Vulnerability and Adaptation (V & A) Assessment Toolkit

The Philippines: Enabling Activities for the Preparation of the Second National Communication on Climate Change to the United Nations Framework Convention on Climate Change (UNFCCC) Project

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Acronyms and Abbreviations

V & A	Vulnerability and Adaptation
UNFCCC	United Nations Framework Convention on Climate Change
EMB-DENR	Environmental Management Bureau-Department of Environment and Natural Resources
GEF	Global Environment Facility
UNDP	United Nations Development Programme
SNC	Second National Communication
PRRM	Philippine Rural Reconstruction Movement
IPCC	Intergovernmental Panel on Climate Change
GIS	Geographical Information System
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
WMO	World Meteorological Organization
GCM	Global Climate Model
RCM	Regional Climate Model
PRECIS	Providing Regional Climates for Impact Studies
SRES	Special Report on Emission Scenarios
NCSP	National Communications Support Programme
NSCB	National Statistical Coordination Board
NSO	National Statistics Office
NEDA	National Economic Development Authority
NDRRMC	National Disaster Risk Reduction and Management Council
PPDO	Provincial Planning and Development Office
M/CPDO	Municipal/City Planning and Development Office
HDI	Human Development Index
MDG's	Millennium Development Goals
GDP	Gross Domestic Product
HH	Household
LECZ	Low Elevation Coastal Zone
UN	United Nations
LGU's	Local Government Units
MAOs	Municipal Agriculture Office
PAOs	Provincial Agriculture Office
UKCIP	United Kingdom Climate Impacts Programme
DOST	Department of Science and Technology
DA	Department of Agriculture

ACRONYMS

BAS	Bureau of Agricultural Statistics
BSWM	Bureau of Soils and Water Management
NIA	National Irrigation Association
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
POs	People's Organizations
NGOs	Non-Government Organizations
GVA	Gross Value Added
CBFM	Community Based Forest Management
PDRRMC	Provincial Disaster Risk Reduction and Management Council
MDRRMC	Municipal Disaster Risk Reduction and Management Council
ENRO	Environment and Natural Resources Office
MPDC	Municipal Planning and Development Coordinator
DSWD	Department of Social Welfare and Development
RET	Rare, Endangered and Threatened
PAWB	Protected Areas and Wildlife Bureau
CI	Conservation International
FMB	Forest Management Bureau
NAMRIA	National Mapping and Resource Information Authority
MGB	Mines and Geosciences Bureau
DA-BAR	Department of Agriculture – Bureau of Agricultural Research
PENRO	Provincial Environment and Natural Resources Office
CENRO	Community Environment and Natural Resources Office
ERDB	Ecosystems Research and Development Bureau
WRI	World Resources Institute
INBAR	International Network for Bamboo and Rattan
FAO	Food and Agriculture Organization
CFNR	College of Forestry and Natural Resources
NIPAS	National Integrated Protected Area System
SFM	Sustainable Forest Management
IFMA	Integrated Forest Management Agreement
SIFMA	Socialized Industrial Forest Management Agreement
ICZM	Integrated Coastal Zone Management
NWRB	National Water Resources Board
FGDs	Focus Group Discussions

USLE	Universal Soil Loss Equation
EO	Executive Order
DBP	Development Bank of the Philippines
LBP	Land Bank of the Philippines
GSIS	Government Service Insurance System
SLR	Sea Level Rise
GHGs	Greenhouse Gases
DEMs	Digital Elevation Models
DPWH	Department of Public Works and Highways
ENRC	Environment and Natural Resources Committee
ICM	Integrated Coastal Management
CEP	Coastal Environment Program
IEC	Information, Education and Communication
UV	Ultra Violet
WHO	World Health Organization
NEC	National Epidemiology Center
NESSS	National Epidemic Sentinel Surveillance System
RESU	Regional Epidemiology Surveillance Unit
PESU	Provincial Epidemiology Surveillance Unit
MESU	Municipal Epidemiology Surveillance Unit
PIPH	Provincial Investment Plan for Health
PIDSR	Philippine Integrated Disease and Response System
NDR	Notifiable Disease Reporting
FHSIS	Field Health Service Information System
CFR	Case Fatality Ratios
EPI	Expanded Program on Immunization
KII	Key Informant Interviews
SPSS	Statistical Package for Social Sciences
EIA	Environmental Impact Assessment
CB-CRM	Community Based Coastal Resource Management
CBA	Cost Benefit Analysis
CEA	Cost Effectiveness Analysis
MCA	Multi-Criteria Analysis

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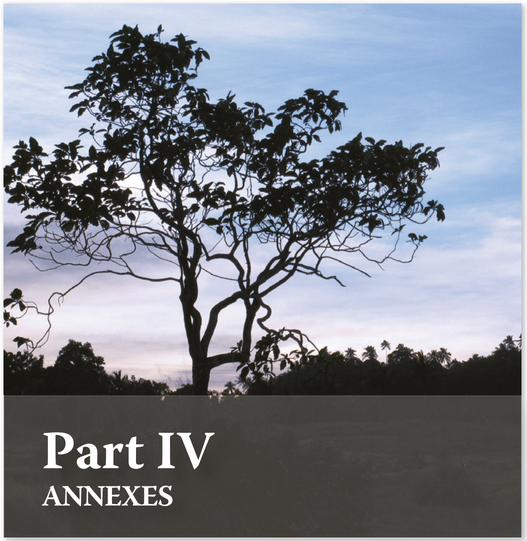


Part I

BACKGROUND/PURPOSE

INTRODUCTION

"Observational evidence from all continents and most oceans shows that many natural systems are being affected by regional climate changes, particularly temperature increases."

IPCC Fourth Assessment Report

The changing climate poses challenges especially to vulnerable, developing countries on how best to cope, and plan for future impacts. The realization for the need to conduct thorough research into climate change impacts to guide planning of appropriate adaptation measures has been growing in recent years.

Vulnerability and adaptation (V and A) assessment builds on recognition that research into vulnerability and adaptation to climate change must include elements and approaches that ensure practical and policy relevance, and that address questions relating to the needs and priorities of the sub-regional, regional and national levels. This assessment also includes an overview of dominant climate change impacts affecting the country and its main vulnerabilities based in credible literature.

As such, climate change needs to be set into appropriate contexts that recognize climate change is one of the many factors to which people need to adjust to in addition to dealing with other immediate and pressing urgencies and a recognition that action must happen now before choice no longer exists.

At the same time, people understand that inappropriate actions can cause more harm than good, so the right choices have to be made. The assessment outlined in this document is designed to help communities make and implement those choices for themselves.

OBJECTIVES

This toolkit is intended to guide, enhance capacity and support the development and implementation of an assessment of vulnerability and adaptation to climate change in the Philippines, that will help inform development plans towards achieving sustainable and climate-resilient communities.

This initiative has the objective of incorporating a best practice framework as applied in the Second National Communication (SNC)[1] into a manual or toolkit for the practitioner.

[1] As a country party to the United Nations Framework Convention on Climate Change (UNFCCC) (signed 02/06/92; ratified 02/08/94; and entered into force 31/10/94), the Philippines stands by its commitment to prepare and submit national communications detailing steps taken to implement the Convention. The Philippines' Initial National Communication was submitted in December 1999 and the Second National Communication is expected to be submitted in the first quarter of 2010.

SCOPE & TARGET

Vulnerability and adaptation (V and A) assessment is meant to serve the needs of the relevant stakeholders, rather than the researcher or analyst. The assessment should therefore be designed to provide information useful to stakeholders to understand vulnerability to climate change and adaptation options. V and A assessment use models or other tools such as GIS maps only as means of providing useful information to stakeholders. The assessment begins by identifying the questions stakeholders would like to have a vulnerability and adaptation assessment answer.

The Questions that V and A Assessment Need to Answer:

- What is the concern and scope of the V and A assessment?
  - Is it food production, water supply, health?
  - Concerns may be expressed not in climate terms, e.g., extreme temperature, but in consequences of climate impacts for people, e.g., drought, flood, malnutrition
- Who may be affected?
- How far into the future is of concern?
- For what purpose is the assessment to be used?
  - Raising awareness (education)?
  - Policy making?
- What kind of output is needed? A map? A plan? Or a road map? Policy framework?

Time Frame of the V and A Assessment

- The time frame being examined is a very important matter.
- If there is more interest in understanding impacts of climate change, then the analysis ought to look over many decades, perhaps out to 2100. [This is because climate change impacts become easier to detect or differentiate from current climate variation in the long run].
- If there is more interest in current vulnerability or adaptation strategies, then the analysis should focus on the next few decades up to about 2050.
- The near future could be defined as 2020 and the far future as 2050.
- This is generally because most policy makers would have difficulty planning for more than a few decades and some might even have difficulty planning for a few decades into the future.

This toolkit has been created by a group of experts for local communities/local government units.

METHODOLOGY

Vulnerability and adaptation assessments are essential tools for the Philippines to evaluate and implement responses to climate change. The V and A Assessment Toolkit is analogous to a cookbook in that it details the study conduct and operations, keeping in mind that a wide variety of possible methods, tools and techniques exist for the assessment task.

The main section of this Toolkit is the step-by-step process for each of the sectors included in the SNC, keeping in mind the need for customization and application of tools in the context of the target site, toward assisting the people living in the study area, who are on the front lines of climate change, to participate in and guide the decisions that will affect their lives, their livelihoods, and their future generations.

A rapid assessment could be done, which is based on expert judgment[2] and should be complemented by a scientific research focusing on scientific methods; incorporating other relevant bodies of knowledge, such as traditional, local and indigenous knowledge, especially with local partners.

