy and Ecosystem Resilience Project (B+WISER) is a project of the USAID in partnership with the DENR. It aims to improve the conditions of selected watersheds through effective and efficient governance in order to sustain the provision of goods and environmental services within the context of climate change. Its specific objectives are to (1) conserve biodiversity in forest areas, (2) reduce forest degradation in targeted priority watersheds, and (3) build capacity to conserve biodiversity, manage forests, and support low emissions development, and (4) contribute to disaster risk reduction at the subnational level.[5]

Tracking the path of the B+WISER, the DENR drew a framework for monitoring and evaluation of the performance of the project patterned after the general framework of the Result Monitoring and Evaluation System[6] developed for all the policies, programs, and projects of the DENR. The RMES also provides a direction for investigating and analyzing the efficiency of the DENR and B+WISER service mechanisms and evaluating the effectiveness and impact of the B+WISER, both on social and environmental aspects of the project.[7]

The intended users of the IRME are the CENRO, PENRO, Region, and the M&E Unit of the PPSO and DENR who will be assigned in the M&E of the B+WISER project.

5 Based on the USAID B+WISER RFPNo. SOL-492-12-000017, May 30, 2012.

6 The RMES was developed by the Resources, Environment and Economic Center for the Department of Environment and Natural Resources.

7 Ms. Monica Cunanan, IRMES framework for the B+WISER Project.

III.3.b. The methodological approach

Inputs: Data and information for the IRME

Series of workshops were conducted to identify and define the indicators to be monitored. The M&E teams and stakeholders started with the B+WISER Project's objectives, components, activities, inputs and expected outputs. These guided the participants in identifying the types and nature of data and information to gather including the offices responsible in executing specific M&E activities. At the field level, activity resource inputs and outputs are going to be monitored by B+WISER technical staffs to assess whether the outputs on the ground are worth the resources that will be spent. Since the M&E system being applied by DENR in its projects is results-oriented, the M&E office of the PPSO limited its RME to intermediate results only. The table below shows the results of the workshop from which the intermediate results and indicators, responsible office, remarks, and recommendations are classified according to the general objectives of B+WISER.

Table 12. Indicators to be included in the intermediate results monitoring and evaluation system

Intermediate Results and Indicators	USAID	DENR	Remarks and recommendations
1. Biodiversity in forest areas conserved			
No. of hectares of biological significance and/or natural resources showing improved biophysical conditions	X		Increased in no. of flora and fauna
No. of people with increased economic benefits derived from sustainable natural resource management and conservation No. of laws, policies, strategies, plans, agreements, or regulations addressing climate change (mitigation or adaptation) and/or biodiversity conservation officially proposed adopted, or implemented	X	X	Increased livelihood opportunities
2. Forest degradation in priority watershed areas reduced			
No. of hectares of forest restored		X	
Amount of Greenhouse Gas (GHG) reduced or sequestered	X		
Amount (USD) of investments leveraged from public and private sectors	X		
3. Capacity to conserve biodiversity, manage forests, and monitor low emissions improved			
METT+ (for protected areas) [D] and GSA+ (for LGUs and WMCs) scores	X		
Number of person hours of training in natural resources management and/or biodiversity conservation and climate change	X		
Number of days of USG funded technical assistance in natural resources management and/or biodiversity conservation and climate change provided to counterparts or stakeholders	X		
4.Capacity for disaster management in highly vulnerable areas increased			
Number of research publications	X		
Number of stakeholders with increased capacity to adapt to the impact of climate vulnerability and change	X		

Source: DENR, 2012

Furthermore, to measure DENR's performance in environmental and natural resources governance, the outcomes and indicators to be monitored are:

a. DENR Organizational Outcome: Efficient, effective and responsive enabling environment for sustainable ENR management ensured
b. DENR Sector Outcomes: Improved conservation, protection and rehabilitation of natural resources Improved environmental quality Enhance resilience of natural systems and communities

Outputs of the RME

As of this VIA compendium report, the IRME of the B+WISER has not been mobilized yet because the B+WISER is in its planning stage.

Process of developing the IRME of the B+WISER

The flowchart of activities conducted to come up with an intermediate M&E for the B+WISER in its simplified form is shown in the figure below.

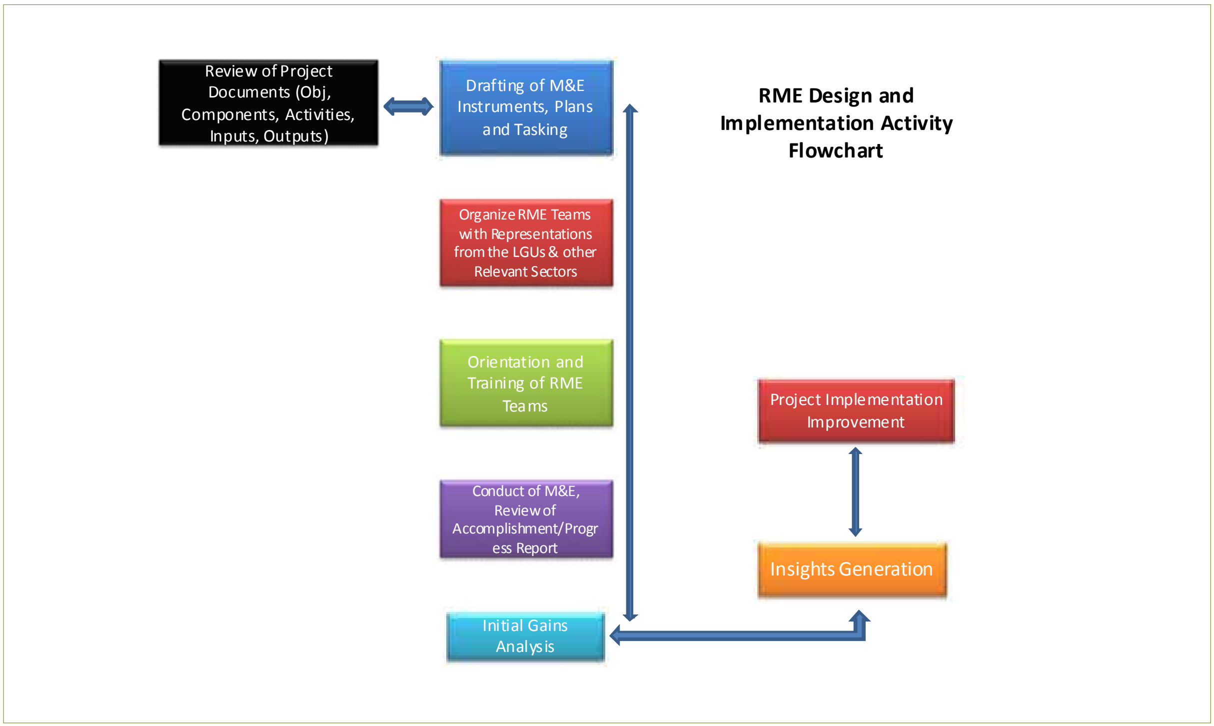


Figure 13. Flowchart of activities in developing the intermediate RME for the B+WISER
Source: DENR, 2012

The activities of the M&E team that led them to the design of the B+WISER intermediate RME are summarized in the table.

Activity	Purpose
Review of project documents	Comprehend the project objectives, targets, activities, resources inputs and expected and unexpected outputs. These are bases for formulating the M&E indicators
Drafting of M&E instruments, plans and tasking	This activity answers how to carry out the M&E. Specifically, the what, where, when, who, how's, and how much's aspects of the M&E are answered.
Organize M&E Teams	M&E outputs as much as possible should be ahead before subsequent implementation activities are carried out. Remember that at any stage of project implementation, information are needed to improve decisions so that expected outputs are achieved or surpassed.
Training/orientation of M&E Teams	M&E is an added cost to project implementation. There is no room for errors that is why the team members should be trained on the "nuts and bolts" of the M&E.
Conduct of M&E	Gathering of data. Data may come from accomplishment and progress reports on the ground. Verification of the accomplishments on the ground is important. Reports sometimes projections. Projections are not acceptable in M&E as accomplishments.
Initial gains analysis	This compares the accomplishments vs. the targets. Desired is that the accomplishments are higher than the targets plus any additional positive unexpected results. These are the initial gains of the project. In reality, losses are more common than gains, which means that somewhere in the project implementation negative deviations exist needing corrective measures.
Insights generation	Transforming the gains or losses into opportunities for further improvement of project implementation

Source: DENR, 2012

The RMES is incorporated at the very start of the program, i.e. program planning up to implementation. A major feature of the RME is a documentation of the outputs and outcomes at all levels that DENR and the B+WISER would want to achieve.[8]

While all the activities of the RMES are very important, there is one essential ingredient that will ensure its sustainability and will make it unique from other M&Es. Also, it will make the findings of the RME unbiased.[9] That ingredient is the participation of People's Organizations especially those working as partners of the DENR in the protection, development and management of the environment and natural resources at the sites where actions are being executed. Furthermore, the local government units that will absorb the responsibilities of sustaining the gains of any projects in the long run, and other NGAs that somehow have something to contribute to the project in terms of manpower and other resources were crucial to the success of protecting and managing the environment and natural resources.[10]

8 Ibid.
9 Ibid.
10 Ibid.

The very reason for the involvement of the several sectors in the RMES is to enhance transparency on the performance of the DENR and the B+WISER.

Once the participatory element is put in place, the RME team proceeded with series of workshops to identify what indicators to monitor and will be used to evaluate the efficiency and effectiveness of the B+WISER and the DENR.

The IRMES includes four major processes: Monitoring Readiness, Progress M&E, Initial Gains Evaluation and Results M&E. Each type of M&E provides a systematic process for tracking, evaluation, documenting and sharing data, information and insights.

The Planning and Policy Office together with the Forest Management Bureau and Foreign Assisted Projects Office are involved in conducting the RMES in coordination with the regional, provincial and community offices of the DENR.

Monitoring readiness refers to the preparation of important RME documents by the PPSO as the lead office of the DENR. It includes RME plan, survey instruments, list of reports needed, list of indicators to be measured, manpower needed, site leaders, list of representative from other NGAs, LGUs, People's Organizations and civil society, logistics needed, survey tools and instruments, data storage device, data transmission mechanism and data processing and management. Having all of these in place at the hands of the RME executing office means that RME is ready.

Progress M&E measures the progress of every activity of B+WISER. Monitor the inputs of the B+WISER team and the DENR in terms of policy, manpower and resources used. These inputs are envisioned to contribute to a given output or progress.

Initial Gains Evaluation establishes the positive effects of the different activities of the B+WISER project. The effects are related to the objectives of the B+WISER and at the same time favourable externalities.

Results M&E measures the ultimate impact or result of the project translated into impacts to the environment, to the social and economic conditions of the people.

III.3.c. Conditions of method application

The B+WISER covers four regions nationwide with the central DENR office as the monitoring and evaluation center. The four regions have their respective M&E teams assigned to monitor the implementation of the projects. Since the M&E units assigned in the project sites are built-in into the organizational structure of the DENR at the central and regional offices, the salaries of the M&E staff are charged to their regular annual budgets.

For M&E operations cost at the 4 regions, the M&E unit of central DENR estimated that about PhP1.5 million is needed by the central office to be shared to the 4 regions would suffice. Each M&E office would have PhP300,000 for travel expenses, supplies and materials, data encoding and processing. However, hardware and software supports may be necessary at the central office and at the 4 regions in the amount of PhP500,000 per M&E unit. This sums up to PhP2.5 million only for the M&E teams at the central and regional levels. This amount is intended to link the regional offices to the central office through an online data transmission from the regions to the central office.

III.3.d. Challenges, lessons learned, and recommendations

The M&E teams have already prepared the M&E plans by region and are ready to conduct M&E schedule by the end of the year. Basically, the project has just started during the second quarter of the year and there is not much physical activity on the ground yet.

Initial lessons learned during crafting of the M&E indicators are a) growing interest on the part of stakeholders especially the local government units who are playing more roles in seeing to it that project outputs are put on the ground; b) inter-agency M&E promotes transparency of where funds are going to be used; and c) convergence initiative between government and donor institutions promote sharing of resources.

IV Climate information and services

IV.1. ORYZA 2000

IV.1.a. Entry point into the adaptation process for method application

One of the sectors most vulnerable to the effects of climate change is food production. Rice production, in particular, is affected by climate variables such as temperature, solar radiation, and rainfall, and thus negative effects of changes in these factors will jeopardize the food supply of rice-consuming regions in Asia and Africa (Angulo, Becker, & Wassmann 2012).

In the Philippines, more than 67% of rice-based farms are irrigated, and there is a growing concern on assessing the impacts of climate change to the yields of rice.

Furthermore, major dams in the country which are major sources of irrigation water are affected with high evaporation due to increasing temperature. Likewise, upland rice which is dependent on rainfall is also affected.

In order to help the LGUs as well as the farmers in their rice production activities, Angulo, Becker, & Wassmann (2012) used the tool ORYZA 2000 to simulate the effect of climate change on rice production. The study's primary objective was to determine the effects of climate change to rice yields of irrigated rice lands in 6 provinces in the Philippines.

The study intended to benefit policy makers for ensuring food security through analysis of the effects of climate change to food production, primarily rice production. The farmers who are in the frontline of farming will also benefit by preparing appropriate farming systems that will meet their families' food requirements under a critical conditions due to drought or excessive rainfall.

IV.1.b. The methodological approach

Inputs: Data and information used for the study

The study by Angulo, Becker, and Wassmann (2012) collected climate data from 1985 to 2002 and rice yield statistics in six provinces – Isabela, Nueva Ecija, Laguna, Camarines Sur, Iloilo, and North Cotabato. Information on climate system of NASA were used as input parameters in ORYZA 2000 to determine potential yields, as well as the yield gaps or the difference between the projected and actual yields.

Outputs of the study

Angulo, Becker, & Wassmann's (2012) found the following results:

a. On a temporal scale, both simulated and actual yields varied strongly between years.

b. Variations in potential or simulated yields resulted from the differences in climate parameters – radiation, temperature differences in wet and dry seasons; climate differences between provinces, and agro-ecological zones. In particular, simulated yield was higher in the dry than in the wet season. However, seasonal factor in the yield differences was more prominent in the savannah agro-ecological zones – Isabela and Nueva Ecija than in humid forest zones – North Cotabato, and Camarines Sur.

c. Variations in the actual yield were also found to be attributable to seasonal differences. In two of the six provinces – Isabela and North Cotabato, yields were higher in the dry than in the wet season.

d. Climate factors, on the other hand, were not as pronounced in the differences in actual yield as in the differences in potential yield. Differences in actual yield were attributable to soil and management factors.

e. Yield gaps were largest in provinces and seasons with highest yield potential (dry and wet seasons in North Cotabato and Iloilo; and dry seasons in Isabela and Nueva Ecija). Seasonal factors in yield gaps were found to be highest in Isabela, a province with savannah-type climate, and lowest in the humid forest agroecological zone (North Cotabato and Camarines Sur). Yield differences were further associated with agronomic parameters such as the rate of urea fertilizer applied, level of soil fertility, and access to urban market. Thus, highest yield gap was found in remote and infrastructurally disfavored provinces (low external input use) with high production potential (high solar radiation and day-night temperature differences) – Iloilo and North Cotabato. Yield gap was found smallest in central provinces with good market access – Laguna and Nueva Ecija.

Process of conducting the study

The study did not present the process used. However, reading from the report, the activities conducted in the simulation of the effects of climate change to rice production in selected areas were conducted through the following activities:

The most likely activities in general of developing the ORYZA were:

a. Conceptualization of the simulation model, the Oryza 2000. Since the concern is rice growth and yield, these are affected by irrigation water, temperature, solar radiation, farm inputs, and farming systems.
b. Formation of the model equations, where rice yield is a function of irrigation water, rainfall, temperature, solar radiation, farm inputs and farming systems.
c. Screening the model through statistical testing of the coefficients, goodness of fit and analysis of the probabilities.
d. Accepting the model upon satisfaction of statistical tests.
e. Model validation. This refers to an actual test of the model by using a separate data set. Again the goodness of the model is screened using another statistical test. If the result is acceptable, the model becomes a useful tool for simulating the effects of variables to the yield.
f. Using the model in simulation. Meaning, if one variable or predictor of rice yield is changed, decreased or increased, what would be the implications to yield?
g. In the case study, the ORYZA 2000 was already developed. What has been done was to apply the model.

In using ORYZA 2000 in the study, the activities that were conducted probably include any of the following in general terms:

a. Setting the objectives of the study. The objective was to determine rice yields under different climate change conditions and farm inputs and practices.
b. Identification of study sites, in this case the provinces of Isabela, North Cotabato, Iloilo, Nueva Ecija, Camarines Sur, and Laguna for selected.
c. Review of the historical data sets of these provinces on rice yields, rainfall, temperature, solar radiation, farm inputs and farming systems to assess whether such data would be a perfect data set for simulating the effects of climate change indicators to rice yields.
d. Processing the historical data sets to suit the requirements of the model.
e. Inputting the processed data sets to the model.
f. Running the model in a computer.
g. Analysing and interpreting the results given by the model.
h. Generating insights for rice farming strategies in preparation for any future changes in the climate.