ENGAGING THE STAKEHOLDERS

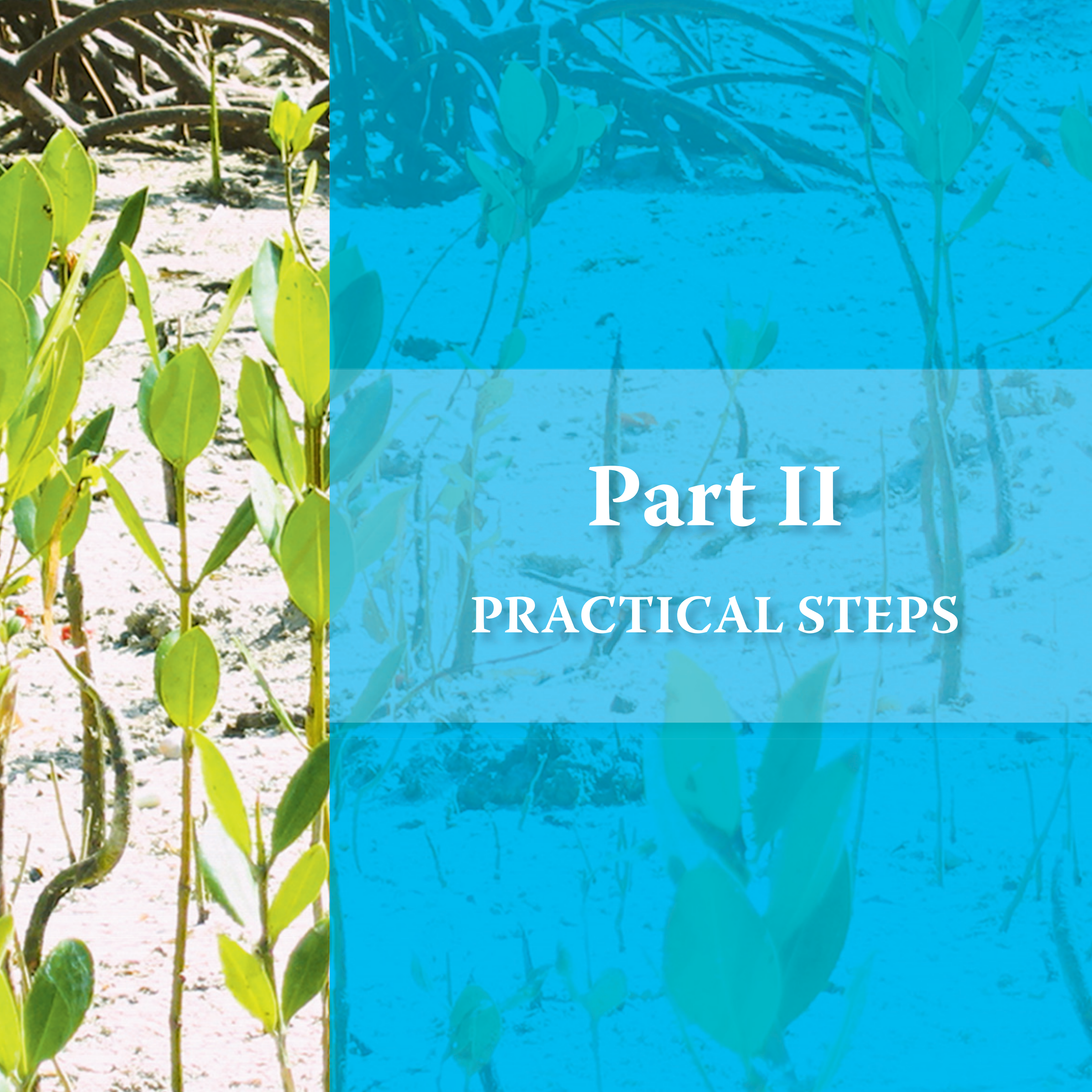
Stakeholders need to be involved throughout the assessment process. In particular they should be involved in determining what will be examined, what adaptations should be considered, and in evaluating results. For some sets of stakeholders, it may not be important who does the analysis, as long as the stakeholders trust that it is being done well. Other stakeholders may wish to take an active role in conducting the analysis or have people they trust (e.g., have worked with previously) conduct the research. Either way, it is important to keep stakeholders involved, at least by keeping them informed about progress and interim results. Identify institutions, individuals or organized groups that need to be engaged in the assessment work.

> It is important to be aware, however, of the subjective nature of expert judgment and the need to select a representative sample of experts to cover the full spectrum of opinion on an issue.

INFORMATION NEEDS

The assessment has to be designed to make full use of available data, scientific as well as indigenous, traditional and local knowledge and perspectives. An indicative list of the main data requirements can be prepared, indicating sources where available and noting as gaps those which are needed but not available.

[2] Expert judgment is an accepted methodology in the UNFCCC and is included in its Compendium of Methods. Expert judgment is an approach for soliciting informed opinions from individuals with particular expertise; and is used to obtain a rapid assessment of the state of knowledge about a particular aspect of climate change. This approach is most useful either in conjunction with a full research study or when there is insufficient time to undertake a full study.



Part II

PRACTICAL STEPS

CLIMATE CHANGE ANALYSIS

INTRODUCTION

This section provides guidance on how to develop climate change scenarios, a short discussion on what climate change scenarios are and why we need to downscale climate change scenarios from a larger area projection, and a review of what is known about regional climate change. This chapter answers the following questions:

- What data are available?
- Why do we use climate change scenarios?
- Where can observed climate and climate model output be obtained?
- Where can tools for downscaling be obtained?

WHAT ARE CLIMATE CHANGE SCENARIOS?

A scenario is a coherent, internally consistent and plausible description of a possible future state of the world (IPCC, 1994). It is not a *forecast;* rather, each scenario is one alternative image of how the future can unfold. A *projection* may serve as the raw material for a scenario, but scenarios often require additional information (e.g., about *baseline* conditions). A set of scenarios is often adopted to reflect, as well as possible, the range of uncertainty in projections. Other terms that have been used as synonyms for scenario are "characterization", "storyline" and "construction".

Climate Change Scenarios describe plausible future changes in climate variables and are usually measured with respect to baseline climatic conditions. Baseline climate is the climatic conditions based on observed data that are representative of the present day or recent climatic trends for a given period of time in a specific geographic area.

WHY DO WE USE CLIMATE CHANGE SCENARIOS?

Climate change scenarios are scenarios of plausible changes in climate. We use them to understand what the consequences of climate change can be. We can also use them to identify and evaluate adaptation strategies. We create climate change scenarios because predictions of climate change at the regional scale have a high degree of uncertainty. By regional scale, we typically mean the sub-continental scale to country level to provincial level. Although it is likely that temperatures will eventually rise in most regions of the world, changes at the regional scale in many other key variables, such as rainfall, are uncertain for most regions.

There is uncertainty about the magnitude and path of change even if the direction of change is certain or likely. *We create scenarios as tools to help us understand how regional climates may change so as to understand how sensitive systems may be affected by climate change.*

> It is critical to keep in mind that regional climate change scenarios are not a prediction of future climate change, but rather a tool to communicate what could happen as a result of human-induced climate change and to facilitate understanding of how different systems could be affected by climate change.

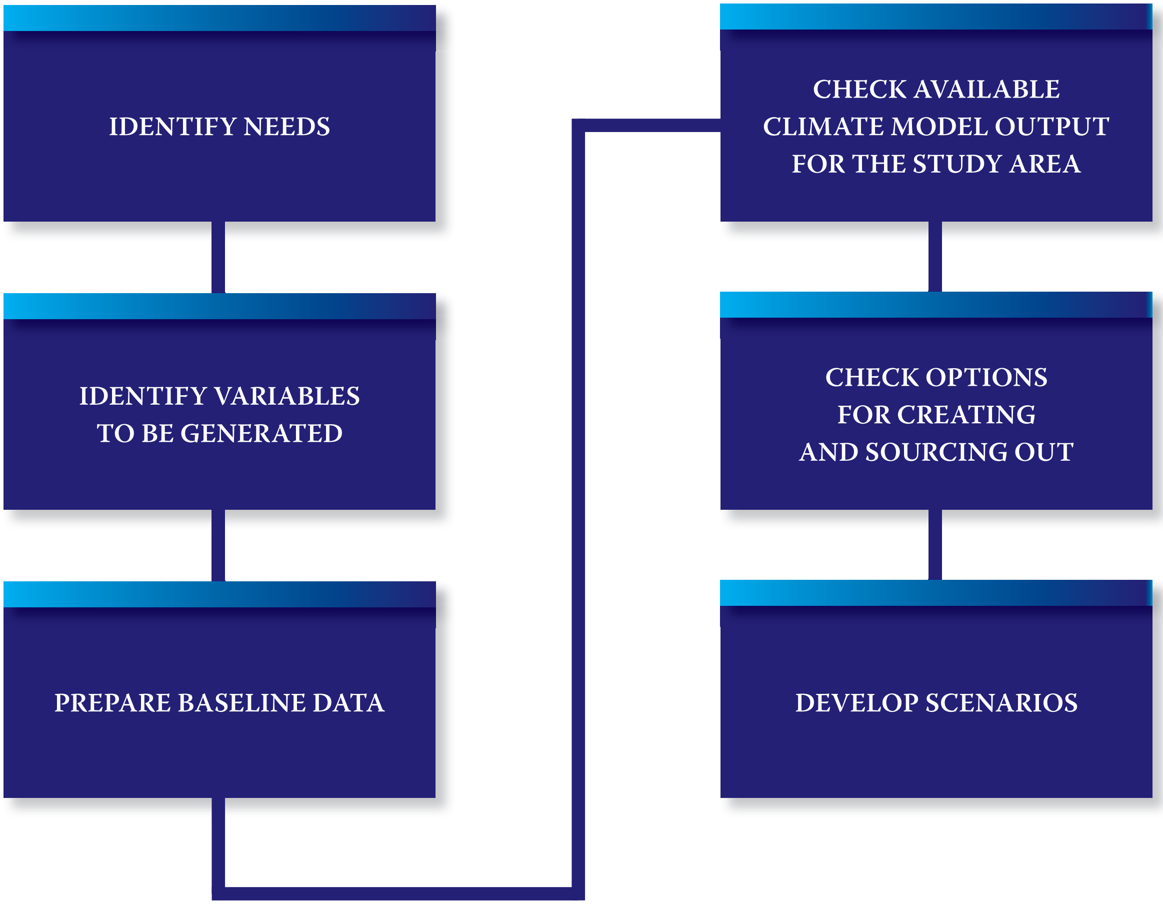
Climate change scenarios should meet the following criteria:

- Consistent with anthropogenic influences on climate;
- Internally consistent; changes in related variables need to make physical sense (Mearns et al., 2001).

If the regional climate change scenarios are to be used in a V and A assessment, they must provide information on the climate variables needed by V and A assessors at a spatial and temporal scale needed for analysis. This may require daily or even sub-daily data at spatial levels as fine as a farm field.

Climate change scenarios can be developed/modelled for worst case (business as usual), best case (global commitments met to reducing greenhouse gas emissions), and an average case scenario. These then provide a range of data to be considered within the individual sectoral analysis e.g. agriculture, coastal, watersheds, forestry and biodiversity, health (as used in the SNC).

STEPS FOR DEVELOPING CLIMATE CHANGE SCENARIOS



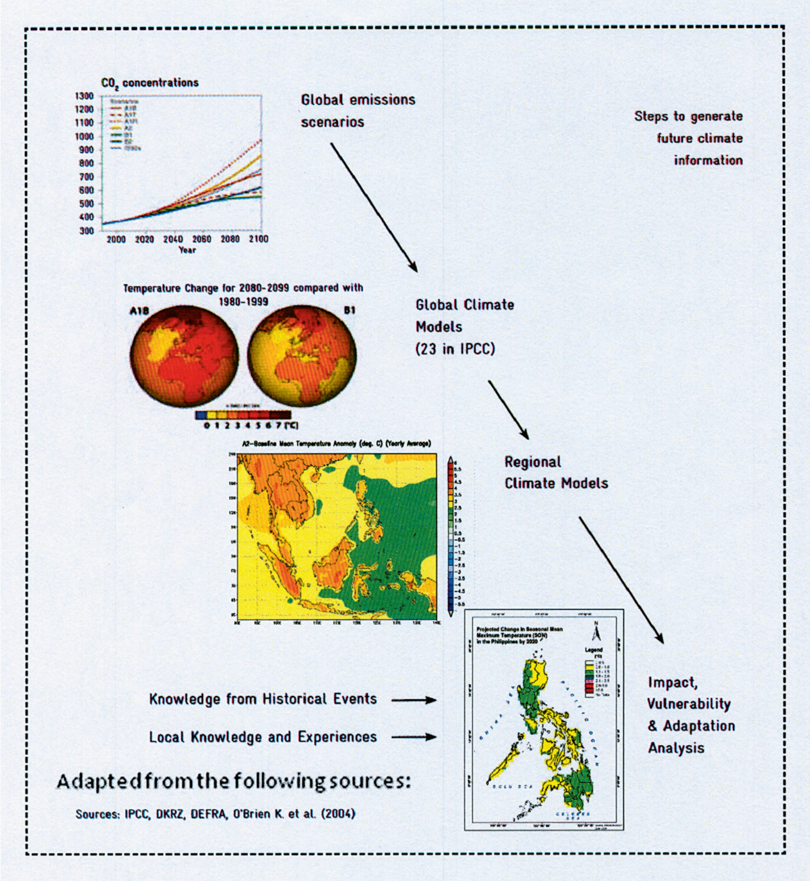
In creating climate scenarios, one of the first things to do is identify the relevant climate variables that are important for the system, place or sector to be examined. Whether analysts can develop scenarios for the variables may depend on whether data for these variables exist in the observed record or whether they can be obtained from climate models. Observed climate data for the Philippines are at the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).

Good-quality observed climate data are required for a given baseline period in order to characterize present-day conditions. The baseline period is dictated by the availability of observed data in a particular locality. In areas where there is no weather station, data from the nearest PAGASA station can be used. The baseline period should be of a sufficient duration to encompass a range of climatic variations, including a number of significant weather/climate extremes. The World Meteorological Organization (WMO) defines the climatological baseline period as 30 years.

For the vulnerability and adaptation assessment, the baseline climate data are used to calibrate and test impact models for various sectors. It is also used to estimate reference impacts. The following are the baseline data during the baseline period commonly used in the V and A assessment:

a. Average daily rainfall
b. Daily mean, maximum and minimum temperatures maximum
c. Daily rainfall
d. Daily relative humidity
e. Daily solar radiation
f. Daily wind speed and direction
g. Cyclonicity
h. Return period (probability of occurrence in a year)
    - Typhoons (observed)
    - Daily rainfall 100mm-150mm; 151-200; 201-250; 251-300; >300
    - 24-hr rainfall > 299mm (observed and projected)
    - Rainfall threshold (you use) for drought (observed and projected)
    - Rainfall threshold (you use) for floods (observed and projected)
    - Temperature change >1OC
    - Rainfall change < 0% and Rainfall change >2%; >5%

CLIMATE MODELS



Climate Change Information for Effective Adaptation:
A Practitioner's Manual.
GTZ Climate Protection Programme. 2009

1. Global emissions scenarios[3] are based on potential greenhouse gas emissions over the next 100 years and as such describe humankind's future development.

2. The global emissions scenarios are used as the basis for global climate models (GCMs) projecting future trends. GCMs are computer models of the coupled atmosphere-land surface-ocean-sea ice system.

3. GCMs can be used to produce Regional Climate Models (RCMs) generating more precise geographical detail.

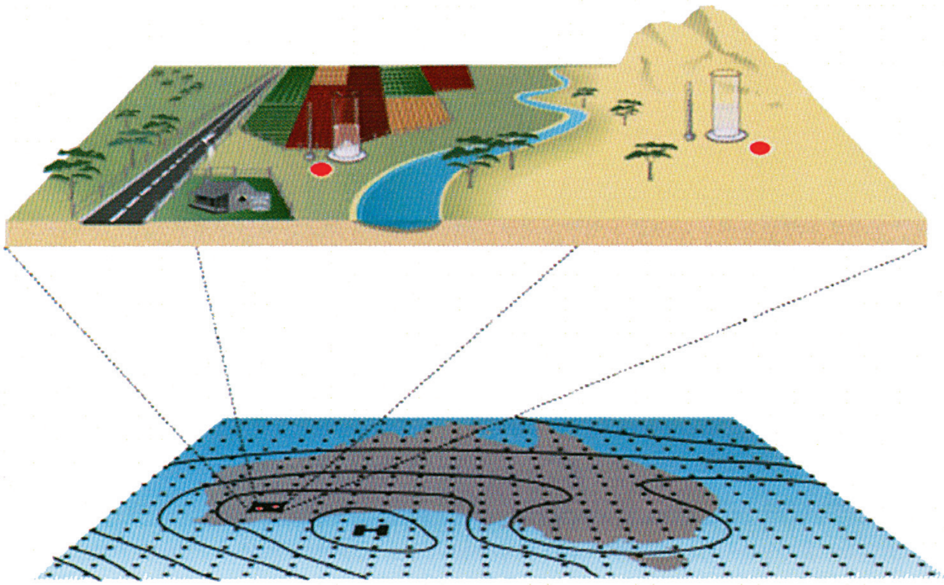
4. GCMs and RCMs can be downscaled and together with knowledge from historical events/analyses and local knowledge/experiences can be used effectively for vulnerability and adaptation assessments.

[3] SRES (Special Report on Emission Scenarios)

GLOBAL CLIMATE MODELS [GCMS]

CLIMATE MODELLING GROUP & NATION	MODEL SYMBOLS	HORIZONTAL RESOLUTION
Bjerknes Centre for Climate Research, Norway	BCCR	~200
Canadian Climate Centre, Canada	CCMA T47	~300
Canadian Climate Centre, Canada	CCMA T63	~200
Meteo-France, France	CNRM	~200
CSIRO, Australia	CSIRO-MARK3	~200
Geophysical Fluid Dynamics Lab, USA	GFDL 2.0	~300
Geophysical Fluid Dynamics Lab, USA	GFDL 2.1	~300
NASA/Goddard Institute for Space Studies, USA	GISS-AOM	~300
LASG/Institute of Atmospheric Physics, China	IAP	~300
Institute of Numerical Mathematics, Russia	INMCM	~400
Centre for Climate Research Institute, Japan	MIROC-M	~300
Meteorological Research Institute, Japan	MRI	~300
Max Planck Institute for Meteorology DKRZ, Germany	MPI-ECHAM5	~200
Meteorological Institute of the University of Bonn, Meteorological Research Institute of KMA, Germany/Korea	MIUB	~400
National Center for Atmospheric Research, USA	NCAR-CCSM	~150
Hadley Centre, UK	HADGEM1	~125

DOWNSCALING is the general name for a procedure to take information known at large scales to make predictions at local scales. It is a method for obtaining high-resolution climate or climate change information from relatively coarse-resolution global climate models (GCMs).



...from a global climate model (GCM) grid
to the point of interest.

DOWNSCALING FROM GCMS

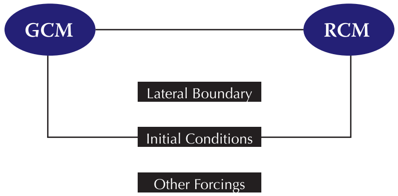
The most common approach to deriving climate change scenarios is to make use of the outputs of global climate models (GCMs). GCMs incorporate the latest scientific understanding of the physical processes at work in the atmosphere, oceans, and Earth's surface and how they are all interconnected. GCMs produce projections of precipitation, temperature, pressure, cloud cover, humidity, and a host of other climate variables for a day, a month, or a year. Typically, GCMs have a resolution of 150-300 km by 150-300 km and are unable to resolve important sub-grid scale features such as clouds and topography. To develop higher resolution outputs, results from GCMs are "downscaled", that is, transformed into results at a smaller scale than GCM grid boxes.

Dynamical Downscaling

RCMs are similar to global climate models, but are of higher resolution

RCMs does not attempt to simulate the entire globe but only a portion

RCMs rely on information at the lateral boundaries to simulate climates for the interior of their model domains



Downscaling is the general name for a procedure to take information known at large scales to make predictions at local scales. It is a method for obtaining high-resolution climate or climate change information from relatively coarse-resolution global climate models (GCMs). There are two commonly used downscaling techniques for obtaining regional climate change projections: statistical and dynamical.

Dynamical downscaling involves the use of a limited-area, high resolution Regional Climate Model (RCM) nested within and driven time dependent lateral and lower boundary conditions from a global climate model.

Statistical downscaling may be used in climate impacts assessment at regional and local scales and when suitable observed data are available to derive the statistical relationships.

Statistical Downscaling

Two-step process basically consisting of:

i) development of statistical relationships between local climate variables (e.g., surface air temperature and precipitation) and large-scale predictors, and

ii) application of such relationships to the output of GCM experiments to simulate local climate characteristics.

For the Philippine SNC, the V and A component used the outputs of the regional model from the Hadley Center, known as *PRECIS,* an acronym which means Providing Regional Climates for Impact Studies.

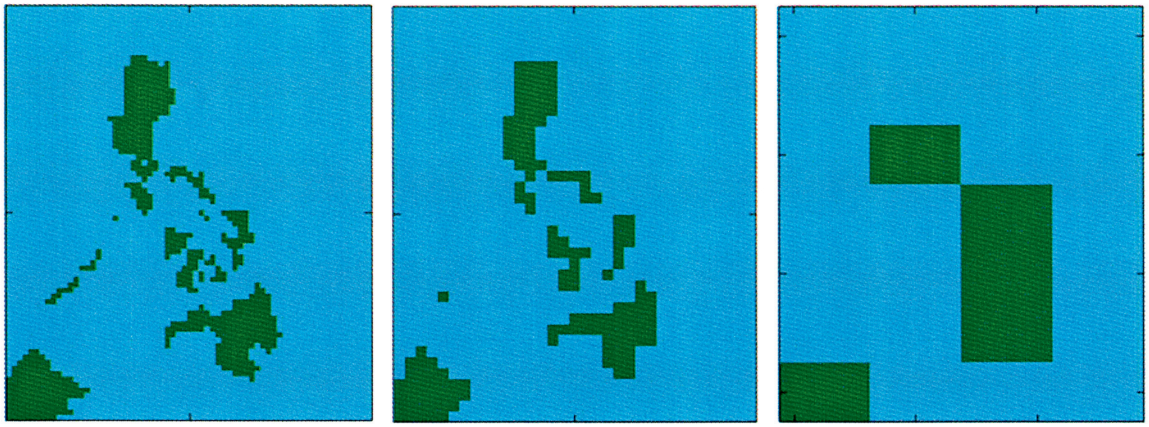
REGIONAL CLIMATE MODELS

Regional climate models (RCMs) are similar to global climate models but of much higher resolution models that focus on a region, typically at a continental or sub-continental scale. Their grid boxes are 50 km or less across. They are therefore able to capture many regional features that GCMs cannot.

However, RCMs must be run with boundary conditions from GCMs (e.g., changes in pressure patterns, sea surface temperatures), so there are typically RCM runs for only a few GCMs. Some applications are for limited periods of time, e.g., a simulated decade.

The advantage of RCMs is that they can provide better spatial representation of climate change than GCMs,but they cannot correct for errors in boundary conditions.

REPRESENTATION OF THE PHILIPPINES WITH DIFFERENT MODEL RESOLUTIONS



25km RCM resolution **50km RCM resolution** **GCM 300km resolution**

Brief description of PRECIS Regional Climate Model (RCM)

- **Regional Climate Model: comprehensive representation of physical processes in atmosphere and on land**
  - **dynamics - atmospheric circulations, cyclones, fronts**
  - **radiation - effects of greenhouse gases and aerosols**
  - **clouds - radiative effects, sulphate aerosol effects**
  - **precipitation - convection, large-scale condensation**
  - **land-surface - soil hydrology (4 levels), vegetation**

The PRECIS climate model (HadCM3Q0 AOGCM) is an atmospheric and land surface model of limited area and high resolution which is locatable over any part of the globe.

It uses regular latitude longitudes grids of resolution 2.5º x 3.75º, 1.25º x 1.25º and 0.44º x 0.44º (approximately 50km) respectively, and divides the atmosphere into 19 levels. The PRECIS RCM is able to run at two different horizontal resolutions: 0.44 ° x 0.44 ° and 0.22° x 22°. The regional climate model used for this study is the Hadley Centre model HadCM3Q0, identical to the RCM used within PRECIS with horizontal resolution 0.220 x 0.220 (25 x 25 km), which allows having more detailed information on climate in the regional scale.

PRECIS is a PC-based regional climate modelling system that was developed at the UK Met Office Hadley Centre for Climate Prediction and Research. PRECIS was developed in order to help generate high-resolution climate change information for as many regions of the world as possible. It is freely available to groups of developing countries in order that they may develop climate change scenarios.

For the SNC it is applied to simulate the baseline (1971-2000) climate for evaluation of model's capacity of simulating present climate and analyze the future climate change responses over the Philippines for two time-slices centered on 2020 (2006-2038) and 2050 (2039–2065).