IV.1.c. Conditions of method application

The tool is designed for trained agronomists with expert knowledge on plant growth processes. Required capacity includes at least two-week training for the use of the software, particularly in the conduct of simple simulations. Online training is also available at the website of IRRI. The program is available at IRRI and it is dowloadable free of charge. Assuming that data needed for the model are readily available, it would not cost a lot to the user to use the model. However, if the user will start from data gathering, the bulk of the cost would be used for this purpose.

IV.1.d. Challenges, lessons learned, and recommendations

The study concluded that climate changes in the past 20 years have had no effect on the yields of irrigated rice. Observed variability in climate conditions under different years, seasons, and among provinces were not related to the projected yields. It was found that factors such as soil and crop management have had stronger effect on the discrepancies in rice productivity.

Impact of the project

The model is useful for simulating the potential effects to rice yields if some of the factors of productions of agriculture are changed. Being able to assess future implications of changing the conditions of rice production leads to better decision-making.

Resource intensity of method

The usual data on the factors of production in agriculture are needed in the model. This can be handled by a BS in agriculture.

Benefit-cost ratio

Without the use of models one has to perform actions on the ground without the benefit of knowing its possible results. Performing any actions on the ground without knowing its effects entails cost. On the other hand, observing first the possible effects of a given action in a model without doing it on the ground also entails cost but not much compared to the cost of doing it right away on the ground. On this basis, the benefit over cost of using accurate models is very high compared to doing it right away on the ground.

Potential and recommendations for replication or integration

Disseminate the model to farmers to help them improve their decisions in rice production. Training them on how to use the models, gather and process the input data, running the model and interpret the results is important.

Perhaps each farmers' association may consider setting up a service facility equipped with computers, simulation program and other software useful to assist farmers in their farming activities.

IV.2. Climate Change and Disease Impact Modeling: Graphical Method

IV.2.a. Entry point into the adaptation process for method application

The tool is appropriate in barangay health centers where there is no electricity to power computers and where the budget of the barangay is insufficient. Most of barangay health centers in the rural areas in the Philippines have no electricity.

The tool covers any of the climate change related-diseases; Modeling is done at one is to one variable at a given time.

IV.2.b. The methodological approach

Disease impact modeling is one of the tools that can be used by planners of the LGU and DOH to predict scenarios of health situation under climate change. There are two general tools used for impact modeling, the graphical approach and mathematical or statistical modeling, which can be used depending on the availability of resources and existence of personnel who can operate the system. The easiest, least cost method used in disease impact modeling is done by graphing the dependent parameter with the independent parameter.

The population sector that is highly affected by diseases that are climate change- induced is the rural poor especially those living in inaccessible areas in the mountains and coastal communities. They don't have electricity and no access to hospitals, clinics, health centers, doctors and medicines. To prepare them in any event of climate change-related disease outbreaks in the future, their community leaders should be able to warn the people when and where such disease incidence will happen.

The primary objective of the case study is to teach rural barangay leaders in the preparation of disease impact models through graphical method. Through these graphical models, they will be able to predict scenarios of health situation in their barangays. Thus, prevent the outbreak of climate change-related diseases.

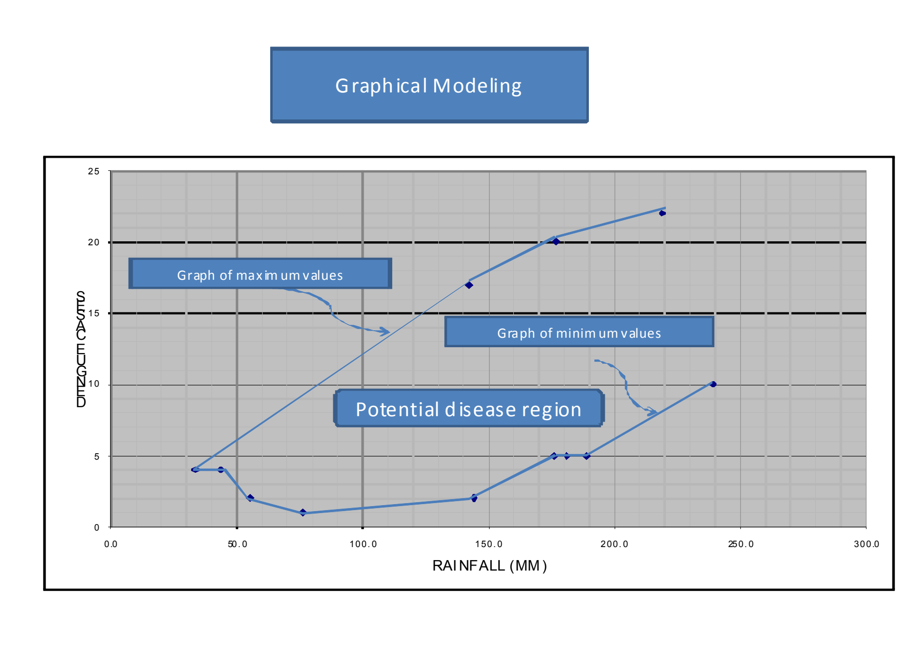
Inputs: Data and information used in the study

The data used in the study are:

1. Historical disease incidence (dengue, malaria, leptospirosis, cholera/typhoid
2. Historical climate change data sets (rainfall, temperature, relative humidity)

Outputs of the study

1. Graphical model of climate change diseases (see result below)



The output is a graphical model of disease impacts vs. rainfall.

If there are several climate change factors, the planner may decide whether to place all the graphs of the diseases and climate change factors in one graphing paper or each in separate graphing paper for clarity.

Process of conducting the study

The procedure in simple step by step activities are enumerated below:

1. Gather historical data on CC-related diseases. Get this from the nearest hospital in the province. If none, request the mayor to write to DOH Manila requesting data on the cc-related diseases.
2. Gather climate change data sets from the nearest weather monitoring stations or from PAGASA. Course request to the municipal mayor.
3. Once the data are at hand, buy several sheets of graphing paper and one ruler.
4. Select a cc-related disease and plot incidence with rainfall. Repeat the process with different diseases and so on until all climate change related diseases are graphed with rainfall.
5. Mark on the graphing paper the maximum and minimum incidences by rainfall.
6. Connect all the points of the maximum. This is the upper boundary where diseases may occur.
7. Connect all the points of the minimum. This is the lower boundary where diseases may occur.
8. The area between the maximum and minimum boundary is the area where disease incidences are possible. Below this area or region is the rainfall.
9. In using the graphical model, the dates that correspond to rainfall should be watched or monitored to see if there is another disease incidence. Plot this in the same graphing paper.
10. Produce several copies of the graphical models and orient households how to use the models.

IV.2.c. Conditions of method application

The method can easily be performed by high school graduates, undergraduates, local planners at the barangay and municipal level, whether in the health sector or in the local government units.

It is appropriate in areas where there are electricity and low budget of the barangay LGUs.

Basic instruments needed are graphing paper and a ruler. Preparing the graphical models for disease incidence due to climate change can be assigned to the barangay health workers.

Stakeholders and institutional setup

Graphical approach to disease impact modeling is intended to bring disease prevention, treatment and control at the community or barangay level. The barangay captain will play a critical role in preparing the graphical models through the barangay rural health workers and disseminate how to use the models as early warning device to the barangay residents. If there are medical doctors in the barangay, they should be invited to participate in the development of graphical models. An administrative order coming from the provincial governors to the mayors should be issued to all barangays leaders for the purpose of drawing the graphs. Training of the barangay health workers to prepare the graphs and how to use the graphs by the residents is necessary.

Resources

The proposed personnel are the barangay health workers with participation of medical doctors in the barangay. If the barangay health workers are assigned to prepare the graphical models, the fund needed would just be a onetime PhP1,000 for the materials needed. Updating may be done every year with the same budget.

Duration and estimated funds used in the conduct of study

Of all the methods useful for disease impact modeling, the graphical approach is the cheapest method and readily available to planners and impact modelers at the barangay level. For an hour, one can already draw a graph of disease incidence and rainfall or temperature assuming a set of historical data is available. The graph can be used as an early warning device of community leaders to alarm their constituents during seasons of disease outbreaks.

The budget necessary to prepare the graphical models assuming that historical data on disease incidence and climate change indicators (rainfall, temperature, relative humidity and solar radiation) are available will need only about PhP1,000 for graphing papers, ruler, pencils and colored pens to prepare the graphical models.

IV.2.d. Challenges, lessons learned, and recommendations

Impact of the project

Most of the barangays in rural areas are not electrified yet. Some are not accessible by land transport. Due to lack of electricity in such barangays and lack of adequate funding, computers and other information technology and health infrastructure are not readily available. Thus, other modes of helping residents in rural areas to prepare themselves in preventing incidence of climate change-related diseases are explored. Thus, the graphical models if seriously followed by the residents will help them prepare the people from climate change-related diseases.

Resource intensity of method

Historical data on disease incidence and climate data are necessary inputs to the graphical modeling. Such data should be sourced out by the PHOs and furnished to all the barangay health workers. Likewise, climate change data must also be requested from PAGASA by the municipal health office through the mayor.

Cost-benefit ratio

The graphical approach is the cheapest. The benefit-cost ratio is surely very high.

Potential and recommendations for replication or integration

A two-day trainors' training for barangay health workers may be conducted to train them on how to prepare the graphical models and conduct information and education campaign to barangay residents. Priority barangays to be trained are those in the rural areas without electricity.

IV.3. Projection of Disease Incidence and Its Socioeconomic Impacts Using Mathematical or Statistical Method of Disease Impact Modeling

IV.3.a. Entry point into the adaptation process for method application

The application of the tool is limited to the use of observed diseases with linear or curvilinear relationships with climate change indicators such as rainfall, temperature, relative humidity, and solar radiation; predicts impacts and approximates trends. Accuracy is dependent on the goodness of fit of the graph considering the data or observations.

It is best applicable when there are more than two independent variables and one dependent variable depending on available hardware and software.

IV.3.b. The methodological approach

Given the disease prevalence in the past, there has been an increasing incidence of CC-related diseases due to the changing climate. Considering that climate change is getting worse in the future, what would be the prevalence of diseases in 2020 and 2050?

One of the components of the NEDA MDGF 1656 project on health is the preparation of disease impact models that could be used for the health sector in projecting disease prevalence in 2020 and 2050.

The project identified dengue, malaria, cholera and leptospirosis for modeling using available health data from the National Capital Region (NCR) and from the Provincial Health Officers (PHOs) of the Provinces of Palawan, Pangasinan, and Rizal. PAGASA provided climate change data (rainfall, temperature, and relative humidity) for the years 1992 to 2009, 2020, and 2050.

The main objective of the modeling is to derive an equation for each of the climate change- related diseases for predicting the possible number of disease cases due to climate change. The secondary objectives are to determine the accuracy of the models in predicting disease cases by comparing the predicted values with the observed values and to estimate the costs of preventing and treating the diseases. The costs are important in the allocation of funds to the local government units for the control, prevention and treatment of the diseases (Lorenzo, et al., 2011).

The DOH, LGUs and PHOs were the targets of the study. It was envisioned that they will benefit from the models and develop other models for different provinces and municipalities.

Inputs: Data and information used for the disease impact models

The assessment of disease data available to determine sufficiency for modeling purposes, including the types of climate change indicators, is summarized in the following table.

Disease	Indicators	National Capital Region	Palawan	Rizal	Pangasinan	Rain fall	Maximum Temperature	Minimum Temperature	Mean Temperature	Initial Vector Population
Dengue	Cases	12m	8md	1md	37dd	M	m	m	m	n
	Alert Threshold	n	12md	12md	12md	m	m	m	m	n
	Epidemic Threshold	n	12md	12md	12md	m	m	m	m	n
Malaria	Cases	12m	8md	1md	1md	m	m	m	m	n
	Alert Threshold	n	n	12md	n	m	m	m	m	n
	Epidemic Threshold	n	n	12md	2md	m	m	m	m	n
Cholera	Cases	12m	n	n	1md	m	m	m	M	n
	Alert Threshold	n	n	n	5md	m	m	m	M	n
	Epidemic Threshold	n	n	n	5md	m	m	m	M	n
Leptospirosis	Cases	12m	n	n	1md	m	m	m	M	n
	Alert Threshold	n	n	3md	4md	m	m	m	M	n
	Epidemic Threshold	n	5md	9md	6md	m	m	m	M	n
Typhoid	Cases	12	n	1md	9md	m	m	m	M	n
	Alert Threshold	n	n	5md	n	m	m	m	M	n
	Epidemic Threshold	n	n	9md	3md	m	m	m	M	n

Legend:
8md = 8 months data
n = no data
37dd = 37 days data
m = matched data not sure whether taken at the same time with disease observations.

Source: Dr. Lorenzo, et al. Feb 8 2011, NEDA MDGF 1656

The disease data from 2002 to 2007 were provided by the PHOs of Pangasinan, Rizal and Palawan and data of NCR from 1992-2009 from the DOH. Daily, monthly, and yearly climate data from 1992-2009, 2020, and 2050 were provided by PAGASA.

A correlation analysis was conducted to determine which climate change variables are correlated to dengue, malaria, cholera and leptospirosis, while regression models were developed using the health data and climate change data. Several models were developed but the best ones were selected according to required statistical tests applied to each of the models.

Outputs of the disease impact models

Based on the report of the NEDA MDGF 1656(2011) the best models with respective equations selected for the diseases are:

Dengue Cases =-1267.347-0.615*Monthly Rainfall-21.389*MaxTemperature+31.442*Relative Humidity
Cholera Cases =8.948+0.026*Monthly Rainfall-1.681*Maximum Temperature +0.663*Relative Humidity
Malaria Cases = - 218.918 - 0.089*Monthly Rainfall + 7.605 *Maximum Temperature

The disease impact models were used to project disease cases that would likely occur in 2020 to 2050. Cost impacts of the diseases were also computed based on the projected disease cases.

No models were developed for leptospirosis and typhoid due to lack of data from the DOH and LGUs.

Both dengue and cholera impact models were sensitive to monthly rainfall, maximum temperature and relative humidity, whereas, malaria is sensitive to monthly rainfall and maximum temperature.

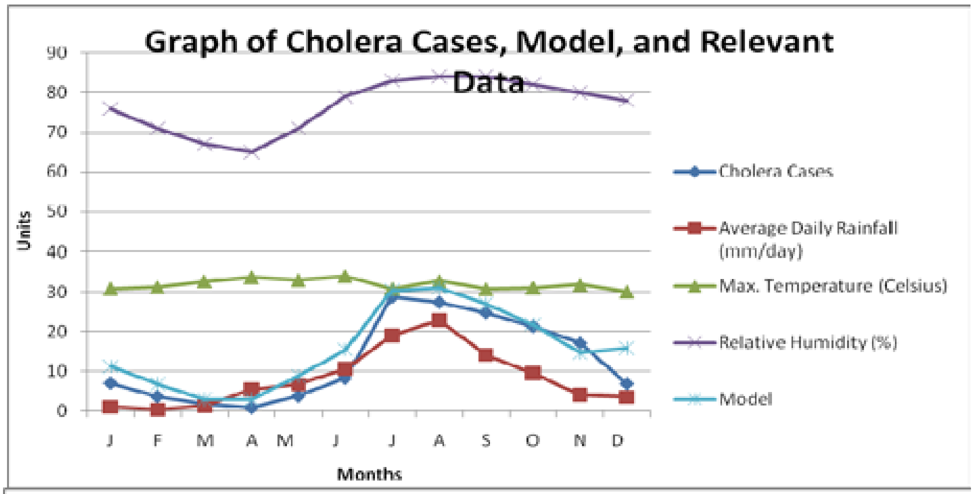
The insights generated from the models are presented in the following table.