The GCM downscaled by PRECIS is the HadCM3, a version of the Hadley Centre's third generation coupled ocean-atmosphere general circulation model. The HadCM3 is based on SRES A1B emissions scenario that assumes a future world of rapid economic growth, low population growth and rapid introduction of new and more efficient technology. In this world, people pursue personal wealth rather than environmental quality with balanced emphasis on all energy sources.

CLIMATE MODEL OUTPUTS: Climate Change Scenario in the Philippines

Changes in temperature (mean, maximum and minimum) and precipitation for different seasons were obtained by simulations of the future (2020 and 2050) with the simulation of the baseline data (1971-2000). Figures 1 and 2 show examples of the model outputs for projected change in the mean annual temperature and precipitation in the different regions in the Philippines.

Fig. 1: Projected Change in Annual Mean Temperature

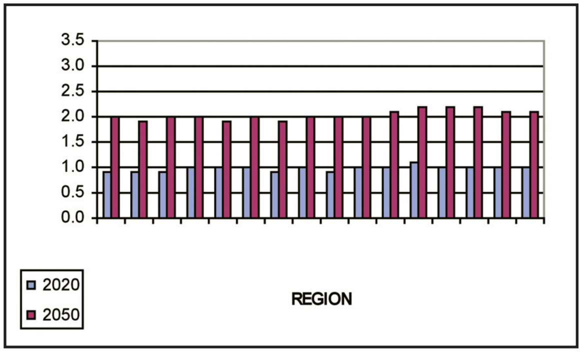
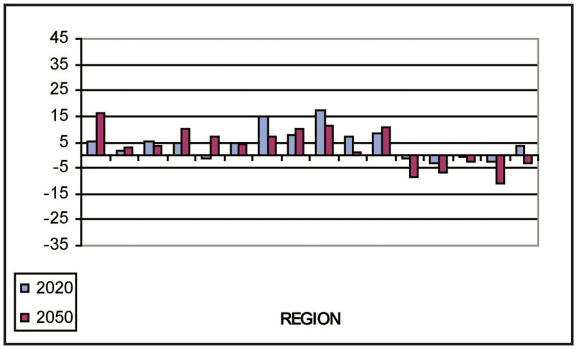
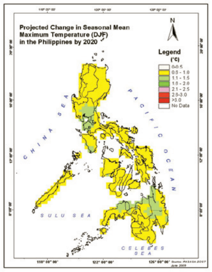
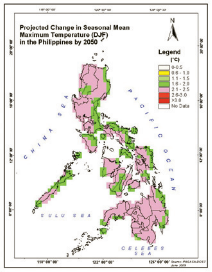
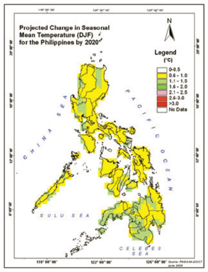
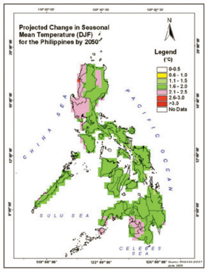
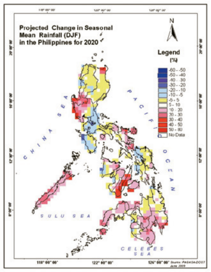
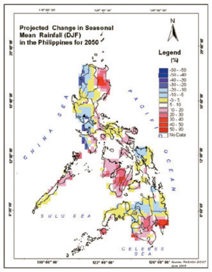


Fig. 2: Projected Change in Annual Mean Rainfall



The projected changes in the country can also be presented by seasons. Sample outputs for the December to February season are shown in the following figures (Figures 3-5).

Figure 3:	Projection	
	2020	2050
Projected Change In Seasonal Mean Maximum Temperature(°C) **DJF** **(December – January – February)**		
Figure 4:	Projection	
	2020	2050
Projected Change in Seasonal Mean Minimum Temperature **DJF** **(December – January – February)**		
Figure 5:	Projection	
	2020	2050
Projected Change in Seasonal Mean Rainfall (%) **DJF** **(December – January – February)**		

CLIMATE MODEL OUTPUTS: Changes in Rainfall and Temperature in the Project Sites

Outputs from GCMs cannot be used directly as inputs in impact studies, Daily outputs from GCMs should be corrected for bias. Bias is the difference between the simulated baseline to the observed data. Figures 6-8 show the observed, simulated and bias corrected daily average minimum temperature for Legaspi, Surigao and Tagbilaran respectively. The graphs indicated that the daily average minimum temperature for the three sites are well simulated by the model. For the daily average rainfall for the three sites (Figures 9-11), there is a large variation between the simulated and the observed rainfall values.

Fig. 6: Observed, Simulated and BIAS Corrected Daily Average Minimum Temperature in Legaspi with Base Period 1971-2000

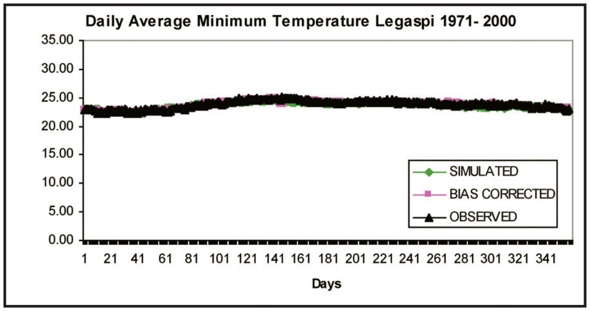


Fig. 7: Observed, Simulated and BIAS Corrected Daily Average Minimum Temperature in Surigao with Base Period 1971-2000

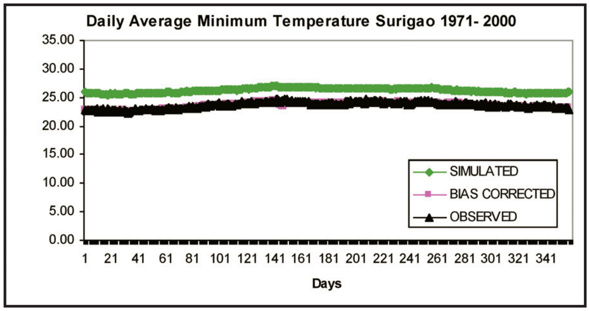


Fig. 8: Observed, Simulated and BIAS Corrected Daily Average Minimum Temperature in Tagbilaran

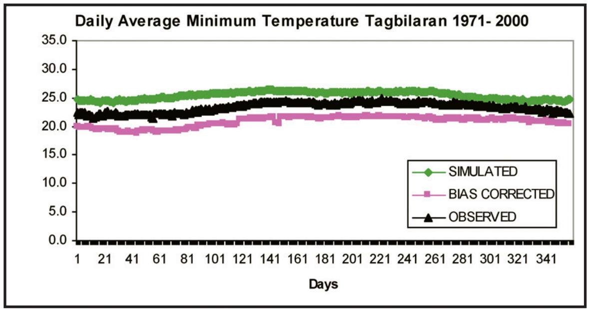


Fig. 9: Observed and Simulated Daily Average Rainfall in Legaspi with Base Period 1971-2000

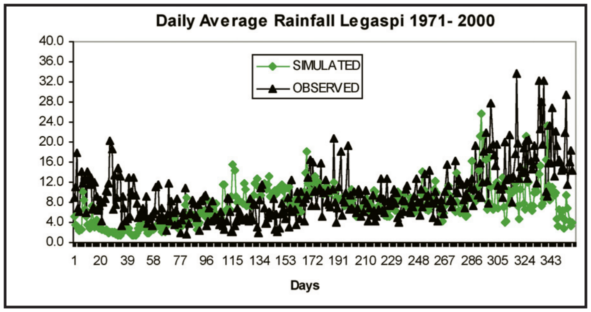


Fig. 10: Observed and Simulated Daily Average Rainfall in Surigao with Base Period 1971-2000

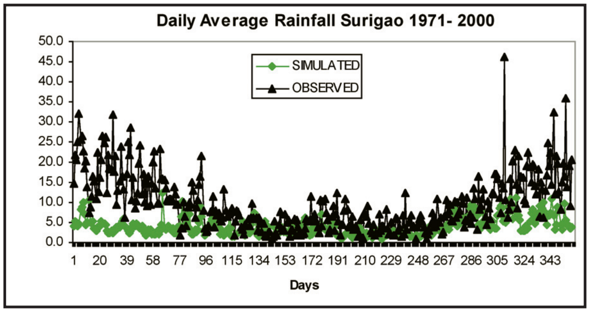
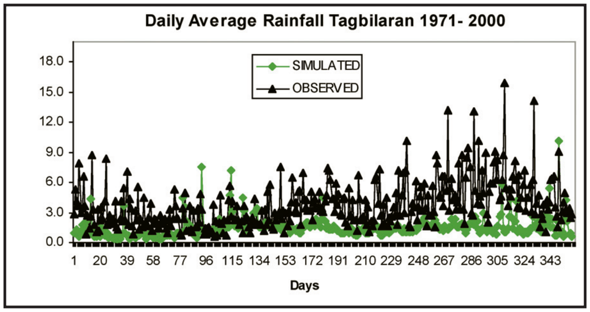


Fig. 11: Observed and Simulated Daily Average Rainfall in Tagbilaran with Base Period 1971-2000

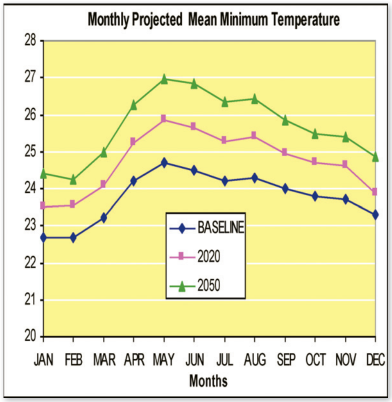


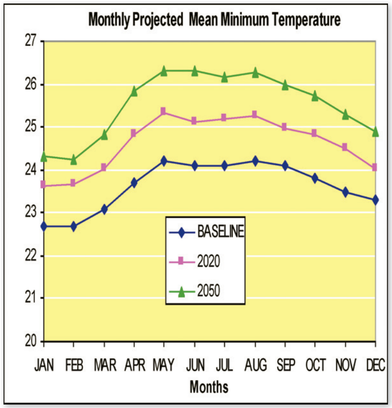
Projected increase in the monthly minimum temperature for the three project sites are shown in Figure 12. The figures indicate that degree of temperature increase varies from site to site. The seasonal pattern in temperature is well simulated by the model. The change in monthly rainfall for the three sites is shown in Figure 13. The graphs show if the monthly rainfall will increase or decrease relative to the baseline period and plans can be adjusted accordingly in preparation.