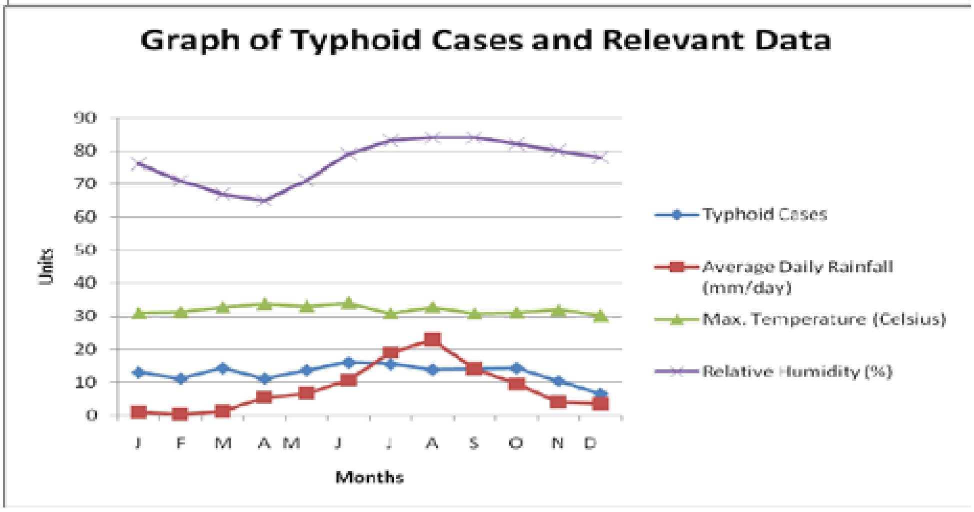
Disease Cases	One unit each of the variables will increase or decrease disease cases per thousand					
	Monthly Rainfall		Maximum Temperature		Relative Humidity	
	Increase	Decrease	Increase	Decrease	Increase	Decrease
Dengue		615		21389	31442	
Cholera	26			1681	663	
Malaria		89	7605			
Leptospirosis and typhoid – no models developed due to lack of data.						
Source: Lorenzo, et al., 2011						

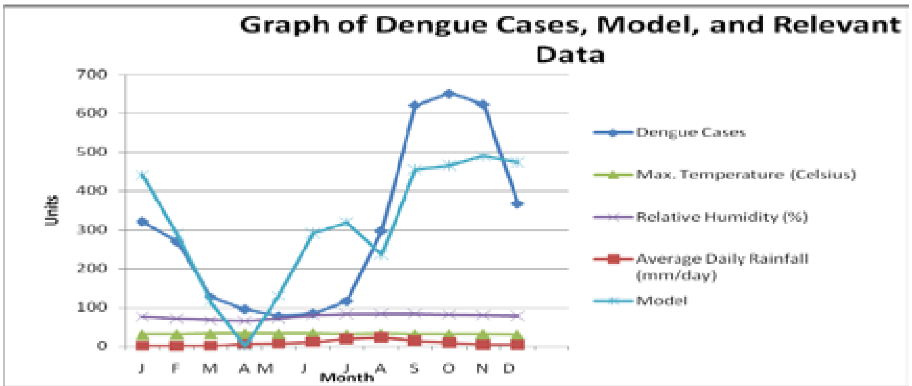
Graphical comparison of predicted and the observed values

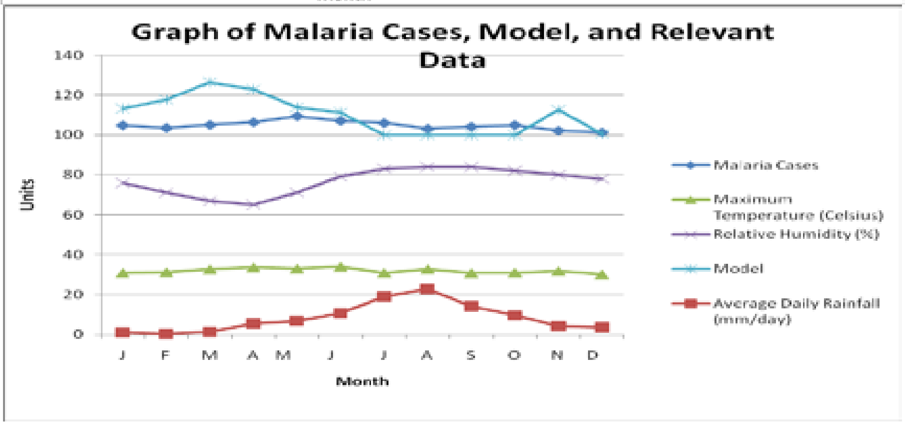
To compare the predicted values with the observed values, graphs were drawn.

The closeness of the predicted values to the observed values indicates accuracy of the models. The figures of the disease graphs overlaid with climate change indicators are shown in the following sections.









Source: Dr. Lorenzo et al., NEDA MDGF 1656

Using the models for 2020 and 2050 projections of disease incidence

Using the models that were selected, the impacts of climate change in 2020 and 2050 in terms of dengue, cholera, cases were projected. The results of the study by Lorenzo, et.al (2011) are shown in the following tables.

Dengue Cases Projection, 2020

Month	Cases	Rainfall (mm/mo)	Max. Temp (°C)	Relative Humidity %
JAN	357	0	31.3	72.9
FEB	327	12.4	32.3	72.9
MAR	8	15.5	34.2	64.1
APR	negative	21	36.6	61.2
MAY	negative	65.1	37.6	66.5
JUN	25	477	33.1	73.0
JUL	82	787.4	32	80.1
AUG	negative	1146	30.3	73.1
SEP	negative	855.6	31.5	72.7
OCT	486	69	33.1	79.6
NOV	99	21.7	32.7	66.1
DEC	743	195.3	30.4	88.4
Total	2,128	3,666		
Source: Lorenzo, et al., 2011				

Dengue Cases Projection, 2050

Month	Cases	Rainfall(mm)	Max. Temp (°C)	Relative Humidity
JAN	310	0	32.6	72.3
FEB	277	3.1	33.7	72.1
MAR	negative	6.2	36.3	63.3
APR	negative	12	38	60.8
MAY	negative	52.7	38.7	64.8
JUN	69	276	36.3	72.6
JUL	189	523.9	34.2	79.8
AUG	negative	657	32.8	72.8
SEP	41	421.6	33.1	72.4
OCT	166	564	32.6	78.8
NOV	negative	213.9	32.9	65.6
DEC	683	217	31.4	87.6
Total	1,735	2,947.4		
Source: Lorenzo, et al., 2011				

Projected cholera cases, 2020

Month	Cases	Rainfall(mm)	Max. Temp (°C)	Relative Humidity
JAN	5	0.00	31.30	72.95
FEB	3	12.40	32.30	72.94
MAR	negative	15.50	34.20	64.13
APR	negative	21.00	36.60	61.25
MAY	negative	65.10	37.60	66.47
JUN	14	477.00	33.10	72.95
JUL	29	787.40	32.00	80.08
AUG	36	1146.00	30.30	73.05
SEP	26	855.60	31.50	72.73
OCT	8	69.00	33.10	79.64
NOV	negative	21.70	32.70	66.13
DEC	22	195.30	30.40	88.44
Total	143	3,666.00		
Source: Lorenzo, et al., 2011				

Cholera Cases Projection, 2050

Month	Cases	Rainfall (mm)	Max. Temp (°C)	Relative Humidity
JAN	2	0.00	32.60	72.33
FEB	0	3.10	33.70	72.11
MAR	negative	6.20	36.30	63.27
APR	negative	12.00	38.00	60.84
MAY	negative	52.70	38.70	64.79
JUN	3	276.00	36.30	72.58
JUL	18	523.90	34.20	79.82
AUG	19	657.00	32.80	72.77
SEP	12	421.60	33.10	72.39
OCT	21	564.00	32.60	78.81
NOV	3	213.90	32.90	65.56
DEC	20	217.00	31.40	87.64
Total	99	2,947.40		
Source: Lorenzo, et al., 2011				

Malaria Cases Projection, 2020

Month	Cases	Rainfall (mm)	Max. Temp (°C)
JAN	19	0	31.30
FEB	26	12.4	32.30
MAR	40	15.5	34.20
APR	58	21	36.60
MAY	61	65.1	37.60
JUN	negative	477	33.10
JUL	negative	787.4	32.00
AUG	negative	1146	30.30
SEP	negative	855.6	31.50
OCT	27	69	33.10
NOV	28	21.7	32.70
DEC	negative	195.3	30.40
Total	258	3,666	395.10
Source: Lorenzo, et al., 2011			

Malaria Cases Projection, 2050

Month	Cases	Rainfall (mm)	Max. Temp (°C)
JAN	29	0	32.60
FEB	37	3.1	33.70
MAR	57	6.2	36.30
APR	69	12	38.00
MAY	71	52.7	38.70
JUN	33	276	36.30
JUL	negative	523.9	34.20
AUG	negative	657	32.80
SEP	negative	421.6	33.10
OCT	negative	564	32.60
Source: Lorenzo, et al., 2011			

Outputs: Costs of disease prevention, treatment and control

Cost of Dengue Cases in 2050

Month	Dengue Cases	Monthly Cost of Diagnosis	% Over Grand Total	Monthly Treatment Cost	% Over Grand Total	Monthly Income Loss	% Over Grand Total	Grand Total
Cost in 2007		2,531.00		1,223.00		357		4,111.00
Cost in 2050		15,470.97		7,475.70		2,182.19		25128.86
JAN	310	4,796,001.00		2,317,467.00	17.86	676,479.00		7,789,947.00
FEB	277	4,285,459.00		2,070,769.00	15.96	604,467.00		6,960,694.00
MAR	negative							
APR	negative							
MAY	negative							
JUN	69	1,067,497.00		515,823.00	3.97	150,571.00		1,733,891.00
JUL	189	2,924,013.00		1,412,907.00		412,434.00		4,749,355.00
AUG	negative							
SEP	41	634,310.00		306,504.00		89,470.00		1,030,283.00
OCT	166	2,568,181.00		1,240,966.00		362,244.00		4,171,391.00
NOV	negative							
DEC	683	10,566,673.00		5,105,903.00		1,490,436.00		17,163,011.00
Total	1,735	26,842,133.00	61.57	12,970,340.00	29.75	3,786,100.00	8.68	43,598,572.00
Basic data source: Borja M, Lorenzo FM et al. (2007) in their study entitled " Burden of Disease and Economic Evaluation of Dengue" (unpublished)								
Note: Dengue cases, alert thresholds and epidemic thresholds were projected using the impact models.								
Costs were projected using a 4.3% annual growth rate (NSO, 2010)								
Blank cells indicate negative figures.								
Source: Lorenzo, et al., 2011								

The authors also extended the use of the models by determining the costs of disease treatments in 2020 and 2050. The results are shown in the following tables.

Cost of Dengue Cases in 2020

Month	Dengue Cases	Monthly Cost of Diagnosis	% Over Grand Total	Monthly Treatment Cost	% Over Grand Total	Monthly Income Loss	% Over Grand Total	Grand Total
Cost in 2007		2,531.00		1,223.00		357		4,111.00
Cost in 2020		4375.10		2,114.09		617.11		7,106.30
JAN	357	1,560,681.57		754,136.00		220,135.00		2,534,953.00
FEB	327	1,432,438.49		692,168.00		202,046.00		2,326,653.00
MAR	8	34,833.37		16,831.81		4913.26		56,578.00
APR	negative							
MAY	negative							
JUNE	25	109,906.04		53,108.00		15,502.00		178,516.00
JULY	82	358,100.38		173,038.00		50,510.00		581,648.00
AUG	negative							
SEP	negative	-						
OCT	486	2,127,359.17		1,027,960.00		300,065.00		3,455,384.00
NOV	99	433,776.55		209,604.96		61,184.40		704,566.00
DEC	743	3,251,177.22		1,571,000.00		458,580.00		5,280,757.00
Total	2,128	9,308,273.00	61.57	4,497,846.00	29.75	1,312,936.00	8.68	15,119,055.00
Basic data source: Borja M, Lorenzo FM et al. (2007) in their study entitled "Burden of Disease and Economic Evaluation of Dengue" (unpublished)								
Note: Dengue cases, alert thresholds and epidemic thresholds were projected using the impact models.								
Costs were projected using a 4.3% annual growth rate (NSO, 2010)								
Blank cells indicate negative figures.								
Source: Lorenzo, et al., 2011								

Process of conducting the study

1. Identification of diseases affected by climate change

Workshops to brainstorm and identify which of the diseases are climate change related are conducted with stakeholders which are mostly medical practitioners. In separate occasions, three consultations with stakeholders were conducted with the DOH and provincial health officers together with the LGUs representing the project sites.

2. Coordination with DOH, DENR, NEDA, PAGASA and other NGAs to introduce the Project and assess the availability of information that can be used in the study. The roles and responsibilities of the different national government agencies in terms of the data and information needed were defined.

3. Sourcing out of data and information on disease cases that were recorded by the DOH and PHOs. The disease data from 2002 to 2007 were provided by the PHOs of Pangasinan, Rizal, and Palawan, while data for NCR from 1992-2009 were from the DOH. Daily, monthly, and yearly climate data from 1992-2009 were provided by PAGASA.

4. Pairing of the disease data with the climate change data

In order to attain better correlation of the dependent and independent variables, one to one correspondence as much as possible should be achieved. This means that the disease incidence that occurred in any given date should also have the climate change indicators on the same date.

5. Forming a general equation model for each of the diseases

Forming the general equation of the model identifies the possible factors that contribute to the disease occurrence. This may include persons who were previously affected by the diseases, their environmental conditions, health and sanitation practices, weather conditions in terms of rainfall, temperature, relative humidity, solar radiation and other factors that contribute to the multiplication of the diseases.

6. CC-related disease = f (estimate of population of mosquito-disease carrier, number of infected human vectors, rainfall, temperature, relative humidity and solar radiation)

The general equation is important to guide the modeler in the nature of data/variables that will be gathered or measured. More or less the identified variables will become the elements of the equation.

7. Determination of variable correlation

This is necessary to screen out independent variables that have no significant correlations to the other independent variables as well as to the dependent variable. Variables that have little correlations are dropped from the equations. Their significance is very little to result in a substantial impact to the dependent variable. Such variables are dropped from the equation because their inclusion would mean additional cost for their measurements or monitoring.

8. Running the model and testing coefficients' probabilities

With the use of statistical software, the model or equation is run. After one run, the results are examined to look weather the important coefficients and their probabilities pass the requirements. If the coefficients and their probabilities are inferior, the model is not accepted and therefore changed.

9. Formulation of other model variants.

In modeling, seldom that in one modeling pass, the best model is developed. Modeling goes through the process searching the best form and the best result. Thus, it is necessary to come with up with different forms of the models until the best one is uncovered.

10. Selecting best model

Selecting the best model refers to the comparison of the correlation of the coefficients, goodness of fit given by the coefficient of determination, probabilities of the coefficients and selecting the best model that has the highest values in terms of the required parameters and statistical test. Furthermore, it is the model that also satisfies actual and logical relationships of the dependent and independent variables.

11. Using the model in projecting disease cases in the future

Once the best model is selected, it can be used in projecting possible disease cases in the future. This is done by plugging in the projected rainfall, temperature and other climate change indicators to the equation or model.

12. Calculating the cost of disease diagnosis, prevention, treatment, and control

Once the projected disease incidences are known, the cost of disease prevention, treatment, control and diagnosis are determined by multiplying the cost per unit of preventing, treating and controlling the climate change related diseases. The cost implications of the diseases are necessary for the allocation of health budget for the local government units.

13. Identification and recommendation of adaptation measures

Adaptation measures are formulated according to the type, nature and magnitude of disease incidence. Most sanitation and health practices designed to maintain the cleanliness of the immediate households' surrounding defined the adaptation measures implementable at the household level. At the barangay level, the adaptation measures are based on the desired state of the environmental condition of the barangay that do not support the habitat and growth of disease vectors. At the municipal level, the need to establish and maintain institutions such as hospitals, clinics and rural health centers to address the need to adapt to such diseases are formulated.

IV.3.c. Conditions of method application

Use of the tool requires knowledge on computers, statistical modeling and interpretations of the results of variable correlations, regression analysis, coefficients of variables and determination and probabilities, and statistical tests required in regression modeling. Also the modeler should be able to know how to use any statistical software to facilitate computational requirements of the modeling without going through its rigorous computational requirement.

Also important is the sources of disease data that are related to climate change. All inputted health data must be those that were confirmed and diagnosed by the doctors of the DOH through their PIDSAR as well as those confirmed treated by provincial and municipal hospitals. Likewise, it is only the PAGASA that can provide official data on rainfall, temperature, relative humidity and other climate change related data that can be used officially for modeling purposes.

Stakeholders and institutional setup

Expected to lead in the disease impact modeling implementation, monitoring and potential expansion in other provinces are the DOH at the national level and the LGU Provincial Health Officers together with the health officers at the municipal and barangay levels. Medical colleges and universities at the municipal level may be invited to participate for research purposes and to tap medical faculty members who are interested in statistical applications In medicine.

Resources

The personnel and expertise necessary for the disease impact modeling are medical doctors and statisticians. Most doctors are engaged as practitioners rather than modelers because of the high tradeoff. Thus, there may not be a good number of doctors that will be engaged in such activity especially at the provincial and municipal levels.

In terms funding unless integrated into the regular budget of the provincial or municipal or barangay health units, modeling will need about PhP250,000 to PhP300,000 per modeling project per disease to be used in data gathering and validation and statistical modeling. The amount spent for the modeling of 4 climate change-related diseases for 4 municipalities/provinces is presented in the following section.

Duration and estimated funds used in the conduct of the study

The actual duration of the project is 6 months with a total cost of PhP843,430. One reason that contributed to the least cost of the study was the availability of data on disease incidence and weather data from PAGASA. The data used were gathered by another study and were furnished to the modeling group.

IV.3.d. Challenges, lessons learned, and recommendations

Impact of the project

The models are important in seeing the future of climate change-related diseases given future climate change scenario. This information determines the budget of LGUs intended to prevent, treat and control cc-related diseases.

Resource intensity of method

Historical data on disease incidence and climate data are important in statistical modeling of climate change related diseases. Models become more accurate when there are more available data. Additional data on the population of disease vectors or carriers, and characteristics of the habitat and environment of disease carriers are important variable worth integrating into the models.