Fig. 12. Projected Change in Monthly Mean Minimum Temperature

LEGASPI	SURIGAO	TAGBILARAN

Minimum Temperature





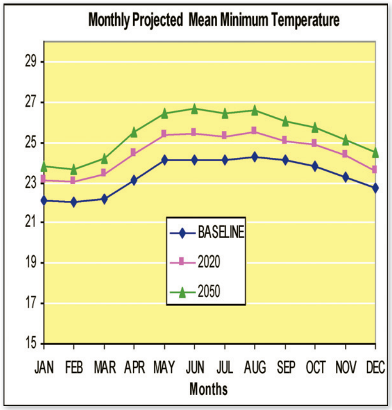
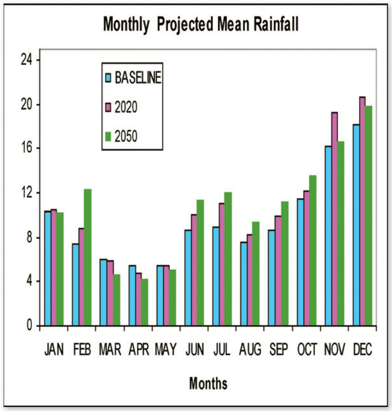
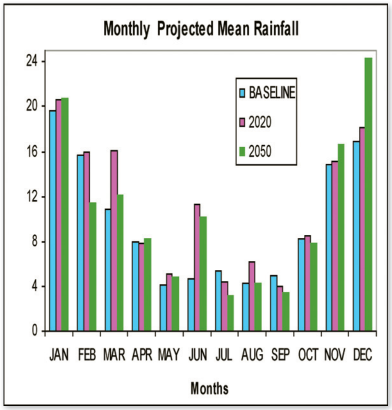


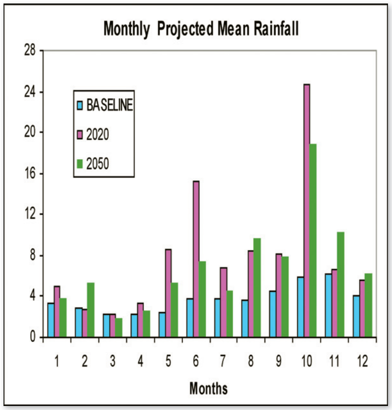
Fig. 13. Projected Change in Monthly Mean Rainfall

LEGASPI	SURIGAO	TAGBILARAN

Monthly Mean Rainfall







UNCERTAINTIES IN CLIMATE MODELLING

Uncertainties are inherent in each of the main stages required to provide climate change scenarios for assessing the impacts of climate. One of the major sources of uncertainties is the incomplete understanding/imperfect representation of processes in climate models ("science uncertainty").

Current global climate models, which contain different representations of the climate system, project different patterns and magnitudes of climate change for the same period in the future when using the same greenhouse gas concentration scenarios. This is the reason why the of use projections from a range of GCMs as input to climate impacts studies, despite their poor resolution, to reflect (at least in part) this "science uncertainty" is strongly being recommended.

In spite of the uncertainties in climate projection, climate scenarios are important tools for depicting future climate and understanding its impacts.

!

There are uncertainties in climate modeling that should be taken into account when assessing the impacts, vulnerability and adaptation options.

SOCIO-ECONOMIC ANALYSIS

INTRODUCTION

This section provides guidance on how to develop socio-economic scenarios, a short discussion on what socio-economic scenarios are and why we need to consider such scenarios in assessing vulnerabilities and adaptation to climate, this chapter answers the following questions:

- What data are available and what would be needed?
- Why do we use socio-economic scenarios?
- How to characterize current and changing socio-economic conditions?

A NOTE TO BEGIN WITH...

It can be very complicated to create detailed and comprehensive socio-economic scenarios; and there may be greater uncertainties about future socio-economic conditions than about climate change.

The best thing to aim for is identification of variables that can substantially affect vulnerability to climate change.

WHAT ARE SOCIO-ECONOMIC SCENARIOS?

The IPCC published a new set of scenarios in 2000 for use in the Third Assessment Report (Special Report on Emissions Scenarios - SRES). The SRES scenarios were constructed to explore future developments in the global environment with special reference to the production of greenhouse gases and aerosol precursor emissions. They used the following terminology:

Scenario: projections of a potential future, based on a clear logic and a quantified storyline.

Storyline: a narrative description of a scenario (or a family of scenarios), highlighting the main scenario characteristics and dynamics, and the relationships between key driving forces.

Each storyline represents different **demographic, social, economic, technological, and environmental developments** that diverge in increasingly irreversible ways.

Socio-Economic Scenarios describe plausible future changes in the highlighted variables above and are usually measured with respect to baseline conditions. Baseline conditions are based on socio-economic data that are representative of the present day or recent socio-economic trends for a given period of time in a specific geographic area.

The most straightforward baseline scenario is to use today's conditions. Why?

- Today's conditions are known
- Easier to communicate about today's conditions than hypothetical future
- This is a starting point
- Can compare to vulnerabilities with hypothetical scenarios to identify variables which most affect vulnerability

Current conditions will change, but forecasting socioeconomic conditions beyond ~25 years has much uncertainty.

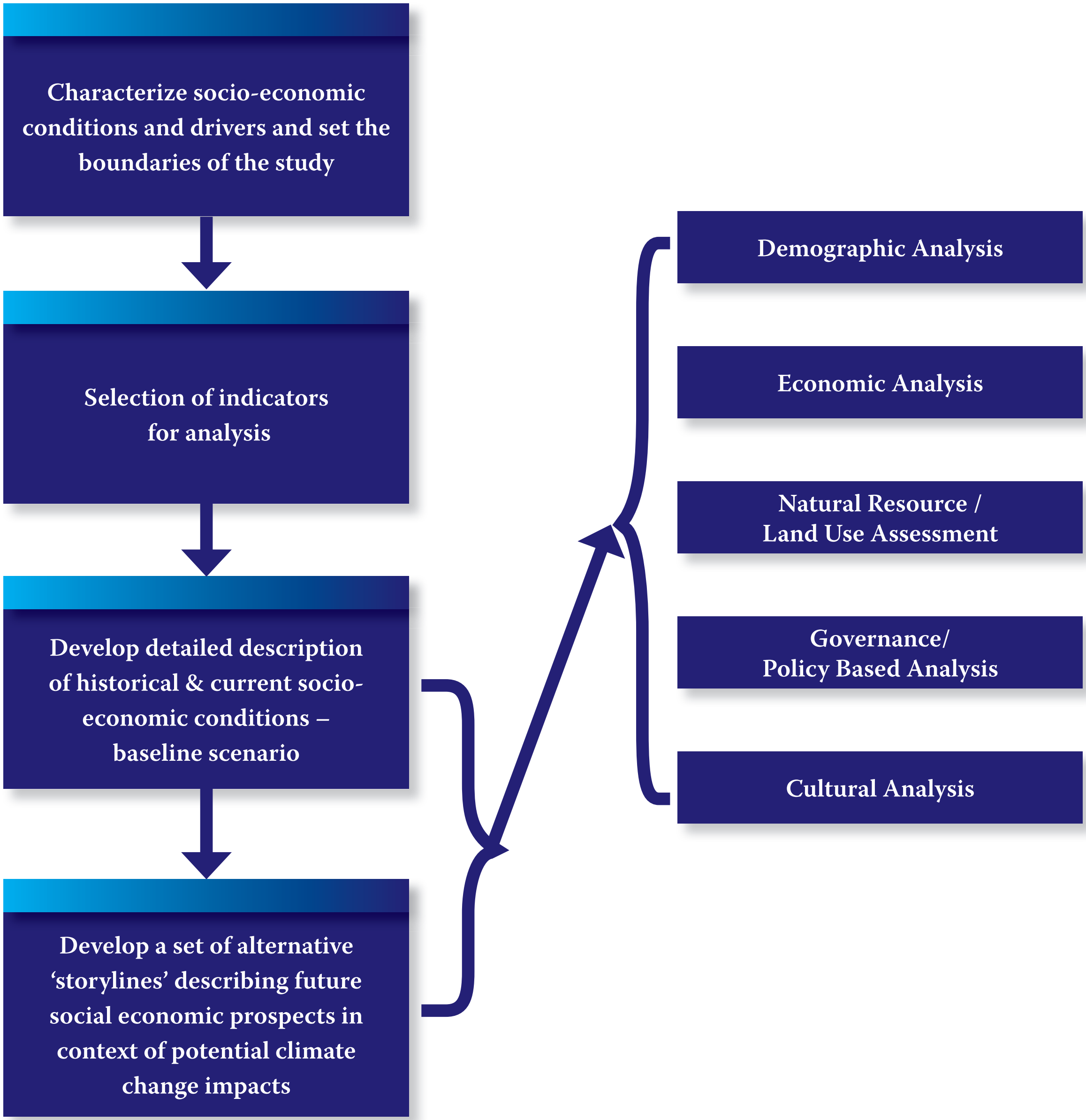
WHY DO WE USE SOCIO-ECONOMIC SCENARIOS?

Vulnerabilities to climate change can be enhanced by non-climate related stresses e.g. poverty, unequal access to resources, food insecurity, trends in economic globalization, conflict, and incidence of diseases. By using socio-economic scenarios we construct plausible reference points to understand how vulnerability may change.

Socio-economic conditions determine key aspects of vulnerability and adaptive capacity to climate change.

Adaptation programs need to be developed to take a holistic approach to complex and interacting stresses (climate and non-climate related) to reduce vulnerabilities and enhance resiliency to climate change.

STEPS FOR DEVELOPING SOCIO-ECONOMIC SCENARIOS



In creating socio-economic scenarios, one of the first things to do is to identify the relevant indicators that are important drivers for the system, place or sector to be examined. There are many indicators available for socio-economic analysis and it is not appropriate to collect data for all. There needs to be selection of the most relevant indicators for the study to retain focus.

Once the indicators to be used have been agreed upon by stakeholder consultation the historical profile can be generated. For the SNC we examined data from 1950 for demographic data and 1980 for economic data. The data was inputted into a spreadsheet computer program (excel in this case) and could be presented in tabular and/ or graphical format for visualization. Graphs generated by the program also included a trend line that was based on linear regression (computed automatically by the program) – for examples refer to figures 14 and 15.

Data* obtained over a longer timeframe will give a more reliable and representative trend line.

Another way to represent the data is by GIS modeling, where data can be plotted into the form of maps and different indicators can be overlaid to provide a comprehensive picture e.g. land use overlaid with population density.

General Criteria for Developing Indicators (NCSP)

The following criteria provide useful guidelines for selecting and developing indicators:

- **Appropriateness and relevance:** The indicator should describe a meaningful characteristic of the sensitivity, vulnerability, or adaptive capacity of the system.
- **Transparency:** The formula and data for calculating the indicator should not be unduly complex or difficult to interpret.
- **Feasibility:** Indicators are based on data. These data must be available to the practitioner or else suitable substitutes need to be identified.
- **Relationship to national scenario:** Either the underlying data or the indicator itself should be linked to key variables or attributes of an overall socio-economic scenario. This criterion enables the indicator and sector storyline to be consistent with the overall scenario assumptions.

Historical data are required for a given baseline period in order to characterize present-day conditions. The baseline period is dictated by the availability of observed data in a particular locality. The World Meteorological Organization (WMO) defines the climatological baseline period as 30 years and at least this was used for the socio-economic baseline period to ensure consistency of timeframes for the overall vulnerability and adaptation assessment.

* Sources of Data: NSCB, NSO, NEDA, NDRRMC, PPDO, M/CPDO

For the vulnerability and adaptation assessment, the following are the baseline socio-economic data used:

Category	Indicators	Indicator for:	Functional Relationship
Human Resources	Population change (including mortality, fertility and migration rates), age structure, unemployment, poverty incidence, dependency and potential support ratios, HDI and MDG's status	Social and economic resources available for adaptation after meeting present needs. Human capital and adaptability of the labor force. Social welfare	Adaptive capacity ↑ as unemployment and poverty incidence ↓ Adaptive capacity ↓ as dependency ↑ Adaptive capacity ↓ as status level (ranking/ attainment) ↓
Economic Capacity	GDP*, household (HH) level income and expenditure, consumption, exports, debt servicing, cost of climate related disasters	Distribution of access to markets, technology, and other resources useful for adaptation	Adaptive capacity ↑ as GDP/capita ↑ Adaptive capacity ↑ as HH level income ↑ Adaptive capacity ↓ as debt servicing ↑ Adaptive capacity ↓ as damages ↑
Environmental Capacity	Population density, land use, urbanization and city growth especially in LECZ's	Population pressure and stresses on ecosystems	Adaptive capacity ↓ as density ↑ Adaptive capacity (of the environment) ↓ as land use changes to residential/industrial ↑

*Whilst GDP is an adequate indicator of national economic prospects it does not translate at a local level, therefore use the household income and expenditure values instead.