Disease impact modeling is very much dependent on the skills of medical doctors with statistical modeling with wide experience on the diseases that are brought by a changing climate. Such skills are very rare even among the medical practitioners. Thus, it may be necessary to tap other health workers and trained them in statistical modeling.

Cost-benefit ratio

Previous to the project that developed the disease impact models, there were no basis for assessing future disease scenarios. The basis for health budgeting at the provincial level is the previous year's budget allocation. With the models, given predicted climate condition in the future, the most likely disease incidence is also predicted through the models where corresponding annual budget appropriation will be based.
Savings from budget misappropriation due to lack of basis is ensured with the models and this is advantage of having the model. Besides in the long run, the costs of the models become insignificant while the savings from potential annual budget misappropriation is realized. Thus, it can be concluded that the benefit to cost ratio is very high with the models.

Potential and recommendations for replication or integration

Due to the differences of the provinces in several factors that define their health conditions, the disease impact models should be replicated if budget permits in all provinces in the country. Doing this would benefit all the provincial governments. If replication will push through in the provinces, there are additional variables that should be measured and included in the models. These are population count of disease vectors, parameters that describe the habitat of the disease vectors and the characteristics of the environmental conditions where the disease vectors are thriving. These variables were not measured in the first tranche of disease impact models.

The provincial government in all the provinces should allocate the required budget to be used for the modeling of disease impacts.

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Appendix:
Other VIA tools

APPENDIX: OTHER VIA TOOLS

The tools compiled in this section include VIA methods and approaches which do not have case studies available from secondary and Internet sources or conceptual studies without applications. VIA tools developed in other countries are also discussed in this section to benefit the users as additional references.

I. VULNERABILITY ASSESSMENT

I.1. FIVIMS

I.1.a. Entry point into the adaptation process for method application

The Philippines FIVIMS is intended to collate and analyze relevant data for measuring and monitoring food insecurity and vulnerability by linking relevant information systems.

It can be used to improve policy making, programming, and actions by collecting data and information on food availability and access as well as stability concerns

Model can be modified to accommodate climate change assumptions for rice growth.

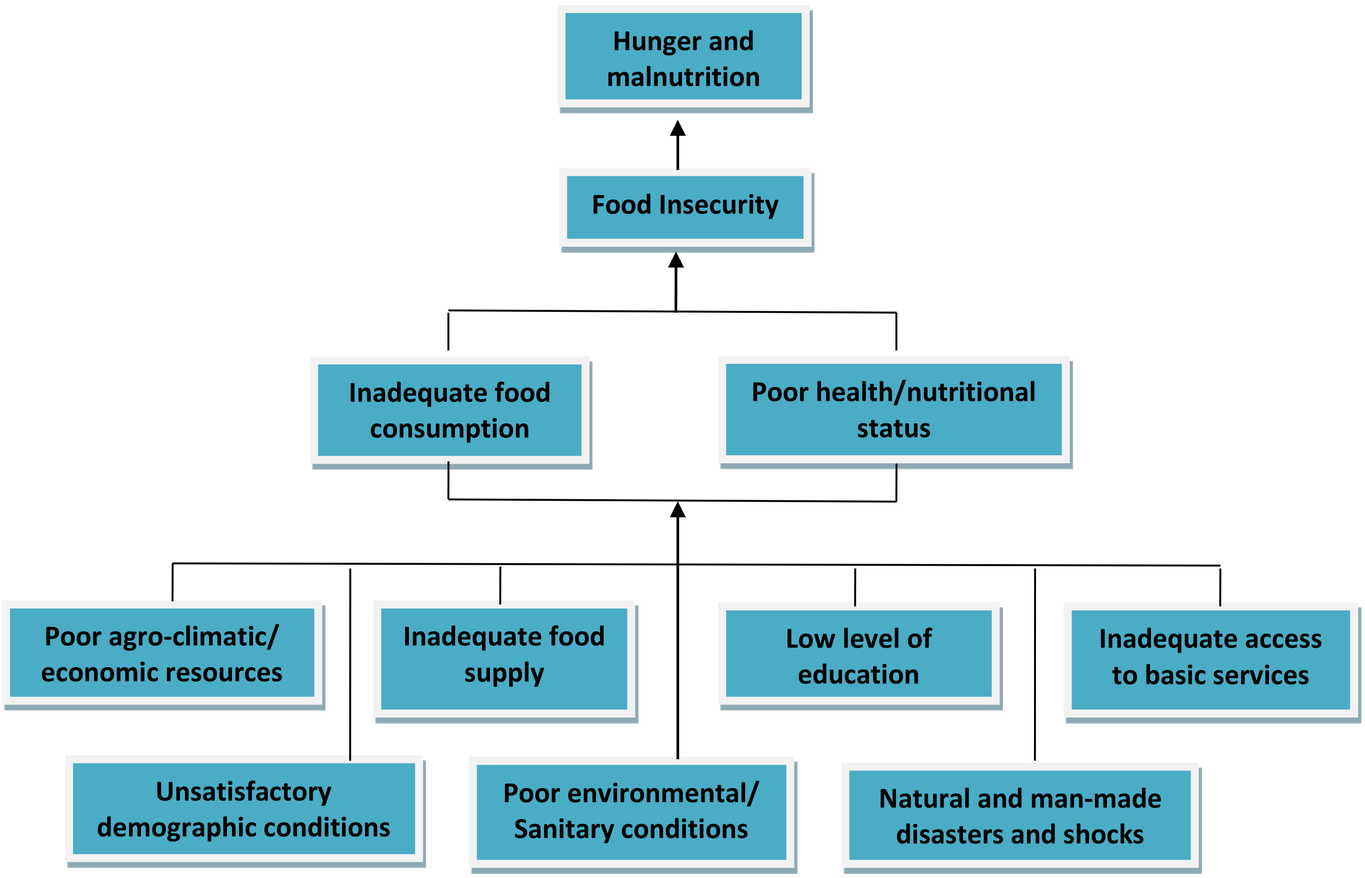
In line with the provisions of the World Food Summit (WFS) and the Millennium Development Goals (MDGs), the Philippine FIVIMS primarily aims to address food insecurity and vulnerabilities of the population.

Specifically, FIVIMS aims to:

1) Align the issues of food security with the national and sub-national priorities in terms of policy-making;
2) Implement a multi-sectoral approach to studying food security through integration of all relevant information;
3) Improve utilization and dissemination of information by taking into account the needs of users;
4) Promote networking and information sharing for better access of users; and
5) Improve research on food security through utilization of more reliable, up-to-date, and quality data

I.1.b. The methodological approach

The Conceptual Framework of FIVIMS



Various social conditions illustrate food insecurity. Briefly put, food insecurity is characterized by 1) lack of physical, social, and economic resources to obtain adequate supply of healthy and quality food, and thereby resulting in 2) poor health and nutritional status of a population. Such conditions, when not addressed effectively or sufficiently, lead to worse scenarios of hunger and malnutrition.

As indicated in the framework, underlying situations become risk factors to inadequate food consumption and poor health status, rendering populations to be vulnerable to food insecurity. Such risk factors include:

- ✓ Low level of education leading to ignorance and lack of persistence to find employment
- ✓ Inadequate source of income
- ✓ Lack of access to basic services
- ✓ Poor environmental and sanitary conditions

On a broader view, conditions from various sectors also contribute food insecurity.

On agriculture:

- ✓ Poor land yield
- ✓ Inadequate hectarage
- ✓ Commercialization and improper land use leading to environmental degradation and poor land yield

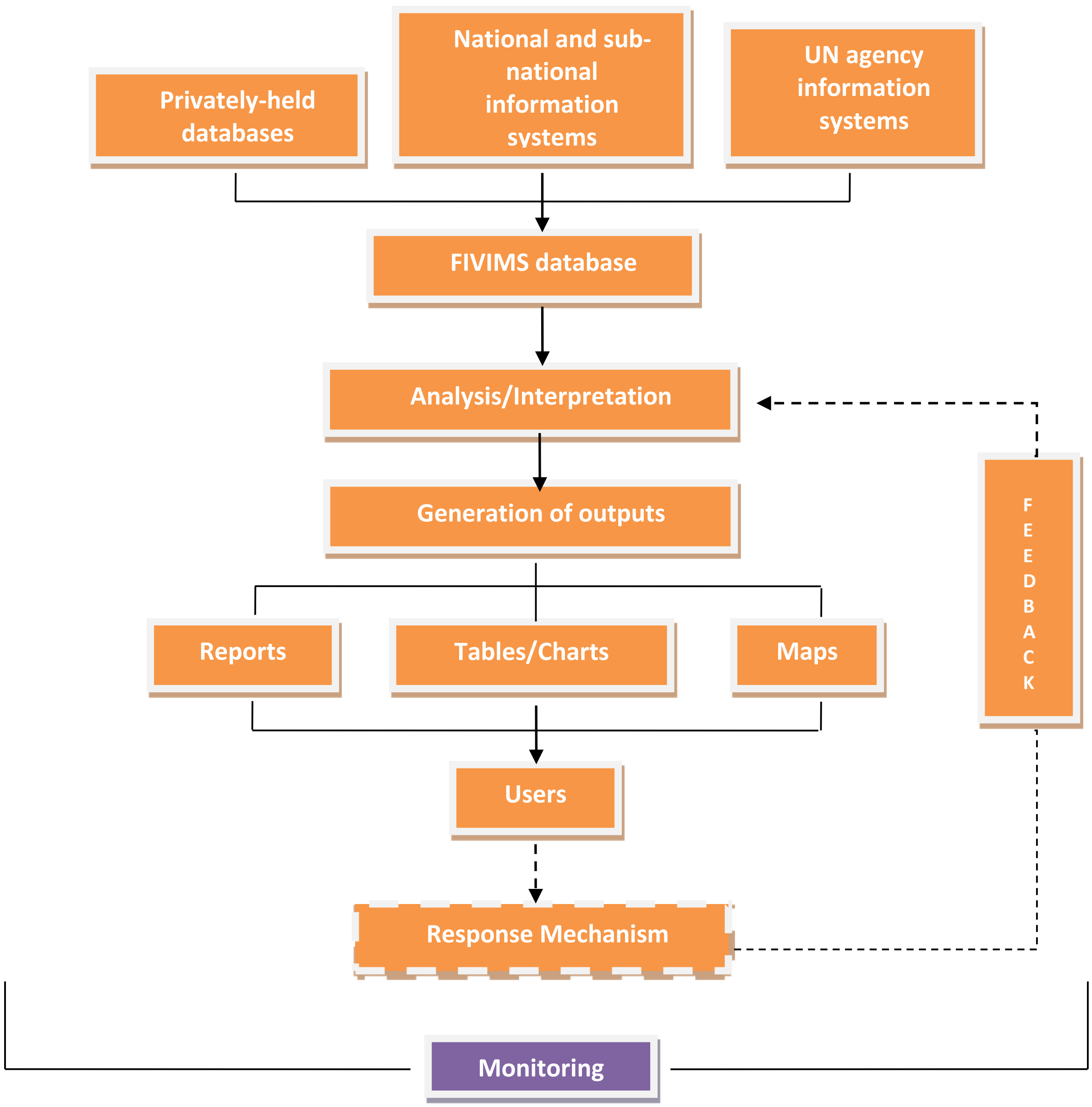
On population:

- ✓ Rapid population, overcrowding, and uncontrolled urbanization leading to food shortages

On climate and environment:

- ✓ Natural and man-made disasters leading to destruction of natural and built resources

The Operational Framework



Procedures of Implementation

1. Agencies will collect, process, analyse, and report data.
2. FIVIMS core group will data from agencies and conduct statistical analysis if necessary.
3. FIVIMS Unit will organize and store data in FIVIMS databank.
4. FIVIMS Unit will analyse and interpret the data, and draft reports.
5. FIVIMS Task Force will approve the reports.
6. The approved reports from the Task Force will then be submitted to the FIVIMS Steering Committee for further endorsement.

7. The FIVIMS Secretariat will then finalize the reports.
8. Reports will be disseminated to end-users.

Application on a National Scale

The Accelerated Hunger Mitigation Program (AHMP) is one of the national projects supported by FIVIMS, through providing research-based information on locating the provinces and households most vulnerable to food insecurity and hunger. Implemented in 2006, the project has found that:

- ✓ 63% , or 49 out of 77 provinces are highly vulnerable to food insecurity
- ✓ 13%, or 10 provinces are less vulnerable, and
- ✓ 23.4%, or 18 provinces are not vulnerable

As recommended by the Philippine National Nutrition Council, these identified 49 provinces became the priority areas for the national government's implementation of AHMP components:

1. *Food-for-School Program (FSP)*
   - Implemented in the 49 FIVIMS/AHMP provinces and NCR villages
   - Provision of daily ration of one kilo of rice to families through children in grade 1, pre-school, and day care centers

2. *Gulayan ng Masa Program*
   - Implemented in 38 out of the 49 FIVIMS/AHMP provinces
   - Promotion of backyard gardening in the rural communities
   - Trainings, seeds and planting materials, poultry, small ruminants, livestock, and fingerlings are provided

3. *Tindahan Natin*
   - Catered more than 300,000 households in NCR
   - Low-priced rice and instant noodles are provided to low income households through accredited stores

*Other program components:

- ✓ Population management measures in 28 project provinces
- ✓ "Kung maliit ang pamilya, kayang kaya" campaign to promote manageable family size
- ✓ Water transport facilities constructed in 33 project provinces, to improve marketing of agricultural products

I.1.c. Conditions of method application

Available data or information may be insufficient for discussion in this section.

I.1.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

I.2. RESILIENT SEAS

I.2.a. Entry point into the adaptation process

RESILIENT SEAS measures the exposure scenarios and the sensitivity and susceptibility and adaptive capacity of the fisheries ecosystem to the changing environment.

RESILIENT SEAS showcases linkages among the barangay, municipal, provincial, and national government agencies, people's organizations (Pos) and other stakeholders, as well as sectoral institutions (DA-BFAR and DENR-PAWB) in facilitating enhanced and more effective implementation of adaptation strategies.

I.2.b. The methodological approach

RESILIENT SEAS (Sentinel Ecosystems of Archipelagic Seas) is an approach integrating the "ecological and social conditions and processes of the Philippine fisheries ecosystems." RESILIENT SEAS covers multi-sectors such as the coastal and marine, biodiversity, and the fisheries.

The tool evaluates the potential impacts and the sensitivity of both the Philippine social and fisheries ecosystems. Furthermore, the tool arises from a modification of the framework by Allison *et. al.*(2009), IPCC 2007. RESILIENT SEAS utilizes the combined climate change and vulnerability assessment approaches in a hierarchical and nested manner.

RESILIENT SEAS employs RESTORED programmatic strategies which address (a) building of resilient coastal communities and environment, and (b) learning of adaptive actions in a wise manner. RESTORED acknowledges and encompasses the strength of organized community-based knowledge, sound and effective marine protected area (MPA) policy implementation, effective collaboration and enforcement of inter-LGU partnerships.

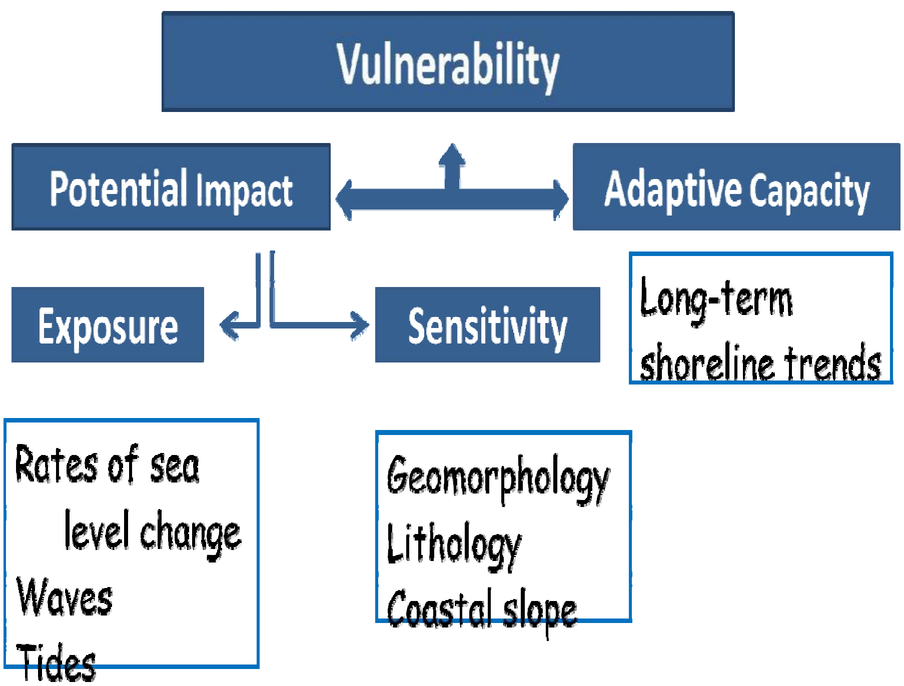
Key Inputs

RESILIENT SEAS uses both historical and projected thermal and local stresses particularly, the potential hazards from activities such as coastal development, marine resources exploitation and marine–based pollution, and on-set and off-set erosion.