Fig. 14: Philippines' Historic and Projected Population Change per Year

The three variants of the UN long-range population projections are used for downscaling the regional population. The low variant is used for A1 and B1, the medium variant for B2 and the high variant for A2

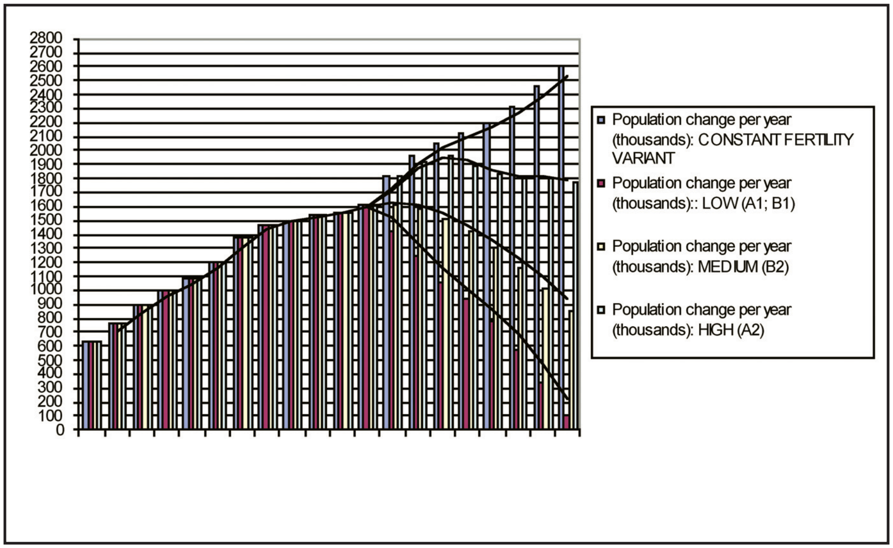
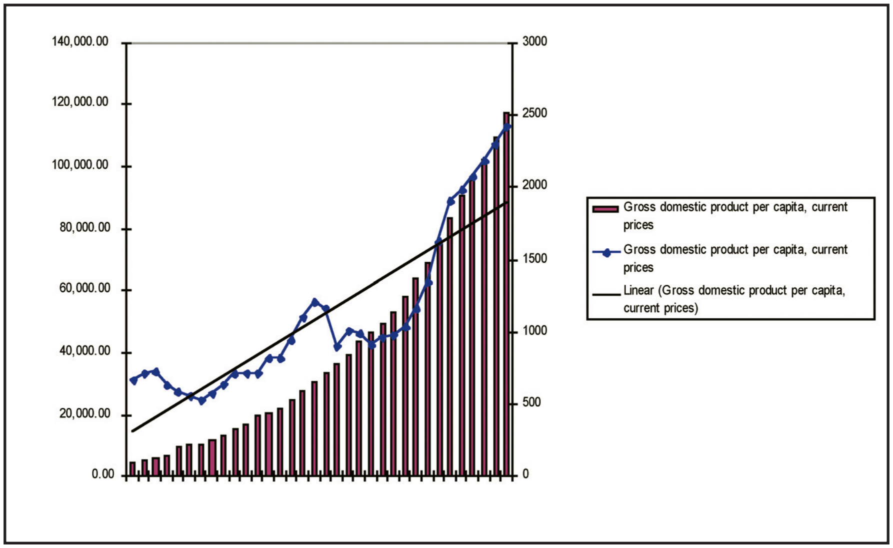


Fig. 15: Historic and Projected GDP per capita



DEVELOPING SOCIO-ECONOMIC STORYLINES

Projections of future scenarios for 2020 and 2050 were conducted for each indicator variable utilized in the baseline scenario by using the trend/percentage rate of increase or decrease from the historical patterns. Quantitative scenarios can be calculated through the adjustment of the linear or exponential curves to the time series. This is known as extrapolation and gives a reference scenario of 'business as usual' and does not consider climate change.

These can be compared to the SRES storylines to see which one it closely relates to (bottom-up approach)*.

For developing a set of 'alternative' storylines, again the SRES scenarios can be used in comparison with national strategic development plans. For 'believability' of the storylines, national and local conditions, vulnerabilities and adaptation practices need to be built into the global (SRES) scenarios for an integrated analysis.

Socio-economic scenarios can be developed/modelled for worst case (business as usual), best case (global commitments met to reducing greenhouse gas emissions), and an average case scenario. These then provide a range of data to be considered within the individual sectoral analysis e.g. agriculture, coastal, watersheds, forestry and biodiversity, health (as used in the SNC).

* Another approach to developing country level scenarios is a top-down approach (downscaling from the SRES scenarios). The latter provides projection data for population and GDP percentage changes relative to the base year, by global region.

Baseline data gathered during the baseline scenario building (through data collection, reviewing country studies, expert judgement, stakeholder input) should be used together with the appropriate SRES scenario percentage change:

Baseline data*(1+D/100)

where D stands for the percentage change from the baseline data as given in the SRES data tables (available from UNFCCC)

AGRICULTURE

INTRODUCTION

This section provides guidance on how to do the assessments of impacts, vulnerability and adaptation measures to address climate change in the agriculture sector in local communities/LGUs.

Steps are provided in order that the practitioners/responsible staff in the local government units (MAOs, PAOS, etc.) are able to do a meaningful assessment of impacts, vulnerability and adaptation in order to inform planning and decision-making in the LGU levels.

WHY AGRICULTURE IS A KEY SECTOR?

Historical climate variations and recent weather/climate events (e.g., tropical cyclones, floods, drought, increasing temperatures and changing rainfall characteristics) confirm our continuing sensitivities to current climate and therefore, in view of the projected further increases in temperature with associated changes in climate, we need to plan and implement proactive adaptation.

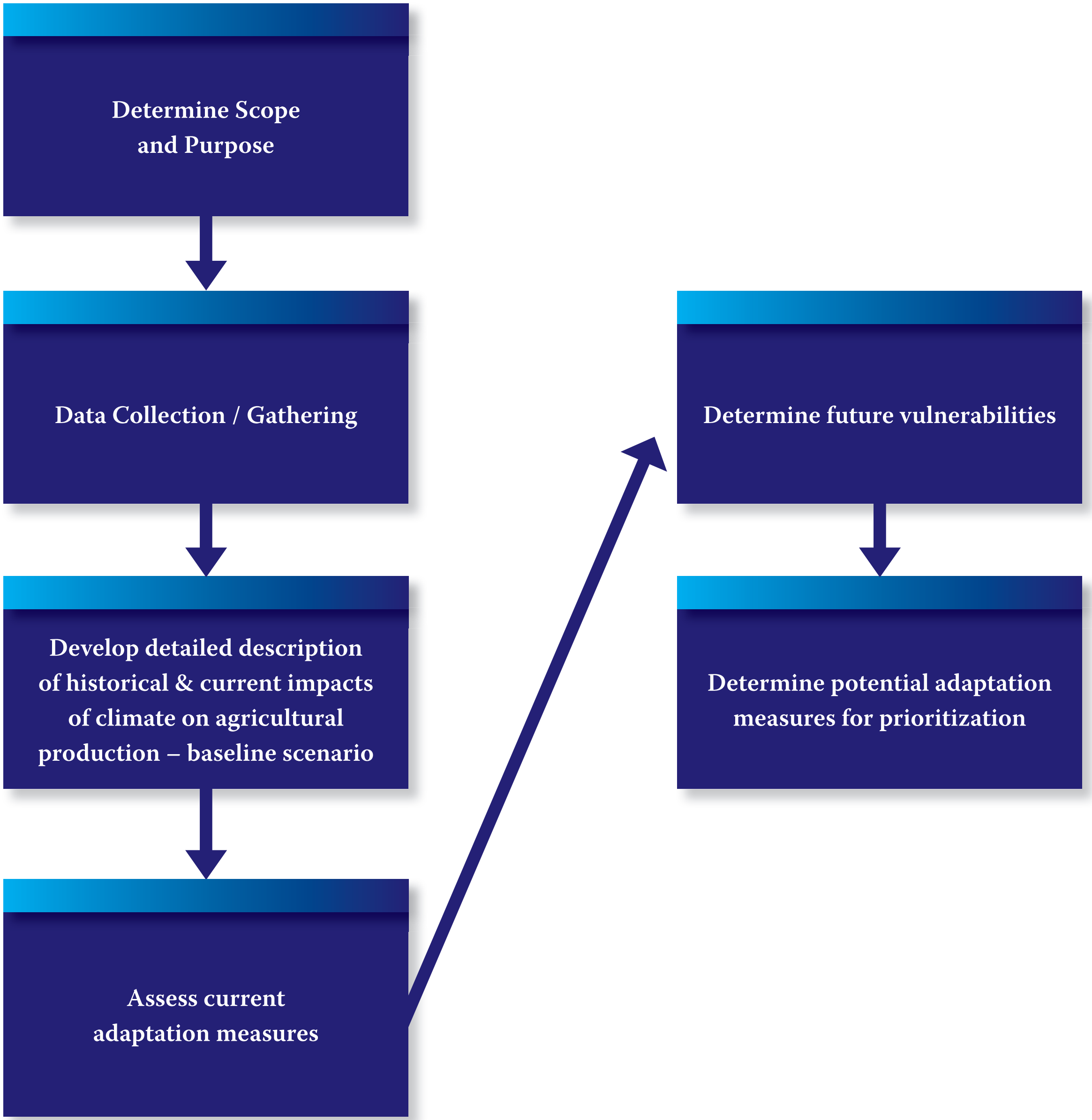
Negative impacts of a highly variable current climate in the agriculture are increasingly being seen. These happen when weather/climate events approach or exceed thresholds, as in the case of El Niño-associated droughts. On the other hand, positive impacts arise when and where weather conditions are favorable to agricultural production, as shown in areas of good harvest when rains were sufficient.

Can we minimize negative impacts and can we take advantage of opportunities that will happen as climate changes? Addressing these challenges will require that we do effective measures directed at enhancing our capacity to adapt or building adaptive capacity and minimizing, adjusting to and taking advantage of the consequences of climate change (UKCIP, 2007).

Building adaptive capacity to climate change requires improving the understanding of climate change and associated risks and location-specific vulnerabilities and building on how we address current climate risk with utmost consideration to uncertainties, particularly those associated with projected climate futures.

Evaluation and selection of adaptation actions or measures should be in terms of their relative contribution towards realising the desired outcome(s) of stakeholders, relative nature of associated risks, economic costs and benefits, technical feasibility and their potential conflicts and synergies with others, like related policies and regulations, and also implications of non-climatic factors.

STEPS FOR DEVELOPING AGRICULTURAL V & A ASSESSMENT



HOW TO DETERMINE SCOPE AND PURPOSE

1. Determine scope and purpose

Important things to consider are the purpose for which the assessment is to be used (planning, decision-making, developing adaptive capacities, enhancing resilience, etc.); who (individuals, groups, etc.) and where (province / municipality/city); and the timeframes.

The purpose and scope of the V&A assessment is to determine/estimate/quantify the local impacts of, and vulnerability to current and projected climate change in the agriculture and food security sector in the provincial/municipal/city levels; and to prioritize which mix of adaptation measures can address these impacts and associated vulnerabilities.

1.1 Specify area and location.

1.2 Cite the importance of the sector in the economy and population of the province/municipality city.

Describe the agriculture in the area (production/growing areas, farming and management systems, crops and livestock production, etc. e.g. Figures 16 & 17)

1.3 Determine timeframes in which assessments are to be made.

Baselines are the 1971-2000 data and future timeframes are 2020 and 2050.