Key Outputs

An enhanced Adaptive Management was bounded by the RESTORED framework. This management approach comprises of short and long term motivating strategies which address the decline and accelerating impacts of climate change.

Framework



The 1st level of vulnerability assessment tools are being undertaken in a participatory manner. This is an objective tool for assessing the vulnerability of coastal areas to erosion and inundation resulting from wave impact and sea level rise. This VA tool is made simple enough for non-specialists such as coastal managers to implement. It is designed to combine the coastal system's susceptibility to charge with its natural ability to adapt to changing environment conditions, "yielding a relative measure of the system's natural vulnerability to the effects of sea-level rise".

The 2nd level is based on simulations on exposure conditions, while the 3rd level discusses details per component vulnerability. The 2nd and 3rd level vulnerability assessment tools provide good opportunities for educational institutions to engage with management.

I.2.c. Conditions of method application

RESILIENT SEAS requires capacity-building trainings and collaboration with key sectors (agricultural, MPA managers and the LGUs), consultations with the key stakeholders, and secondary data gathering.

The tool is developed by institutions such as NEDA, UP Marine Science Institute, and De La Salle University.

I.2.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

I.3. Integrated Coastal Sensitivity, Exposure, Adaptive Capacity for Climate Change (I-C-SEA-C Change) Assessment Tool

I.3.a. Entry point into the adaptation process for method application

The tool is used for scoping and rapid assessment of the vulnerabilities of local communities in terms of their biodiversity, fisheries, and coastal resources. It also allows for comparison of vulnerabilities across multiple sites.

Through the coordination and monitoring efforts by the Marine Resources Division of the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCAARRD), the program targets 54 million Filipinos or 60% of the national population whose major sources of livelihood come from the marine ecosystem.

I.3.b. The methodological approach

The tool assesses coastal communities' vulnerability* to the effects of climate change, in terms of their biodiversity, coastal integrity, and fisheries.

*Vulnerability – the intersection of the three main factors:
1) sensitivity – characteristics of a system that respond to exposures from the changes in climate;
2) level or threat of exposure – the measure of intensity or severity of the conditions in the physical environment which then leads to changes in the conditions of biophysical systems; and

3) lack of adaptive capacity – the inability of a system to cope with climate change

Rubrics or criteria for each factor are described in the Key Outputs and Inputs.

Moderate vulnerability entails the presence of any two of the tree factors, while high vulnerability refers to the presence of all the three factors.

Key Inputs

Criteria for sensitivity:

- Nature and condition of coral, mangrove, and seagrass communities
- Condition of the beach/coasts due to erosion and flooding

Criteria for adaptive capacity:

- Socio-economic conditions of fishers, i.e. settlement, educational attainment, and economic activities of fishers
- Health of coastline habitats and habitat restoration efforts
- Water quality

Criteria for exposure:

- Sea level rise
- Surges of waves and storms
- Temperature of the sea surface
- Rainfall

Key Outputs

General output will include:

Local understanding and engagement among the coastal communities concerning relative vulnerabilities to climate change and its effects

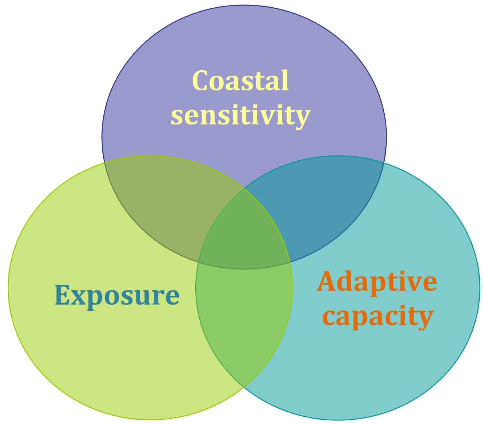
More specific outputs are illustrated in the following figure.

ICSEA-CChange Assessment Tool: Sample output

Integrated Coastal Sensitivity, Exposure and Adaptive Capacity for Climate Change (ICSEACC)
First Level SENSITIVITY RUBRIC **Municipality: _______________**

				LOW (1-2)	MEDIUM (3-4)	HIGH 5	Site Name	
COASTAL HABITAT	**Is there a coral reef in your area (with a defined profile)?**	1	How much of the coastline is lined by coral reefs/ communities?	More than 50% is lined by coral reefs/ communities	Between 25 to 50% is lined by coral reefs/ communities	Less than 25% is lined by coral reefs/ communities		
		2	What is the highest hard coral cover (%)?	over 50%	between 25 to 50%	less than 25%		
	Are there large seagrass meadows?	3	How much of the shallow areas are covered by seagrass?	seagrasses cover more than half of the reef flat	seagrasses cover more than 1/8 to 1/2 of of the reef flat	seagrasses cover less 1/8 of the reef flat		
		4	What is the maximum number of seagrass species?	mixed bed with over 5 species	2 to 4 species	monospecific bed		
	Are the mangrove areas widespread?	5	How much of the natural mangrove areas are left?	over 50% of the natural mangrove areas are left	between 25 to 50% of the natural mangrove areas are left	less than 25% of natural mangrove areas are left		
		6	What kind of mangrove forest is left?	riverine-basin-fringing type	riverine-fringing type	scrub-fringing type		
FISH AND FISHERIES	**What kind of fishery operates in your barangay/area?**	7	Dominant catch	catch predominantly pelagics (tuna, mackerel, etc)	catch a mix of demersal and pelagic species	catch predominantly demersal fish e.g. groupers		
		8	Catch rate	>8kg per day (or equivalent CPUE)	3 to 8kg per day (or equivalent CPUE)	<3kg per day (or equivalent CPUE)		
		9	Are the fishing gears used restricted on shallow water (coral, mangrove, seagrass) habitats?	mostly mobile fishing gear	presence of both types	considerable number of habitat-associated gear (e.g. fixed gear on seagrass beds)		
	How important is the fisheries to the community?	10	Population density (Concentration of population)	200 persons or less per square kilometer (1 HH per 2.5 ha)	between 200 to 500 persons per square kilometers (1 HH per 1.25 ha)	more than 500 persons per square kilometer (1 HH per 1 ha)		
		11	Fisheries ecosystem dependency	35% or less of the population are fishers	36% to 60% of the population are fishers	more than 60% of the population are fishers		
COASTAL INTEGRITY	**Is the coastline prone to erosion and marine flooding?**	12	Has the beach changed much in the last 12 months?	land gain/accreting	stable	eroding		
		13	Is the coastline prone to erosion?	Rocky, cliffed coast; beach rock	Low cliff (<5m high); cobble, gravel beaches; alluvial plains	Sandy beaches; delta; mud- or sandflat		
		14	Width of shore platform (m)	>100	[50, 100]	<50		
		15	Is the coast steep?	<1:50	1:50 to 1:200	>1:200		

The Integration of Coastal Sensitivity, Exposure, and Adaptive Capacity as a Measure of Vulnerability



Framework

I.3.c. Conditions of method application

The tool allows for comparison of general vulnerabilities across multiple sites. It is also capable of accessing available data from other related tools, i.e. Coastal Integrity Vulnerability Assessment (CIVAT) and the Tool for Understanding Resilience of Fisheries (TURF). Furthermore, the tool allows for participation and engagement of local stakeholders on measuring vulnerability and planning for adaptation strategies, since the tool does not recommend specific adaptation options.

Successful utilization of the tool would involve coordination among experts from the fields of climate and climate change, adaptive mechanisms, coastal ecosystem and fisheries, leaders of local coastal communities, and local governments.

No information has been provided regarding the estimated cost of utilizing the tool, although funds will be needed in order to carry out trainings and coordination among the local governments and communities, and experts from the relevant fields.

The tool is developed by the Department of Science & Technology, through the program RESILIENT SEA, and monitored by the Marine Resources Division of the Philippine Council for Agriculture, Aquatic, and Natural Resources Research and Development (PCARRD), in coordination with the University of the Philippines Diliman –

Marine Science Institute, University of the Philippines – Visayas, Bicol University, Xavier University, Mindanao State University at Naawan, and the De La Salle University.

I.3.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

I.4. Modeling Sea Level Rise and Surge with GIS Data Sets for Malaysia

I.4.a. Entry point into the adaptation process for method application

Low lying areas including people and infrastructures situated therein are vulnerable to sea level rise. It has been calculated that if the glacier and icecaps will melt due to high temperature, the sea will rise at 80 meters high. This would increase sea level in different countries. Real experience on sea level rise affected by tsunami happened in the Indian Ocean in 2005. The sea level rose at 30 meters high. Given these potential heights of sea level rise, which portions of coastal countries would be flooded?

The objective of the study by Usery, Choi, & Finn (n.d.) was to demonstrate how GIS-raster mapping can show flooding of coastal areas at any given heights of sea level.

National governments of archipelagic countries, the fishery officials, local government officials and planners and people living in coastal communities who are vulnerable to sea level rise were the main targets of the study.

I.4.b. The methodological approach

Inputs: Data and information used in the study

According to Usery, Choi, & Finn (n.d.), the data used in the model were topographic map containing elevations above sea level, infrastructure map, population map, and other maps indicating other ground features. The other set of data used were potential heights of sea level rise probably due to tsunami, undersea volcano eruption, earthquake, storm surge and very heavy rainfall.

Outputs of the study

The model used by Usery, Choi, & Finn (n.d.) simulated the areas that would be flooded at a given height of sea level rise. Areas including communities, infrastructures, human population, and other socio-economic establishments at any elevations would be submerged. Thus, statistics on flooded area, area of communities under water, infrastructures damaged due to flood, statistics on affected human population and other socio-economic are some of the information that can be estimated.

Process used in the study

The model used raster-based GIS digital mapping of land elevations, land cover types and population and other land features. Raster mapping refers to the representation of ground features in an area scale or raster on a map. A raster represents an area scale or resolution.. The CEGIS demonstrated the following resolutions: 1-kilometer (global), 90- meter (regional) and 30- meter (regional/specific areas).

By simulating sea level rise at different heights, corresponding areas defined by elevations would be flooded. Thus, populations, land cover types and other land features within a certain elevation would also be flooded.

The accuracy and types of insights that could be learned from the modeling of sea level rise depend on the accuracy, number and types of geographical data sets used in the modeling.

The information that could be generated from the simulation or animation is limited to land features that were mapped together with the topographic or elevation map.

Site specific information about the magnitude of sea level rise, tidal action, shoreline configuration, and other characteristics could not be determined (Usery, Choi, & Finn, n.d.).

I.4.c. Conditions of method application

Available data or information may be insufficient for discussion in this section.

I.4. d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

I.5. Hotspots: Mapping Climate Change Vulnerability in Southeast Asia

I.5.a. Entry point into the adaptation process for method application

Southeast Asia is composed mostly of developing countries. These countries lack the resources and technology to enable themselves to mitigate or adapt to climate change. Because they lack such resources and technology, they are dependent on technological and financial assistance from developed counties.

To guide the rich countries in allocating international development fund on climate change, technology, and capacity building assistance for the poor countries, EEPSEA came out with a vulnerability assessment study to determine which countries are vulnerable (Yusuf & Francisco, 2009 & 2010).

Furthermore, the study also characterized the communities according to the vulnerability criteria set by the IPCC. The countries covered in the study were Thailand, Vietnam, Laos, Cambodia, Indonesia, Malaysia, and Philippines. Analysis was conducted at the regional level, provinces, or districts, depending on the availability of the data (Yusuf & Francisco, 2009 & 2010). Vulnerability as defined by IPCC as the "The degree to which a system is susceptible to, or unable to cope with the adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity" (IPCC 2001, p.995). Operationally, it is defined as

Vulnerability= f(exposure, sensitivity, and adaptive capacity). This was the framework used in the study.

According to Yusuf & Francisco (2009 & 2010), the study's main objective was to conduct a climate change vulnerability assessment of least developed countries in Southeast Asia in order to determine the allocation of international aids for climate change**.**

The study was intended for international funding aid on climate change from developed countries. In the Philippine context, it will guide provincial/district leaders in budgeting for DRR, CCA and calamity fund.

I.5.b. The methodological approach

The framework used in the study by Yusuf & Francisco (2009 & 2010) was based on the IPCC framework where exposure, sensitivity, and adaptive capacity were integrated through map data, and transformed into indexes.

Inputs: Data and information used in the study

The data used were maps transformed into hazard indexes:

1. Cyclone risk map
2. Drought risk map
3. Flood risk map
4. Landslide risk map
5. Sea level rise risk map
6. Multiple hazard map

1. Population density map
2. Protected areas map (biodiversity index)

3. Adaptive capacity index map (socio-economic, technology and infrastructure)

Outputs of the study

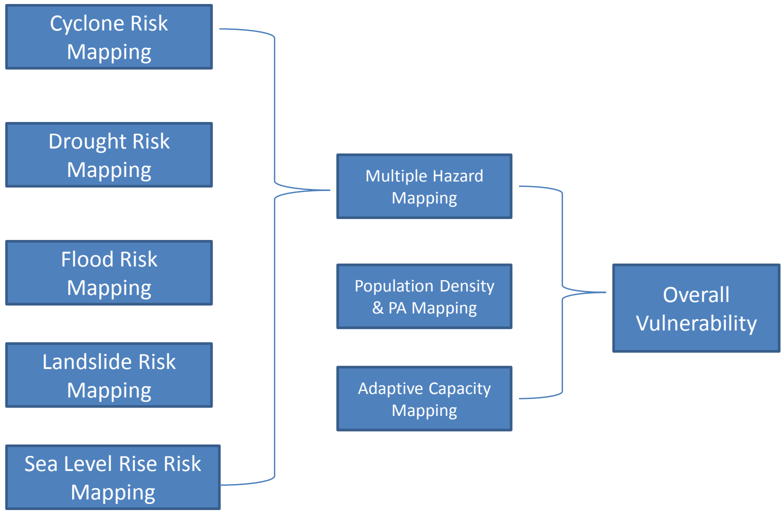
The outputs of the study are the ranking of the Southeast Asian countries according to their overall vulnerability, exposure, sensitivity, and adaptive capacity.

A sample of their outputs for the second 25 provinces of the Philippines is shown below. The same were also mapped using GIS (Yusuf & Francisco, 2009 & 2010).

No	Country	Province/District	Vulnera-	Country	SEA	Expo- bility	Country	SEA	Sensi-	Country	SEA	Adaptive	Country	SEA
26	Philippines	Isabela	0.44	26	71	0.55	31	65	0.14	9	61	0.67	18	122
27	Philippines	Zambales	0.44	27	73	0.70	10	16	0.01	68	497	0.74	8	49
28	Philippines	Davao Del Sur	0.44	28	74	0.59	26	53	0.05	24	240	0.55	44	319
29	Philippines	Camarines Norte	0.44	29	75	0.62	21	43	0.03	34	348	0.57	33	274
30	Philippines	Catanduanes	0.44	30	76	0.52	40	84	0.14	8	59	0.60	27	224
31	Philippines	Surigao Del Norte	0.43	31	80	0.51	42	88	0.10	16	98	0.51	57	374
32	Philippines	Misamis Occidental	0.43	32	82	0.61	22	48	0.01	59	452	0.52	55	366
33	Philippines	Pampanga	0.42	33	90	0.64	20	41	0.05	21	207	0.81	4	17
34	Philippines	Lanao Del Sur	0.42	34	94	0.50	44	92	0.02	44	402	0.38	68	516
35	Philippines	Lanao Del Norte	0.41	35	97	0.55	30	64	0.01	58	451	0.49	60	426
36	Philippines	Northern Samar	0.41	36	99	0.49	46	96	0.01	70	513	0.38	69	520
37	Philippines	Oriental Mindoro	0.40	37	104	0.55	33	68	0.04	25	252	0.56	36	286
38	Philippines	Ifugao	0.40	38	105	0.54	37	77	0.02	52	428	0.48	61	436
39	Philippines	Pangasinan	0.40	39	106	0.60	25	52	0.03	32	320	0.69	16	97
40	Philippines	Leyte	0.39	40	111	0.54	35	72	0.02	48	417	0.53	47	345
41	Philippines	Negros Oriental	0.39	41	112	0.51	41	86	0.02	41	394	0.47	62	448
42	Philippines	Bukidnon	0.39	42	116	0.52	39	83	0.04	28	295	0.53	48	347
43	Philippines	Quirino	0.39	43	118	0.57	29	60	0.02	42	397	0.65	21	145
44	Philippines	Zamboanga Del Norte	0.38	44	121	0.44	58	132	0.01	64	471	0.37	70	527
45	Philippines	Tarlac	0.38	45	122	0.59	27	54	0.02	47	414	0.73	10	61
46	Philippines	Negros Occidental	0.38	46	123	0.48	48	104	0.08	17	138	0.56	37	291
47	Philippines	Marinduque	0.37	47	130	0.55	32	67	0.01	61	457	0.60	28	227
48	Philippines	Western Samar	0.37	48	134	0.48	49	105	0.01	72	527	0.45	64	473
49	Philippines	Cagayan	0.37	49	137	0.54	34	71	0.02	45	405	0.65	22	148
50	Philippines	Masbate	0.36	50	139	0.41	62	150	0.01	66	480	0.36	71	529

Process of conducting the vulnerability assessment

The process applied in the study by Yusuf & Francisco (2009 & 2010) is depicted in the flowchart diagram below.