Fig. 16 Estimated Yield in the Philippines (1970-2008)

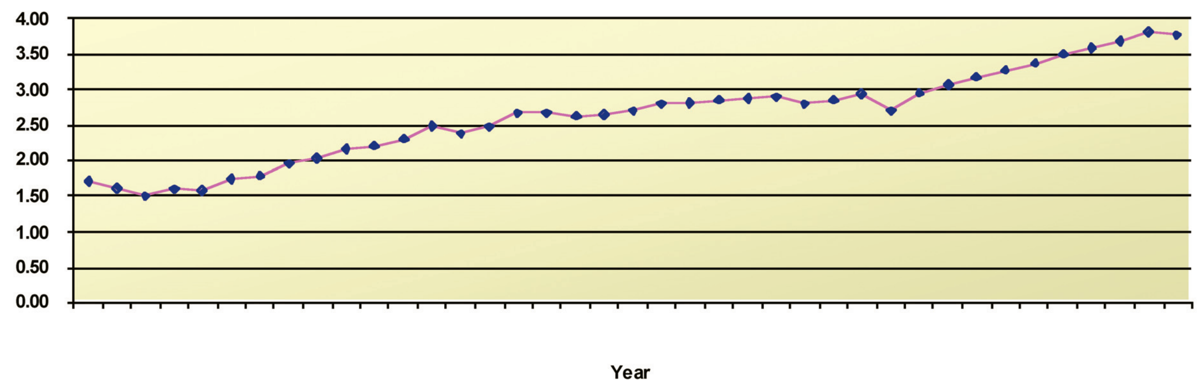
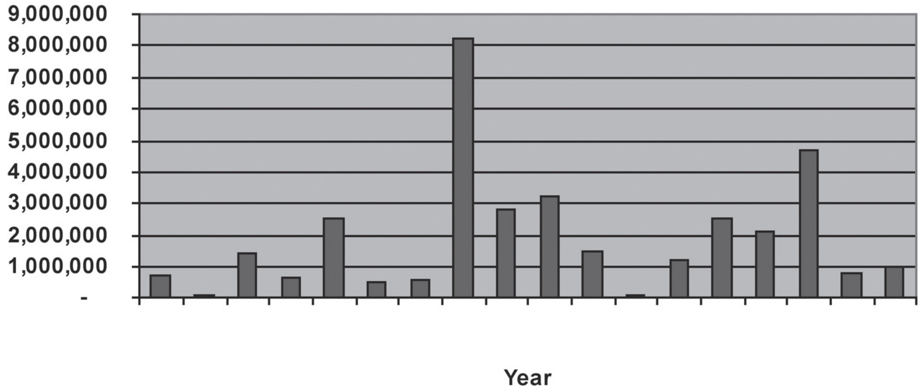


Fig.17 Rice Production Losses Due to Flashflood and Typhoons (1991-2008)



DATA COLLECTION / GATHERING

2. Gather needed data/information/profiles, proxy information and sources.

Table of needed data/information and sources

Type of Data	
Climate Statistics	**Agricultural Data**
Rainfall	Production areas
Temperature	Soil Types / Characteristics
Humidity	Farming Systems
Wind	Crops Planted
Tropical Cyclones	Cropping Patterns and Schedules
Drought Occurrences	Nutrient and Pest Management

Changes in Climate	Agricultural Data
Rainfall	Support Services
Temperature	Crop Yields
Humidity	Damages
Wind	Production Inputs and Losses
Tropical Cyclones	Pests and Diseases
Drought Occurrences	Livestock Production
	Government Programs / Projects

Sources:
PAGASA/DOST

DA, Offices of MAOS, PAOS, BAS, BSWM, NIA, PhilRice, agricultural colleges/universities, PCARRD, etc. field offices of POs/NGOS

Other data sources are development plans in local planning offices and socio-economic profiles and projections from NEDA.

2.1 Describe climate and current socio-economic profiles of the area.

Characterize climate variability (i.e. rainfall, floods, droughts, changes in these parameters, etc.) and current socio-economic conditions in the area e.g. Figures 18 and 19.

Use climate statistics and extreme events data from PAGASA, and socio-economic figures from NEDA, national yearbooks, census reports, reports from provincial/municipal/city planning offices, etc.

Fig. 18: Agriculture's Contribution to GDP, 1946-2003

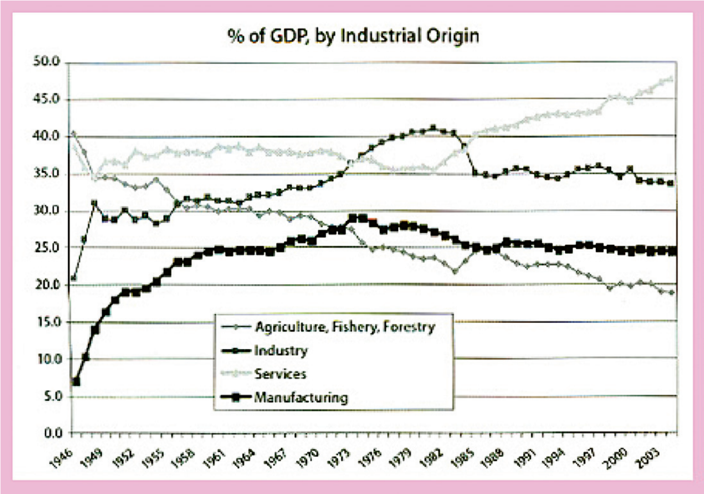
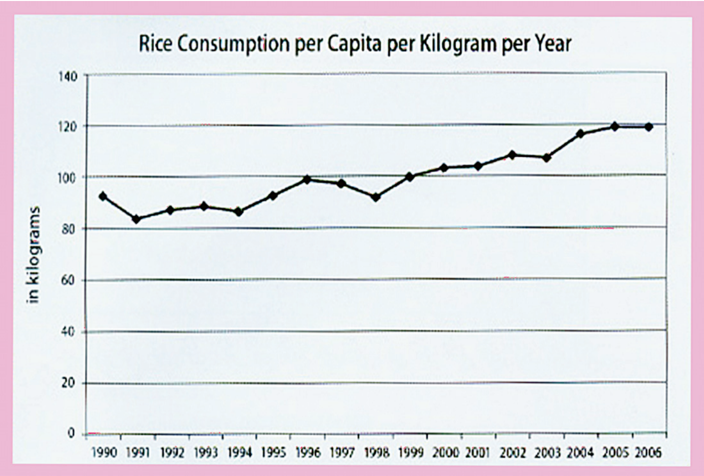


Fig. 19: Rice Consumption per Capita, 1990-2006



HOW TO CHARACTERIZE HISTORIC AND CURRENT IMPACTS OF CLIMATE ON AGRICULTURAL PRODUCTION

3. Characterize/describe impacts of historic and current climate (1971-2000) (baseline) on agricultural production in terms of yearly losses/damages/damaged areas due to floods/droughts, losses of production inputs, yields/GVAs, and impacts on food security rice imports), etc.

   3.1 Do a historical analysis of cropping areas, damages, losses and production volumes/incomes.
   3.2 Quantify relationship between yields and annual/seasonal rainfall using graphs and regression analysis, etc.
   3.3 Assess impacts on yields.

      Measures of impacts of extreme events (droughts/floods or El Nino/La Nina, too little/too much rains) are departures from normal yields.

      Measures of impacts of tropical cyclones are extent of damaged areas and normalized damage reports.

   3.4 Characterize vulnerability to current climate by considering severity of impacts vis-à-vis the current farming management practices, access to extension and other government support/programs/projects (seeds, new varieties, technical assistance, irrigation services, etc,), other adaptation measures in place like insurance, transfer of knowledge/ technology from demonstration farms and pilot areas for different farming management systems, subsidies, access to micro-finance, etc.

      Document how these have benefitted the different subsectors, lessened damages/agricultural input losses, enhanced the resilience of the subsectors, etc.

   3.5 Characterize climate risks and vulnerability using the equation:

      Risk = probability x consequence (Gouldby & Samuels, 2005)
      where probability or likelihood expressed in terms of frequency the hazard occurred in the past and consequence is either losses or damages

      Alternatively, the equation below could be used:

      Risk = (Exposure to Hazard) x Vulnerability
      where exposure is dependent on population or resource area and its adaptive capacity

HOW TO ASSESS THE CURRENT ADAPTATION MEASURES

4. Assess the current adaptation measures.

    4.1 Do an exhaustive survey of current adaptation measures in the field.

    The adaptation matrix given below can be used to assess the effectivity of adaptation measures in the field. Instruction for rating: Put a check where it applies.

Adaptation Matrix

Location: (Province/Municipality/Barangay)					
Source of Information: **Recorded by:**					
Adaptation title: **Short description:**					
Prevalence among livelihood:					
	Small farmers	Landless	Fishermen	Rural artisans	other
None					
Few					
Common					
Majority					
Benefits to livelihoods:					
High					
Medium					
Low					
Effectiveness for hazard:					
	Drought	Flood	Cyclones/ typhoons	High Temperatures	Other (ie., health of farmer)
High					
Medium					
Low					
Costs and benefits: Initial cash outlay ■ Low ■ Medium ■ High Sources of credit: ■ Self/family ■ Moneylender ■ Cooperative ■ Commercial bank ■ Government/Donors					

4.2 Validate through focus group discussions, key informants' interviews, ground truthing and site visits.

4.3 Document all best practices.

Decision making:

Implements	Household	Barangay	Municipal/ Provincial	Regional/ National	Internat'l Orgs.
Facilitates/agent					
Regulates					
Approves					
Monitor/evaluate					
Time frame:					
Time to make a decision					
Time to implement action	Within Season	Within a year	Planning cycle, up to 5 years	Dev't. planning, up to 10 years	Long term, over 10 years
Length of time action is effective					
Timing of benefits received by farmer					

Benefits to other farmers:
- ■ Low or none
- ■ Economic/ poverty reduction
- ■ Environmental
- ■ Socio-cultural
- ■ other

Is action included in existing plans:

Information to implement action
Information is available to:
■ Farmer ■ Barangay ■ mun/province

Skills to implement action are available:
■ Farmer ■ Barangay ■ mun/province

Conflicts
Does this action lead to conflicts?
■ None ■ economic/poverty reduction
■ environment/resources ■ social/cultural

If environment or natural resources are a constraint, is this :
■ Local ■ Provincial

If social or cultural values are an issue, please describe (gender, etc.)

HOW TO DETERMINE FUTURE VULNERABILITIES

5. Determine future vulnerabilities.

    5.1 Choose methods and tools based on availability of data and resources.

    See the following for tools, methodologies for impacts vulnerability and adaptation assessment and evaluation:

    - UNFCCC 's Compendium on methods and tools to assess impacts of, and vulnerability and adaptation to, climate change;

    For adaptation to climate change;

    - IPCC-TGICA, 2007: General Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment. Version 2;
    - Malone EL, Smith JB, Hurd, BH, Moss, RH and Bouille,D.,2004; Developing Socio-economic Scenarios For Use in Vulnerability and Adaptation Assessments. New York, United States, UNDP;
    - Others, such as those on risks and risk management, etc.
    - UNFCCC's Compendium of decision tools to evaluate strategies

Approaches are:

- ✓ Qualitative

  These include expert judgment, analogs, surveys such as focused group discussions, round table discussions, scenario building, farmer assemblies.

- ✓ Quantitative

  These include modeling (use of model runs) which can be both statistical and numerical, GIS mapping and overlaying of various maps, consensus from consultations, key informant interviews and scenario building using quantitative indices.

  For bio-physical impacts, crop models are run (ORYZA 2000 for rice and DSSAT for rice and corn) using projected changes from 2020 and 2050 climate scenarios;

  The model runs will give the simulated yields given the projected changes in temperatures and rainfall under the two timeframes.

  For economic projections, socio-economic scenarios also under the two timeframes are to be applied to arrive at the vulnerability of the sector in 2020 and 2050.