Source: Yusof and Francisco, 2008 Hotspots!! Mapping Climate Change Vulnerability in Southeast Asia. EEPSEA.

The countries that are least developed or still developing are Vietnam, Laos, Cambodia, Thailand, Malaysia, the Philippines, and Indonesia. From these countries, 590 sub-national areas with 341 districts (*kabupaten/kota*) in Indonesia, 19 provinces (*khet*) in Cambodia, and 17 provinces (*khoueng*) in Lao PDR, 14 states (*negeri*) in Malaysia, 74 provinces in the Philippines, 72 provinces (*changwat*) in Thailand, and 53 provinces (*tinh/ thanh pho*) in Vietnam (Yusuf & Francisco, 2009 & 2010).

The process of conducting the vulnerability assessment study comprises the following procedures:

Climate hazard maps

Digital maps (in grid/raster format) for frequency of droughts, floods, and cyclones, for about 20 years (1980-2000/1/3), physical exposure to landslides, and inundation zones of a five-meter sea level rise were obtained. These maps were normalized using the following formula:

$$Zij = (Xij - XiMin)/(XiMin - XiMAX)$$

Where: Zi,j is the standardized climate hazard of type i of region j;
Xi,j is the unstandardized climate hazard of type i of region j;
XiMAX is the maximum value of the climate hazard indicator over region j, and
Xi Min is the minimum value of the climate hazard indicator over region j

The simple average of the five standardized climate hazard indicators was selected in overlaying all five hazard maps to draw the single multiple hazard map. Equal weights of the hazard maps were assumed since the degree of importance of each hazard is unknown (Yusof & Francisco, 2009 & 2010).

Human and ecological sensitivity maps

Yusof and Francisco (2009 & 2010) used the population density maps from the Urban Extent Database (GRUMP version 1) of the Center for International Earth Science Information Network (CIESIN). The information used was the number of people per square kilometer in 30-arc-second (1- km) resolution. Yusof and Francisco 2009 & 2010) converted the unit of observation from the 1-km resolution into province/district by averaging across administrative boundaries. This produced maps of average population density for each of the provinces/districts in the region. These were used as human sensitivity index. The ecological sensitivity map was represented by data on protected areas from the Terrestrial Eco- regions GIS Database of the World Wildlife Fund (WWF). Protected area is reflected as a percentage of the area of the total land area of the province/district. The overall sensitivity map produced from the human and ecological factors was derived using the weighted averages of the standardized values of population density and protected area (as a share of total area) for each of the provinces/districts. Population density was weighted 0.70 whereas protected area was weighted 0.03). This weight allocation was based on the higher importance of human sensitivity over protected area (Yusuf & Francisco, 2009 & 2010).

Adaptive capacity map

Yusuf and Francisco (2009 & 2010) defined adaptive capacity as the degree to which people can adjust through practices, processes, or structures to soften the impact or offset potential damage of climate change or take advantage of opportunities. Operationally, this definition is represented by the general equation as,

Adaptive Capacity = f(socio-economic factors, technology, infrastructure)

Where:

Socio-economic indexes are human development index, standard of living, longevity, education, poverty incidence, and income inequality.

Technology is represented by electricity coverage and irrigation.

Infrastructure is a function of the extent of irrigation, road density, and communication.

The weights assigned to the climate change indicators were derived during the Climate Change Experts Consultation Meeting in Bangkok in 2008 through an 'expert opinion polling' approach.

Overall Climate Change Vulnerability Map

The overall index of climate change vulnerability map was derived from the averaged of the normalized indicators of exposure (multiple hazard risk exposure), sensitivity (human and ecological), and adaptive capacity (Yusuf & Francisco, 2008). The regions, provinces/districts with the highest averaged indexes are highly vulnerable whiles those with smaller indexes are not vulnerable. Between these extremes are regions, provinces/districts that are mildly vulnerable and moderately vulnerable (Yusuf & Francisco, 2009 & 2010).

I.5.c. Conditions of method application

Available data or information may be insufficient for discussion in this section.

I.5.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

I.6. Analysis and Mapping of Impacts under Climate Change for Adaptation and Food Security (AMICAF)

I.6.a. Entry point into the adaptation process for method application

On a macro level, project implementation is interlocked with the country's agricultural, economic, and climate change adaptation policies. For instance, the implementation of AMICAF in the Philippines is in coordination with the Department of Agriculture. On a micro level, the project is immersed into the community and household level in order to identify the particular conditions of vulnerability, existing socio-economic conditions, and other contributing factors to food security, and conversely, the communities' existing adaptive mechanisms.

This approach covers assessment of agricultural impacts of climate change and vulnerability of households to food insecurity and formulation of appropriate adaptation strategies.

I.6.b. The methodological approach

In coordination with FAO, the government of Japan has developed an international project called Analysis and Mapping of Impacts under Climate Change for Adaptation and Food Security (AMICAF), based on the country's adaptation policies to global warming. Equipped with its comprehensive framework, the project examines how climate change impacts food security and formulates adaptation strategies to improve the food security of vulnerable households.

Key Input(s)

Inputs will be composed of the data to be gathered from steps 1 to 3:

Step 1: Data from the MOSAICC Toolbox:

1. Downscaled climate data
2. Estimates of discharge rates in the water resources under projected climate conditions, using the STREAM precipitation run-off model
3. Simulated crop yields under future conditions of climate change and technological progress, using WABAL or a crop-specific water balance model
4. Assessment of the economic impacts of projected crop yields and water resources conditions, using the Provincial Agricultural Market (PAM) model

Step 2: Micro-econometric modeling to measure households' vulnerability to food insecurity.

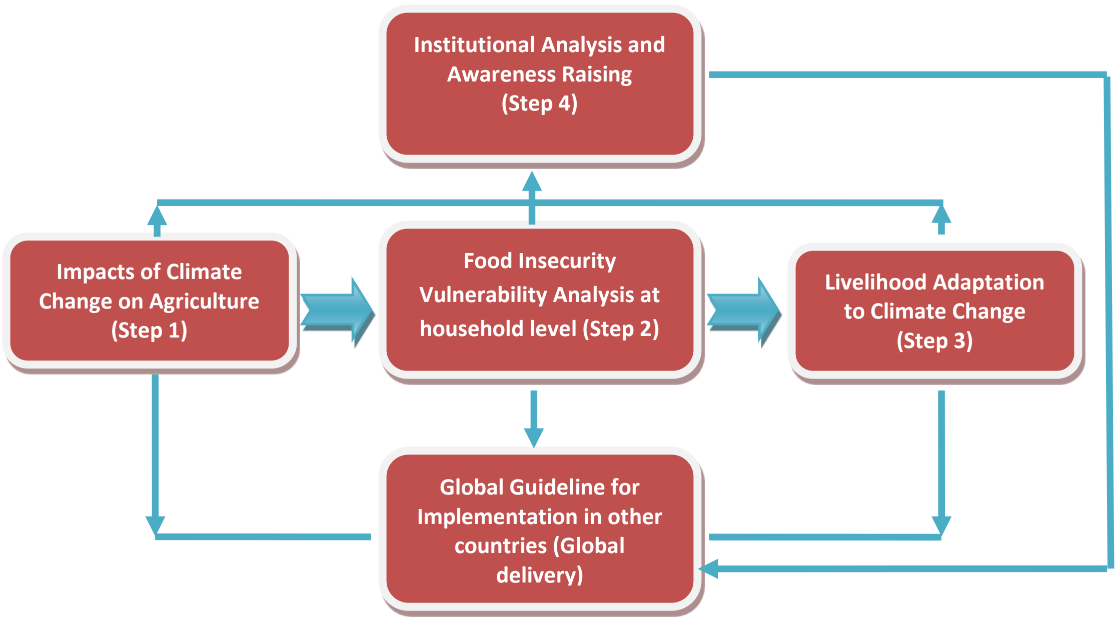
Step 3: Identification and evaluation of adaptation options and strategies at the community level to help improve people's coping ability in the face of climate change effects on food security.

Key Output(s)

1) Enhanced awareness and improve institutional level of assessment; and
2) The adaptation measures to food insecurity

Framework

Linking Climate Change and Food Security



Source: Sasaki, Hiroki. (n.d). *Japanese adaptation policy and AMICAF (Analysis and mapping of impacts under climate change for adaptation and food security) project* (PowerPoint slides). Accessed at http://www.oecd.org/tad/sustainableagriculture/50168378.pdf

The framework begins with assessing the impacts of climate change on agriculture using the tool MOSAICC with its four components – climate (downscaled climate data), hydrology (conditions of water resources under different future climate scenarios), crops (yields under different future climate scenarios), and economy (economic impacts of future crop yields and water resources projections). Outcomes of step 1 establish the micro-economic models necessary in facilitating step 2, which involves assessing vulnerability and other contributing factors to food insecurity at the household level as an effect of climate change. In AMICAF, a household's vulnerability to food insecurity refers to its probability of falling at or below a food security threshold. Through mapping, the locations of the vulnerable household groups will then be identified. Step 3 will be the identification and evaluation of adaptive strategies that help vulnerable communities sustain their livelihoods and cope with food insecurity in the face of climate change. Outcomes of the third step will be analyzed vis-à-vis the results of first step so as to harmonize the livelihood adaptation options with the community's cropping and water resources conditions in relation to climate change. The fourth step will seek to raise awareness on vulnerability and climate change impacts such as food insecurity. To widen awareness, an improved institutional level of assessment, through institutional analysis, policy simulations, and knowledge management, is also vital. On a global scale, the ultimate outcome will be the development of guidelines for implementation of the framework in other countries.

I.6.c. Conditions for method application

The project framework applies a bottom-up approach in which the communities' adaptation options identified in step three will be tightly linked with the outcomes of step 1 or the agricultural and economic impacts of climate change. In turn, a top-down method is applied when the integration of the community assessment and the agricultural and economic conditions leads to a formulation of a complementary set of adaptive strategies to heighten food security of the vulnerable households.

AMICAF calls for the following components for successful implementation:

On the project level:

- Interdisciplinary team (composed of climatologists, agrometeorologists, economists, and hydrologists) to spearhead the utilization of the MOSAICC toolbox
- Interdisciplinary team (may be composed of social scientists, economists, climatologists) to assess the vulnerability of households to food insecurity, their existing livelihood conditions, and adaptive practices in coping with the effects of climate change. This team will also conduct awareness-raising activities and institutional analysis.

On the national level:

- Implementation will be governed by a country's agricultural department, in coordination with a multidisciplinary committee for climate change.

This approach is developed by FAO in coordination with the national government of Japan.

I.6.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

I.7. Modeling Approach for Marine Resources: DHI Guidelines for Marine Sustainable Adaptation in the Face of Climate Change

I.7.a. Entry point into the adaptation process for method application

This guide may serve as reference for project decision-makers, designers, investors, and management teams. Specifically, potential users of this guide include authorities, developers, utility companies, and consultancies.

This guide covers various topics in the impacts of climate change on marine resources and coastal areas including increasing temperature, sea level rise, increased storminess, changes in wave conditions, changes in precipitation, ocean warming, and acidification.

In terms of scale of analysis, the guideline is applicable to all levels – local to national scales. Methods proposed also allow for both large and local scales of analysis.

I.7.b. The methodological approach

The DHI group has published three sector-specific guidelines to sustainable adaptation in the face of climate change – guidelines for marine, urban, and water resources. This guideline focuses on quantifying the impacts of climate change on marine infrastructures, coastal areas, and the marine environment. It outlines the available methodologies and tools for impact assessment and adaptive strategies to climate change, and discusses the systems of its implementation.

Inputs: Data and information used for modeling

Stage 1 inputs: guidelines/decision-making inputs from the project team and relevant sectors in selecting the CC scenario

Stage 2 inputs: relevant sources, i.e. past studies, subject matter experts
: identified components of vulnerability

Stage 3 inputs: selected marine focus areas
: time horizons
: climatic and oceanographic parameters
: climate models such as global climate models (GCMs) and regional climate models(RCMs)
: downscaling methods, i.e. dynamic and statistical downscaling
Stage 4 inputs: identified adaptation options
: evaluation criteria for the adaptation options

Stage 5 inputs: monitoring and review mechanisms for adaptation plan

Outputs of the Tool

Stage 1 output: clear problem, objectives, location/climate region
: chosen future climate change scenario

Stage 2 outputs: vulnerability assessment and initial adaptation planning
: risk tolerance level and decision-making criteria

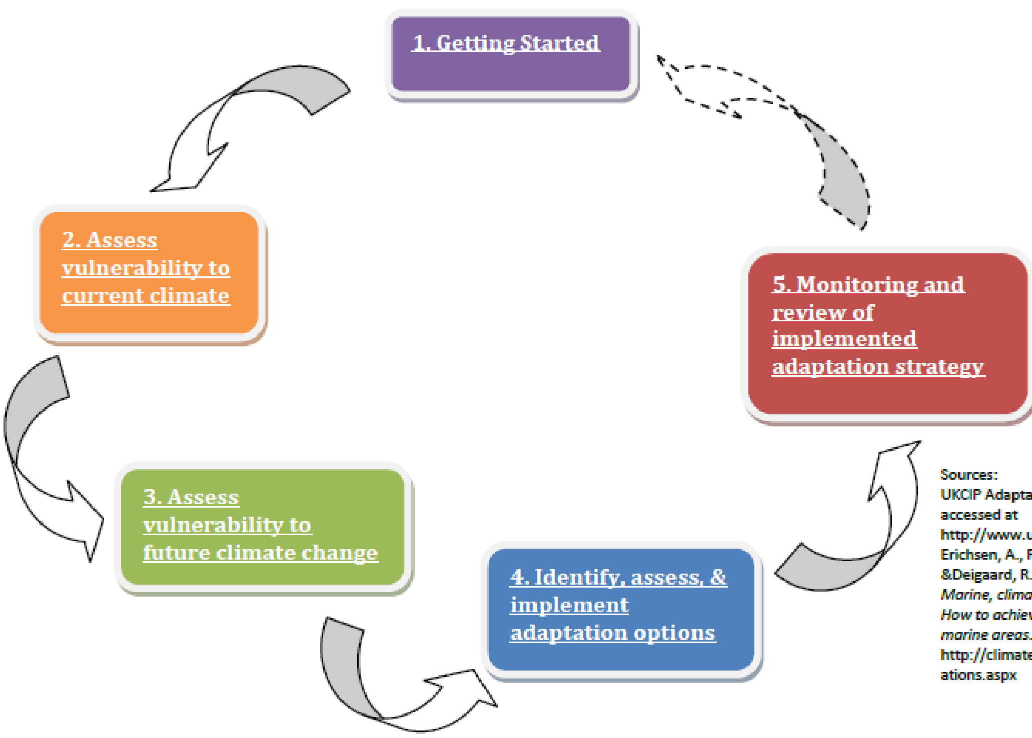
Stage 3 output: future climate vulnerability assessment

Stage 4 outputs: final decision on the adaptation strategy, and its implementation plan

Stage 5 outputs: adaptive management practices

Framework

The UKCIP Adaptation Wizard



Sources:
UKCIP Adaptation Wizard, accessed at http://www.ukcip.org.uk/wizard/;
Erichsen, A., Rugbjerg, M., Mangor, K., &Deigaard, R. (2011). *Marine, climate change guidelines: How to achieve sustainable adaptation in marine areas*. DHI. Accessed at http://climatechange.dhigroup.com/Publications.aspx

The DHI team on marine resources modeling has adopted the framework of the UK Climate Impacts Programme (UKCIP) Adaptation wizard. Applied in the context of marine resources, these stages are further modified in order to align with the sector components, thus:

The Key Processes:

1. **Getting Started**
    - Identification of problem, objectives, location, & climate scenario

2. **Assessment of vulnerability to current climate**
    1. *Determine objectives and scope*
        - audience, user requirements, and needed outputs are identified
        - engagement of key internal and external stakeholders
        - assessment targets must be set
        - appropriate spatial and temporal scales of analysis are identified
        - selection of assessment approach based on targets, user needs, and available resources

    2. *Gather relevant data and expertise*
        - review of related studies; engagement of subject matter experts

- development of projections of climate conditions and ecological responses

3. *Assess components of vulnerability*
   - examine climate sensitivity, climate change exposure, and adaptive capacity of targets; estimation of overall vulnerability
   - level of confidence and uncertainty in the assessment must be documented

4. *Apply assessment in adaptation planning*
   - adaptation planning should be based on vulnerability of the targets
   - the likelihood of climate scenarios should also be considered

3. **Assessment of vulnerability to future climate change**
   - May be conducted according to specific foci in marine areas vis-à-vis specific time horizons or specific oceanographic parameters

I.7.c. Conditions for method application

This guideline provides a systematic approach to addressing climate change impacts on marine resources. Capacity required in applying this method includes access to the modeling tools, GCMs, RCMs, records of past weather events, etc. An interdisciplinary team composed of experts from marine and coastal resources, climate modeling, and other relevant fields is also vital in method application.

I.7.d. Challenges, lessons learned, and recommendations

More details on proposed adaptation options and criteria for decision-making could be provided.

I.8. Modeling Approach for Water Resources: DHI Guidelines

I.8.a. Entry point into the adaptation process for method application

This guide may serve as reference for project decision-makers, designers, investors, and management teams. Specifically, potential users of this guide include authorities, developers, utility companies, and consultancies.

It is capable of covering various issues in water resources management worldwide – flood management, integrated water resources management, ecosystem conservation and restoration, infrastructure design and management.

In terms of scale of analysis, the guideline is applicable to all levels – local to national and transnational scales. Flexible methods are proposed in order to cater to the available economic, human, technical resources in a given context.

I.8.b. The methodological approach

This guideline focuses on how the impacts of climate change can be taken into account in water resources management. It outlines the available methodologies and tools for impact assessment and adaptive strategies to climate change, and discusses the systems of its implementation.

Key Input(s)

Stage 1 inputs: guidelines/decision-making inputs from the project team
:initial research on all possible variables and drivers, inc. climate that affect the water resource under study

Stage 2 input: criteria for assessing adaptation options (*win-win, low regret, flexible, or high resilience*)

Stage 3 inputs: review of study objectives – basis for selecting a modeling tool
: review of potential impacts of climate change

Stage 4 inputs: initial list of climate variables, time horizons, climate forcing scenarios
: estimates of uncertainties, and error margins

Stage 5 inputs: information to be obtained from any of the three approaches – scenario analysis, classical decision analysis, and robust decision-making.

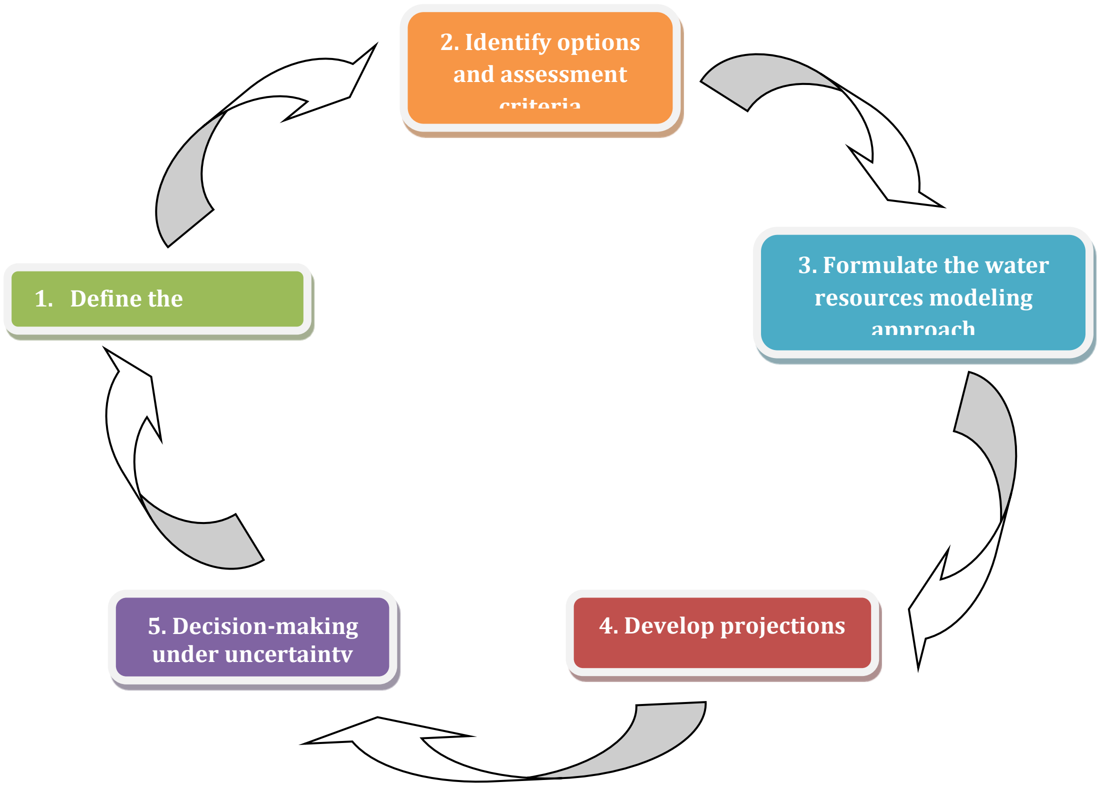
Key Output(s)

Stage 1 outputs: clear problem, objectives, scope; identified variables and drivers other than climate

Stage 2 output: selected adaptation strategy
Stage 3 outputs: selected modeling tool(s) for the project; preliminary impact assessment
Stage 4 outputs: climate projections
Stage 5 output: adaptive management practices

Framework

Work Flow of the Guidelines in Approaching Water Resources Issues



Source; Asadullah, A.M., Butts, M., Glennie, P., Lingaard-Jørgensen, P., Madsen, H., &Riegels, N. (2012). *Water resources, climate change guidelines: How to achieve sustainable adaptation*. DHI. Accessed at http://climatechange.dhigroup.com/Publications.aspx

I.8.c. Conditions for method application

This guideline provides a comprehensive step-by-step approach to addressing the impacts of climate change on impact assessment studies, adaptation studies, and water resources management.

For successful utilization of this approach, the project team should have access to the modeling tools, GCMs, RCMs, etc.An interdisciplinary team composed of experts from water resources management, hydrology, and climate modeling is also a key resource.

The costs of applying these guidelines will depend on the type of project being undertaken and the specific area of water resources being studied.

I.8.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

II. MAINSTREAMING AND CLIMATE PROOFING

II.1. Mainstreaming Disaster Risk Reduction and Climate Change Adaptation in Comprehensive Land Use Planning (CLUP)

II.1.a. Entry point into the adaptation process for method application

The Philippines has several destructive natural forces that hinder the country's physical, social and economic development. Typhoons, volcano eruption, earthquakes have destroyed several valuable human lives, infrastructures, and important ecosystems. To maintain the development path of the country, the government has ordered through the Laws on Disaster Risk Reduction and Climate Change that all local government units and national government agencies should start integrating into their plans and programs DRR and CCA concerns. Thus, a methodology on how to integrate DRR and CCA to the comprehensive land use plans and comprehensive development plans of all the LGUs nationwide is crucial to mitigate and to adapt to the effects if disasters and impacts of climate change.

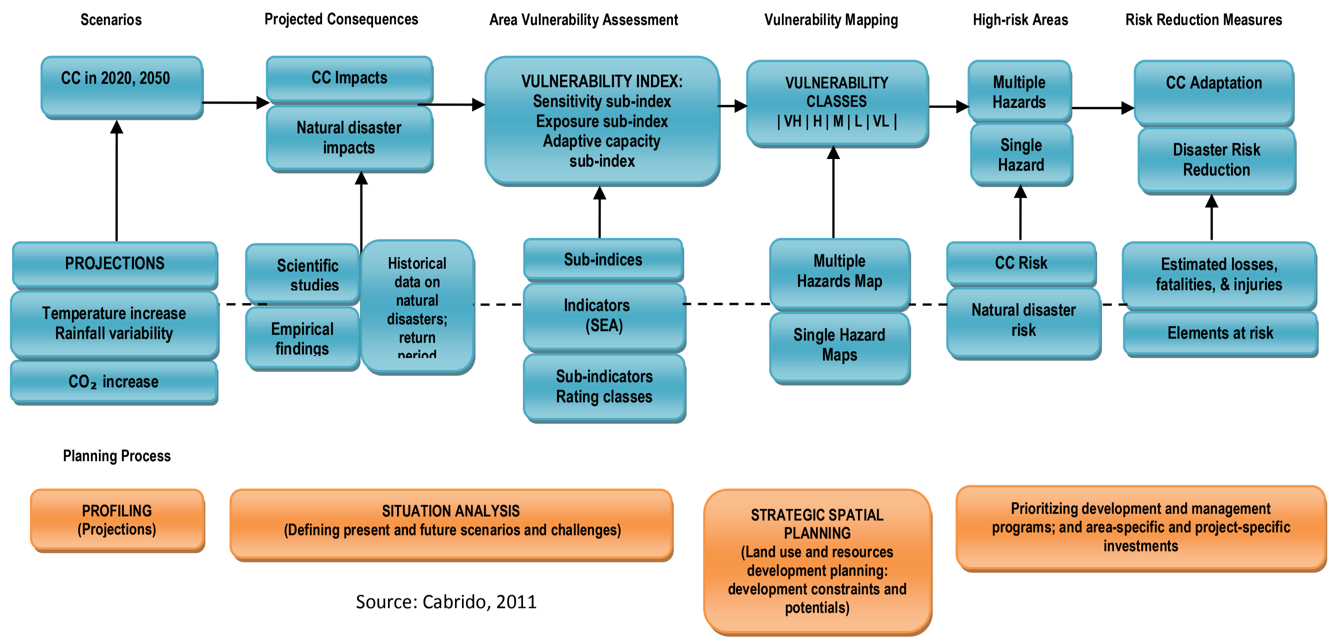
Dr. Cabrido has proposed his approach in integrating DRR and CCA in CLUPS and CDPs to all LGUs in the country. Thus, his study aimed to mainstream these two concerns to the governance planning system of each LGU in the country.

All regional and land use planners in the Philippines including mayors of cities and municipalities and heads of national government agencies.

II.1.b. The methodological approach

The study was a conceptual study. It used the IPCC framework on vulnerability assessment with further transformation of exposure, sensitivity, and adaptive capacity to vulnerability indexes. The framework that guides the planners in mainstreaming DRR and CCA is presented below.

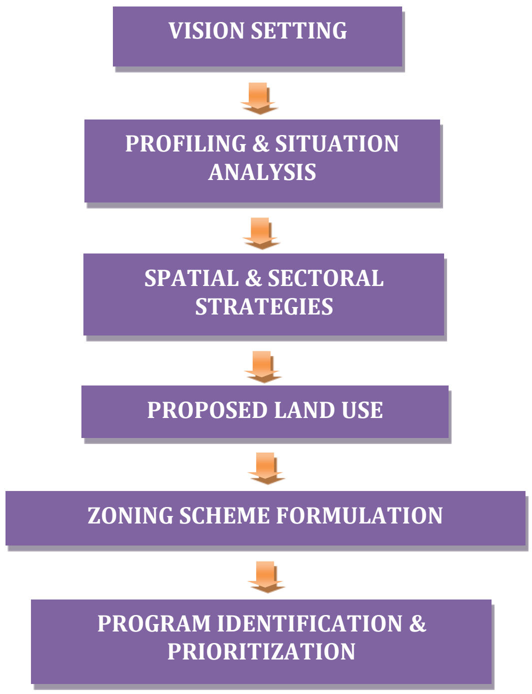
Framework for Mainstreaming Climate Change and Disaster Risk in Sectoral Development Plan



Source: Cabrido, 2011

To delve deeper into the phases of the planning process, Cabrido (2011) presented the flowchart below.

The Planning Process



Source: Cabrido, 2011

In vulnerability assessment, Cabrido (2011) recommended the following indicators and types of data to be used. These indicators and corresponding data requirements are summarized in the table below.

Impact Parameters	**Summary Vulnerability Index**		
	Sensitivity indicators (susceptibility)	**Exposure indicators (extent and number)**	**Adaptive Capacity indicators (adaptation measures)**
Forestry sector			
1.Erosion	Rainfall volume	Extent of denuded areas	Reforestation efforts
	Percent forest cover	Extent of upland farms	Soil erosion control measures
	Vegetation or forest types	Extent of kaingin areas	Soil conservation/agroforest y
	Slope class		
	Land use		
	Soil type		
2.Landslides	Rainfall volume	Settlements (number of houses and residents)	Maps on landslide-prone areas

		within & below landslide-prone (high-risk) areas	
	Slope class	Extent of cultivated agricultural lands below landslide prone areas	Awareness of exposed population on landslide risk
	Distance to fault lines		Relocation efforts by LGU
	Lithology		Efforts on stabilization of slopes in landslide
	Frequency of earthquake with intensity of 6 and above in Richter scale		Alert and preparedness system for seismic activity
	Presence of construction activities		
3.Flooding	Rainfall volume	Extent and number of riverine communities at risk	Maps of flood-prone areas
	Slope	Extent and number of settlements & population in floodplains at risk	Reforestation efforts
	Proximity to river	Types and value of physical assets exposed to downstream flooding	Soil erosion control & soil conservation practices in the watershed
	Percent forest cover in watershed	Extent of flood-prone areas in lowland areas	Riverbank stabilization efforts
	Land use in riparian areas and flood plains	Extent of agricultural areas risk	Solid waste disposal & management
			Flood control & drainage facilities in floodplain areas
			Flood preparedness
			Warning system & evacuation routes
			Relocation of high risk population
4.Wildfires	Vegetation types	Extent of grasslands	Fire prevention, preparedness, and control programs
	Kaingin plots	Extent of kaingin areas adjacent to forest areas	Fire awareness &consciousness campaign
	Forest tourist campsites	Number of tourist campsite adjacent to forest areas	Presence of firebreaks
	Droughty areas		
5.Drought	Percent forest cover	Extent of upland farms & number of families affected	Small scale upland irrigation program

	Land use	Value of crops lost	Water conservation practices adopted
	Incidence of El Niño	Extent of areas affected by El Niño event	
	Rainfall volume		
	Presence of river and streams		
Biodiversity sector			
1.Forest fires	Land use in buffer zone	Extent of buffer zone cultivated	Monitoring and surveillance program for protected area
	Kaingin plots inside protected areas	Size of kaingin plots inside core zone	PA zoning enforcement
	Human settlements inside protected areas	Number of houses and population of residents living inside core zone	Relocation of informal settlers living inside core zone
2.Diseases and pests	Temperature & moisture	Areal extent of spread of diseases and pests	Prevention, control, & eradication of pests & diseases
	Presence of alien-invasive species	Areal extent of spread of alien-invasive species	Control and removal of alien species
	Presence of exotic wildlife animal	Number of endemic & critically endangered species affected by pests & diseases	R & D of diseases cure & prevention
	Cultivated crops inside protected areas	Extent of agricultural crop cultivated land inside core zone that are affected by pests and diseases	Relocation of croplands outside strict protection zone into buffer zone
			Monitoring & protection of critically endangered species
3.Heat waves/heat stress	Temperature tolerance level of flora & fauna species	Number of flora and fauna species with recorded low temperature tolerance level	Species and habitat protection programs
	Migration capacity of plant species	Number of flora & fauna species with migratory capability	Assisted natural regeneration program
	Critically endangered species	Number of species becoming extinct	Cloning and seed dispersal program
		Number of critically endangered species at risk	Monitoring and protection of critically endangered species
4.Sea surface temperature increase	Coral types	Number of species of corals highly sensitive to increased temperature	Establishment of more sanctuaries and marine-protected areas
	Phytoplanktons		Mapping of sea surface temperature

	Fish species	Number of reef fish species highly sensitive to increased water temperature	Fishery stock assessment in fishing grounds and MPAs
	Sea grass meadows	Number of species of sea grass highly sensitive to increased temperature	Mangrove reforestation
	Mangroves	Number of species of mangroves highly sensitive to increased temperature	
Coastal and marine sector			
1.Sea surface temperature increase	Mangroves	Number of mangrove species highly sensitive to temperature increase	Establishment of more sanctuaries & marine-protected areas
	Coral reef	Number of coral species highly sensitive to temperature increase	Mapping of sea surface temperature
	Sea grass meadows	Number of sea grass species highly sensitive to temperature increase	Fishery stock assessment in fishing grounds and MPAs
	Fish	Number of fish species highly sensitive to temperature increase	Mangrove reforestation
	Phytoplanktons	Number of families totally dependent on fishing as source of livelihood & income	Coastal waters pollution control programs
2.Ocean acidification	Coral reefs	Extent of coral bleaching in reefs	Establishment of more sanctuaries & marine protected areas
	Planktons	Number of species of marine organisms at risk	Coastal waters pollution control programs
	Marine organisms/fisheries	Number of families totally dependent on fishing as source of livelihood & income	
3.Sea level rise & flooding	Wetlands	Extent of wetlands inundated	Mapping and zoning of coastal habitat at risk
	Coral reefs	Extent of nesting sites of birds in beaches, sandy sands & shores, salt marshes, coastal	Relocation of coastal settlements at high risk areas

		wetlands & low-lying islands flooded	
	Mangroves	Salinity increase in groundwater and wetlands	Wetland protection program
	Seagrass	Extent of settlements & population affected by floods	Groundwater analysis & conservation program
	Fish	Physical assets and infrastructures, tourism facilities, inundated by floods	Climate proofing of physical assets and infrastructures
	Beach erosion	Agricultural lands & beach areas affected	Cultivation of saline tolerant crops and trees
	Coastal settlements		Beach erosion control and physical protection programs
	Agricultural lands		
	Wetland and sea birds		
	Groundwater		
	Topography/elevation		
4.Watershed runoff, nutrient load, and sediment load	Coral reef	Extent of sedimented coastal waters	Mapping of affected and high risk areas
	Sea grass meadows	Extent of coastal waters affected by algal bloom	Watershed rehabilitation programs
	Mangroves		Agricultural inputs (fertilizers and pesticides) management programs and practices
5.Tropical cyclones and storm surge	Coral community growth form in the upper reef slope and crest	Extent of shallow coral reefs	Physical protection of high risk potential land areas, beaches, & shorelands
	Beaches and coastal shores	Extent of beaches and coastal shores frequently affected/damaged by typhoons	Early warning system disaster preparedness program
	Mangroves	Extent of settlements & population affected	Agro-meteorological monitoring & cropping calendar bulletins
	Sea grass	Physical assets and infrastructures damaged	
	Coastal settlements	Agricultural lands affected	

Source: Cabrido 2011

II.1.c. Conditions of method application

The approach calls for a team of climatologists, climate change and adaptation experts, disaster preparedness and management experts, land use and planning experts, M & E team, and their system coordination with local authorities, and community leaders and organizations. Project team should also be capable of conducting trainings, particularly on the use of the VA index tool.

II.1.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

III. MONITORING AND EVALUATION

III.1. Learning to ADAPT

III.1.a. Entry point into the adaptation process for method application

The assessment of the current monitoring and evaluation methodologies and approaches was guided by the ADAPT or Adaptive, Dynamic, Active, Participatory, and Thorough principles.

Specifically, the evaluation was conducted as follows:

1. Input-Output-Outcome based evaluation
2. Process-based evaluation
3. Evaluation of behavioral change
4. Economic evaluation

This approach entailed multi-discipline and multi-sectoral processes. Moreover, this may be used both in the local and national arena wherein initiatives and discourses on climate change adaptation and disaster risk reductions measures are being addressed.

III.1.b. The methodological approach

This work attempted to assess the existing fundamental, conceptual, and methodological practices and principles that guide current Monitoring and Evaluation approaches. The assessment was done in the context of climate change adaptation as well as disaster risk reduction scenarios.

Key issues, challenges, gaps, and limitations pertaining to the theoretical and methodological assumptions and underpinnings were addressed intensively.

Apart from the review, comparisons were likewise conducted in order to evaluate several determinants which both allow and constrain adaptation opportunities. By accomplishing these, policy planning and decision making process with long-term adaptation and developmental results are expected.

The following are the M&E methodologies employed in this case study:

1. **Input-Output-Outcome Evaluation**
    - The focus of this method was to assess effectiveness
    - Determining the adaptive capacity elements beforehand was imperative
    - This was assessed vis-à-vis a set of indicators
    - The underlying assumption is that an increase in adaptive capacity will result in a reduced vulnerability

    The same treatment was given both to:

(a) Process-based Evaluation
(b) Evaluation of Behavioral change

2. **Economic Evaluation**
    - This specific M&E methodology highlighted efficiency
    - Economic loss served as the basis for evaluation and measuring adaptation benefits
    - Rational decision making is assumed, as well as
    - The ability to identify baseline and projected benefits and losses

Key Inputs

Procedures of Disaster Risk Assessment:

1. Hazard characterization and frequency analysis – inventory of hazards that affect the province or region. This includes all types of natural hazard such as rain-induced landslide, flood, earthquake, volcanic eruption, tsunami, typhoon.
2. Consequence analysis – estimate of fatality and damage costs for each hazard type per event. How much is the cost of damage to human lives, property, infrastructure and environment?
3. Risk estimation – estimate of fatality and damage costs for each hazard type per year in map and table form
4. Risk evaluation – a prioritization map for risk reduction focusing on high risk areas

Components of Development Planning and Mainstreaming:

1. Vision – refers to a desired state after application of an adaptation measure as seen or expected from the present time.

2. Planning environment:

2.1. Population of people within the planning environment. The population is both a contributing factor and at the same time recipient of impacts.
2.2. Economic activity includes human and institutional activities dealing on the provision of goods and services to humanity as a whole.
2.3. Physical resources and transport includes infrastructures and transport system for mobility of people and resources
2.4. Land use and physical framework. Refers to the different uses of the land for protective and productive uses including how such land uses are allocated and implemented under a physical framework.
2.5. Income and services. Income of individuals and business companies, employment and income generating activities.
3. Development issues. What are the problems that hinder development plans.
4. Strategies and PPAs. How are developments strategies financed and implemented? Would PPP be appropriate?
4.1. Project evaluation and development. What are the emerging developments from the results of evaluating projects?
4.1.1. Investment program. What are the investment opportunities and programs that a business would want to participate in.
4.1.2. Budgeting. How much is needed to finance and implement project to achieve its objectives.
4.1.3. Project implementation, monitoring and evaluation. Carrying out the project on the ground, keeping track of its activities, resource uses and accomplishments? Are the objectives achieved? And are there good and bad spill-over effects?

Key Outputs

This study with the use of several Monitoring and Evaluation Methodologies presented the following outputs:

1. Comprehensive evaluation of the following:

- Existing M&E initiatives both in adaptation and disaster risk reduction
- Comparison of existing practices in terms of methodology and concepts
- Determinants, i.e., both those that may enable and constrain adaption options

2. A set of Adaptive, Dynamic, Active, Participatory and Thorough (ADAPT) principles

- These are useful in facilitating the development of M&E frameworks
- It is foreseen that the said principles will be used for initiatives which aim to contribute in the integration of adaptation processes

3. Opportunity for changes by challenging the existing M&E principles and practices

- New sets of practices include the following concepts/themes:
  - ✓ Provide room for flexibility
  - ✓ Account for uncertainty and complexity
  - ✓ Encourage an understanding of the linkages between (1) capacity, (2) action, and (3) driving force of individuals and communities towards change

4. Proposed Experience-based Learning M&E processes

- This is in consideration of the type of adaptation options that address climate change and variability

- The purpose of this is to determine key indicators on adaptive capacity, as well as its relationship to the following:
  - ✓ Adaptation processes
  - ✓ Preventing and reducing risks
  - ✓ Reducing vulnerability

Based on the evaluation, the three key issues of M&E presented below were explored:

1. M&E approaches put emphasis extensively on inputs as well as outputs.

   - As a result, processes are not taken into consideration in deterministic approaches

   - By shifting the 'what' questions to 'how and why questions, M&E approaches should be able to determine and form long term adaptation and disaster risk reduction plans and actions

   - Thus, a holistic M&E approach is needed to support this shift on adaptive mechanisms, especially on policy planning and decision making processes

2. M&E: static versus dynamic

   - Based on the evaluation, current M&E approached tend to be more static rather than dynamic

   - There is a proposed shift from static quantitative indicators to frameworks which allow for dynamism and flexibility

   - Shift of focus towards factors that take into consideration temporal elements, i.e., changes through time

3. M&E: effectiveness versus efficiency

- It is proposed to balance or shift the focus from result-oriented approaches to efficiency-based methodologies

- Highlights need to be directed to evidence-based knowledge especially in decision-making processes

III.1.c. Conditions of method application

Existing Monitoring and Evaluation Approaches on climate change adaptation and disaster risk management were evaluated based on current key issues, challenges, gaps, as well as limitations. Highlights were directed to comparisons on methodological and conceptual contexts by which these approaches are grounded.

This approach is manageable for as long as mastery and/or familiarity to the different Monitoring and Evaluation approaches as well as the key elements and indicators of climate change and disaster risk reduction are determined and established.

Cost will cover intensive training and workshop on the various M&E approaches are useful in order to identify key issues, challenges, gaps and limitations as well as to develop and open opportunity for the development of a set of new, Adaptive, Dynamic, Active, Participatory and Thorough (ADAPT), efficient methodologies, principles and practices.

The cost of implementing M&E of climate change adaptation measure and disaster risk reduction depends on the number of project activities to be monitored, extent of coverage, objectives of the M&E and available fund intended for M&E. M&E is an expensive activity, which could be replaced with strict and comprehensive supervision in the implementation of a project. While this project has not reported the time and cost used in conducting the M&E, estimates based on similar M&E of projects of different types may be used to measure how much would be needed in the conduct of M&E for climate change adaptation measures and disaster risk reduction.

On a project basis, the usual contract for an M&E activity is PhP2,000,000 for a 6-month contract involving mostly ground validation of reported physical outputs of foreign-funded project[1]. For locally funded M&E, the M&E cost is much lower to about 50% of the M&E under foreign funding. Since M&E is heavily dependent on human resources for ground base activities, about 40% of the contract cost was spent for project staff, 20% for field-based expenditures, 20% for supplies and materials, and 10% for

[1] Based on the Project Benefit Monitoring and Evaluation and Physical Monitoring and Evaluation of 24 watershed rehabilitation projects and 13 mangrove rehabilitation projects implemented by DENR from 1996 to 2003 under the funding of the Japan Bank for International Cooperation, now JICA.

transport rental and 10% for overhead. Most of the contractors that did the M&Es were NGOs.

M&E that are implemented by NGAs to track their performance in their regular projects would cost lower because they have branches assigned in the field which they could tap to gather pertinent data. They only spend for training of their manpower in the field on M&E.

The timeliness of M&E recommendations depends on how fast the M&E teams process their data. This could only be done, if the office in-charge of M&E is backed up by a computer system that can be used in processing the data and operated by a trained and knowledgeable staff. A computer set up worth Php100,000 (3 units with peripherals) with software on statistics, GIS and customized program on M&E. GIS software price ranges from PhP30,000 (low end GIS but workable) to PhP250,000 (high-end GIS like ArcGIS), PhP50,000 (statistical software) and customized M&E software worth Php300,000 (M&E programming contract) would be necessary. The total cost of hardware and software is PhP700,000. Plus additional training cost of PhP100,000 and additional notebooks worth PhP200,000 for different offices which would be utilizing M&E information for improving decision-making. This sums to PhP1,000,000.

III.1.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

III.2. Results-based Management (RBM)

III.2.a. Entry point into the adaptation process for method application

The tool is appropriately used in the monitoring and evaluation phase of any climate adaptation measures.

III.2.b. The methodological approach

Results-Based Management (RBM) involves management of project inputs and activities that are consistent or in compliance with the design, budget and work plan.

It measures inputs and activities and compare with project budget and work plan. Activity achievement is measured in terms of immediate outputs, intermediate outcomes and long-term impacts.

It also includes a wide range of activities, such as setting objectives, developing indicators, defining targets, monitoring performance and analyzing results vis-à-vis targets.

Key Inputs

a. Project activities,
b. Targets of activities
c. Activity inputs (manpower, funds, technical know-how, resources, etc.)

Key Outputs

Depending on the climate change adaptation or mitigation project, the outputs are:

a. Outputs of project activities
b. Costs of project activities
c. Comparison of targets and outputs
d. Cost efficiency of project activities

III.2.c. Conditions for method application

The capacity required for the application of the tool involves thorough understanding of the project design, implementation, and input-output analysis. Knowledge of computer application, particularly Microsoft Excel is also important.

The cost of monitoring and evaluation projects usually depends on the number of activities, area covered, and the approach used.

III.2.d. Challenges, lessons learned, and recommendations

Challenges lie in uncertainties pertaining to climate projections and in differentiating climate variability and climate change.

IV. CLIMATE INFORMATION AND SERVICES

IV.1. Modeling System for Agricultural Impacts of Climate Change (MOSAICC)

IV.1.a. Entry point into the adaptation process for method application

The tool is best applied on the following:

1. Preparing downscaled climate projection data for crop and hydrology based on observations and GCM (Global Circulation Models) outputs
2. Obtaining meteorological and hydrological data based on the topographical analysis.
3. Potential evapotranspiration calculation routine
4. Planting date and growing season length calculator

6) Hydrology
- Estimates water resources through simulation of the water flow accumulation in river catchments.

7) Spatial Tools for River Basins and Environment and Analysis of Management Options (STREAM) – a grid-based precipitation-runoff model developed by Water Insight, The Netherlands. The tool simulates the discharge rate in large catchment areas.
8) Crops
- Simulates crop yield projections under climate change scenarios using crop forecasting method

9) AgroMetShell – crop-specific soil water balance model
10) AQUACROP – estimates crop yield in response to water supply and agronomic management
11) Evaluates the economic impacts of varying crop yields at the national level, and simulates the effect of policy responses.

MOSAICC caters to national level analysis to be carried out by different relevant institutions. The system also allows for assessment of climate change impacts at the local level, particularly on water resources, crops, and food security. It also allows for vulnerability analysis and simulation of agricultural policy responses.

IV.1.b. The methodological approach

An integrated package of models used for assessing the impact of climate change on agriculture and its effect on the economy at the national level. All models are installed in one central server and are connected to a database which facilitates data exchange.

Four Main System Components and Models:

1) Climate
- Prepares downscaled climate projection data for crop and hydrology based on observations and GCM (global climate models) outputs

Models:

- Statistical Downscaling Portal (SD Portal) developed by the Santander Meteorology Group in the University of Cantabria, Spain. The tool is used for downscaling climate data through climate grids generated by GCMs

- Interpolation module adapted from AURELHY, or the method used for obtaining meteorological and hydrological data based on the topographical analysis.
- Potential evapotranspiration calculation routine
- Planting date and growing season length calculator

2) Hydrology

- Estimates water resources through simulation of the water flow accumulation in river catchments

Model:

- Spatial Tools for River Basins and Environment and Analysis of Management Options (STREAM) – a grid-based precipitation-runoff model developed by Water Insight, The Netherlands. The tool simulates the discharge rate in large catchment areas.

Inputs: climate data, soil characteristics, land cover, discharge observations

Outputs: discharges, water accumulation in dams

3) Crops

- Simulates crop yield projections under climate change scenarios using crop forecasting method

Key Input

Climate:

1) Low resolution projects from the General Circulation Models (GCM) of the Intergovernmental Panel on Climate Change (IPCC)
2) Historical weather records

Hydrology:

1) Historical water use statistics
2) Historical discharge data
3) Soil and land use data
4) Dam characteristics

Crops:

1) Historical yield records
2) Crop characteristics
3) Soil data
4) Technological progress scenarios

Economy:

1) Current state of economy
2) Macroeconomic scenarios

Key Outputs:

1st Component – Climate: downscaled climate projections
2nd Component – Hydrology: water resources projections
3rd Component – Crops: yield projections
4th Component – Economy: economic impacts

IV.1.c. Conditions of method application

The tool allows for:

- Presenting different impacts of climate change since data exchange is possible among the models
- Data exchange may be done efficiently and transparently.
- Short processing time of simulations
- The information sharing feature on the web interface of the tool promotes cooperation among the experts in the inter-disciplinary working group.

MOSAICC is designed to be installed by a host national institution and managed by a multidisciplinary working group, composed of experts from relevant sectors (climatologists, agrometeorologists, economists, hydrologists) and end-users. Training sessions for the use of each model are also essential. Educational degree requirement at least MS level with hands-on experience in all the above expertise.

In terms of cost, the tool is free. Funds, however, should be provided for trainings and installation of servers.

The tool is developed by the Climate, Energy, and Tenure Division of the Food and Agriculture Organization (FAO) – Italy, and FAO – Philippines.

IV.1.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

IV.2. Climate Change Impact Model for Philippine Water Resources (CCIM v1.1)

IV.2.a. Entry point into the adaptation process for method application

The CCIM v1.1 is designed to be used by local and national planners design as a guide for the analysis of water availability and water usage in each city/municipality. It allows the user to estimate current and projected water resources and vulnerability.

IV.2.b. The methodological approach

Under the MDGF Programme, The CCIM v1.1 is a stand-alone Windows-based software, which runs a database in MS Excel (Version 2003 or later). The CCIM allows the user to estimate current and projected water resources vulnerability.

Key Input

Input parameters include: province name, municipality name, size of watershed (can be determined from the ArcGIS database or from a supplied map/table), land cover (if not filled out, a standard land cover distribution will be used), population, agricultural land (if not filled out, a standard percentage of land area will be used), precipitation (annual or quarterly from supplied table), and dam/impoundment contribution.

Key Output

Groundwater potential[2], which is based on the calculated annual infiltration (computed from precipitation, watershed size and land cover). Surface water potential (which is calculated annual runoff volume plus impounded water sources).

IV.2.c. Conditions of method application

Familiarity with water balance equations may be required. However, a training manual gives a step by step procedure to CCIM use.

In terms of cost, the tool is free and a copy of the manual may be requested from the authors. Organizations responsible are NEDA and the UP National Institute of Geological Sciences.

IV.2.d. Challenges, lessons learned, and recommendations

Available data or information may be insufficient for discussion in this section.

[2] It should be noted that groundwater potential does not mean total aquifer supply but a percentage of this supply equivalent to annual infiltration (safe yield). Extracting only the annual infiltration volume will result in a water table level that is maintained at a safe level. Currently, NWRB is using a standard 10% of total rainfall as the safe yield value (Strengthening the Philippines' Institutional Capacity to Adapt to Climate Change – Water Resources Sector, MDGF)

Climate Change Commission – Philippines

Climate Change Office
Rm. 238 Mabini Hall
Malacañang Compound
San Miguel, Manila

Phone: +63 2 735 3069
Email: info@climate.gov.ph
www.climate.gov.ph