5.2 In cases where data do not support model runs, a simple methodology is used; the multi-stakeholder or community-based approach making use of analogues of historical and current impacts.

Steps are as follows:

- Develop vulnerability indices (formal/informal); and
- Determine level of sensitivity based on vulnerability indices developed and the assessments of current impacts and vulnerabilities.

Matrix for assessing the vulnerability by assessing the impacts due to the climate attributes

Climate attributes	Damaged areas/ damages	Losses in production inputs	Damage due to pests	Impacts on yield/ production
Change in rainfall				
Early onset of rains				
Delayed onset of rains				
Too little rain				
Too much rain				
Increase in temperature				
High temperature				
Extreme events				
Areas affected by droughts				
Areas affected by floods				
Areas affected by typhoons				

Suggested scoring:

Small 1
Moderate 2
Large 3

High sum of scores indicate high vulnerability.

HOW TO DETERMINE POTENTIAL ADAPTATION MEASURES FOR PRIORITIZATION

6. Identify all adaptation measures, especially community innovations, indigenous technologies, those that facilitate effective technology transfer, best practices in similar environments, etc.

   An effective approach draws on a mixture of adaptation strategies such as:

   ~ coping with risks associated with present climate variability and extremes (baseline scenario);
   ~ introducing adaptation measures incrementally;
   ~ enhancing flexibility or resilience of hard-to-reverse investments (i.e., infrastructure for irrigation, etc.); and
   ~ introducing adaptation measures to coincide with planned maintenance or upgrades of infrastructures;

   6.1 Do a multi-criteria analysis.

   The table on the next page gives the main types and some specific examples of adaptation strategies in the agriculture sector.

Prioritize these adaptation measures by using multi-criteria analysis.

Do a multi-criteria analysis.

Design a matrix which could be used in analyzing and prioritizing the adaptation strategies to be recommended. Include all the criteria to be used and design indicators by which the different criteria are assessed. (i.e., targets of opportunity, cost-benefit, effectiveness, ease of implementation, social/cultural acceptance, gender-sensitiveness, etc.).

Table of main types of adaptation strategies in agriculture

Technological	✓ crop development ~ new crop varieties to increase tolerance and suitability ✓ weather and climate information systems ~ early warning systems that provide weather and climate forecast ✓ resource management innovations ~ develop water management innovations, including irrigation ~ develop farm-level resource management innovations
Government programs and insurance	✓ agricultural subsidy and support programs ~ modify subsidy, support and incentive programs to influence farm-level production practices ~ change assistance programs to share publicly the risk of farm-level income loss associated with disasters and extreme events ✓ resource management programs ~ develop and implement policies and programs to influence farm-level and water resource use and management in light of changing conditions ✓ private insurance ~ develop private insurance to reduce climate-related risks
Farm financial management	✓ diversify source of household income ✓ develop alternative livelihood sources
Farm production practices	✓ farm production ~ diversify crop types and varieties to address environmental variations ~ change intensification of production to address risks ✓ land use ~ change location of crop/livestock production ✓ irrigation ~ implement selective irrigation practices to address moisture deficiencies ✓ timing of operations ~ change timing of farm operations to address changing growing seasons and changes in climate

An adaptation decision matrix could be designed similar to below:

Screening Adaptation Options

Adaptation Option	High priority	Target of Opportunity	Low Costs	Low barriers	Social Cultural Acceptance	Other benefits (no ill effects etc.)
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

List all adaptation strategies to be ranked.

Suggested scoring is:

Very High	5
High	4
Moderate	3
Low	2
Very Low	1

Note that the higher the sum total of scores, the higher the ranking.

For indicators, the Delphi technique could also be used.

6.3 Validate results in a multi-stakeholder consultation.

6.4 Define underlying cross-cutting issues, constraints, barriers.

Closely examine how issues encountered in the sector could also affect the other sectors. For example, water quality and water quantity are seen to impact on the other sectors, so that adaptation measures would have to be assessed further through an integrated assessment.

Constraints and barriers to implementation of adaptation measures need to be carefully studied as these will affect activities related to technology transfer and also in ensuring the enhancement of adaptive capacities, and increasing the resiliency of the sector. One possible source of constraints to implementation is the enabling policy environment, like existing subsidies/support being provided to some agricultural inputs. It is even possible that some agricultural policies currently implemented run counter to the objectives of enhancing resiliency and adaptive capacities of both the agricultural workers and the production areas.

WATER RESOURCES AND FORESTRY

INTRODUCTION

This section provides guidance on how to do the assessments of impacts, vulnerability and adaptation measures to address climate change in the water resources and forestry sector in local communities/LGUs.

Steps are provided in order that the practitioners/responsible staff in the local government units are able to do a meaningful assessment of impacts, vulnerability and adaptation in order to inform planning and decision-making in the LGU levels.

WHY WATER RESOURCES AND FORESTRY IS A KEY SECTOR?

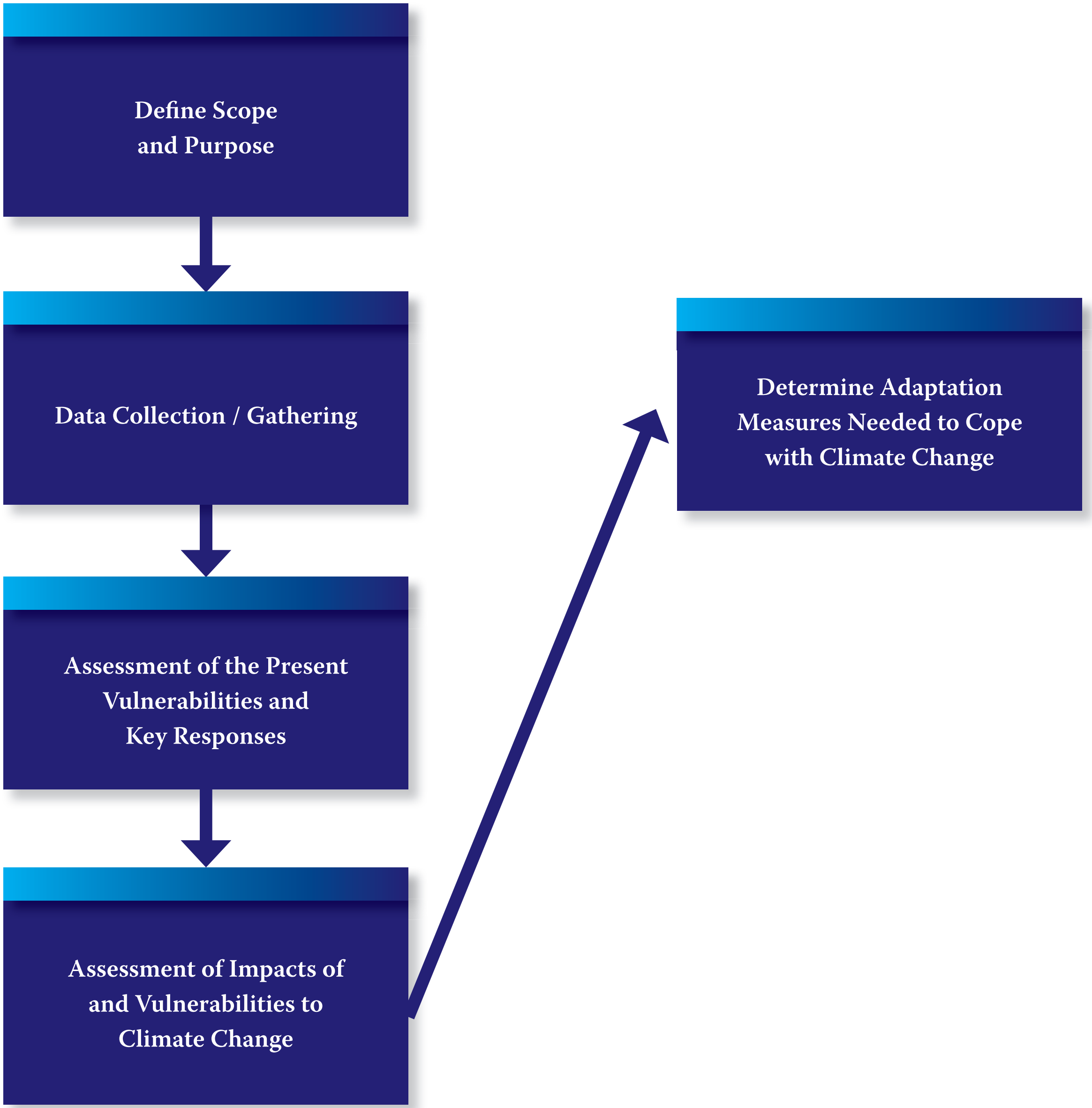
Major river basins in the Philippines are considered as lifeblood and driver of the Philippine economy. However because of the current conditions of these watersheds and the effects that climate change is bringing to these watersheds, these perilous areas are losing their potentials to contribute to development and natural resources conservation.

The forest ecosystem will be the one mostly affected by the future climate change.

The likely reduction of some forested areas will in turn affect biodiversity due to the opening of more forestlands as a result of the movement of lowland farmers in the uplands to undertake farming or other land based livelihood. The socio-economic pressure humans put on the environment is considered a great threat to the system's sustainability, thereby making these areas more vulnerable to climate change.

The socio-economic pressures serve as both problem and challenge. It is a problem because forest clearance will inevitably happen in the near future as the need to sustain the needs of the family is far more important than any other environmental issues. It can be an opportunity especially for the local government sector to dwell more on the social problem of poverty, which has been found out as the root cause of most problems related to the environment.

STEPS FOR DEVELOPING THE WATER RESOURCES AND FORESTRY V & A ASSESSMENT



HOW TO DEFINE THE SCOPE AND PURPOSE

Definition of the scope and purpose of the assessment process which basically aims at identifying the sectors, people and places that will be affected by climate change, and the scale of assessment that will be carried out.

Climate change is known to impact a wide range of human and natural systems including resources, environmental functions and services, and socioeconomic development at various levels and scales usually in an intricately interconnected fashion. As critical as the need is for responding properly and promptly to climate change related risks, it is equally vital that the required assessment of impacts, risks, vulnerabilities and adaptation options be made as integrated and comprehensive as possible yet should be so focused that the implementation of adaptation responses is not constrained by the vastness of efforts and logistics required. Thus it is essential that the scope and purpose of V&A assessment be defined properly following the key steps below.

1. Identification of key impact areas of climate change particularly the sectors, peoples, places, livelihoods and resources that will likely be affected by climate change. For water and the forestry sector, some of the impact areas may include

    a. Natural forests
    b. Protected areas
    c. CBFM areas
    d. Ancestral domains
    e. Reforestation areas
    f. Tree plantations
    g. Agroforestry areas
    h. Agricultural areas
    i. Roads and other infrastructure
    j. Settlement areas
    k. Streamflow
    l. Fruit tree plantations
    m. Livelihoods other than agriculture and forest-based livelihoods

The impact areas can be identified using one or combinations of the following methods:

a. Reviewing existing reports (of LGUs, NDRRMC, PDRRMC, MDCC, DENR, PAGASA, NCSB) of damages due to climate related disasters and events such as typhoons, floods, droughts and landslides. The potential impact areas of climate change are the sectors, people and places that are frequently and/or seriously affected by past disaster events as indicated by the magnitude and/or cost of damages caused by disaster events. In some areas and cases, the impact areas may not necessarily be affected by climate disasters but are affected by changing seasonality of rainy and dry season or simply by excessive rain or increase in temperature.

b. Interviewing key informants (LGU executives, planners, government agencies)

c. Holding participatory workshops and FGDs involving representatives from local communities, farmer groups, LGU officials (ENRO, PAO, MPDC, DSWD, MDCC) women and youth groups and other local groups.

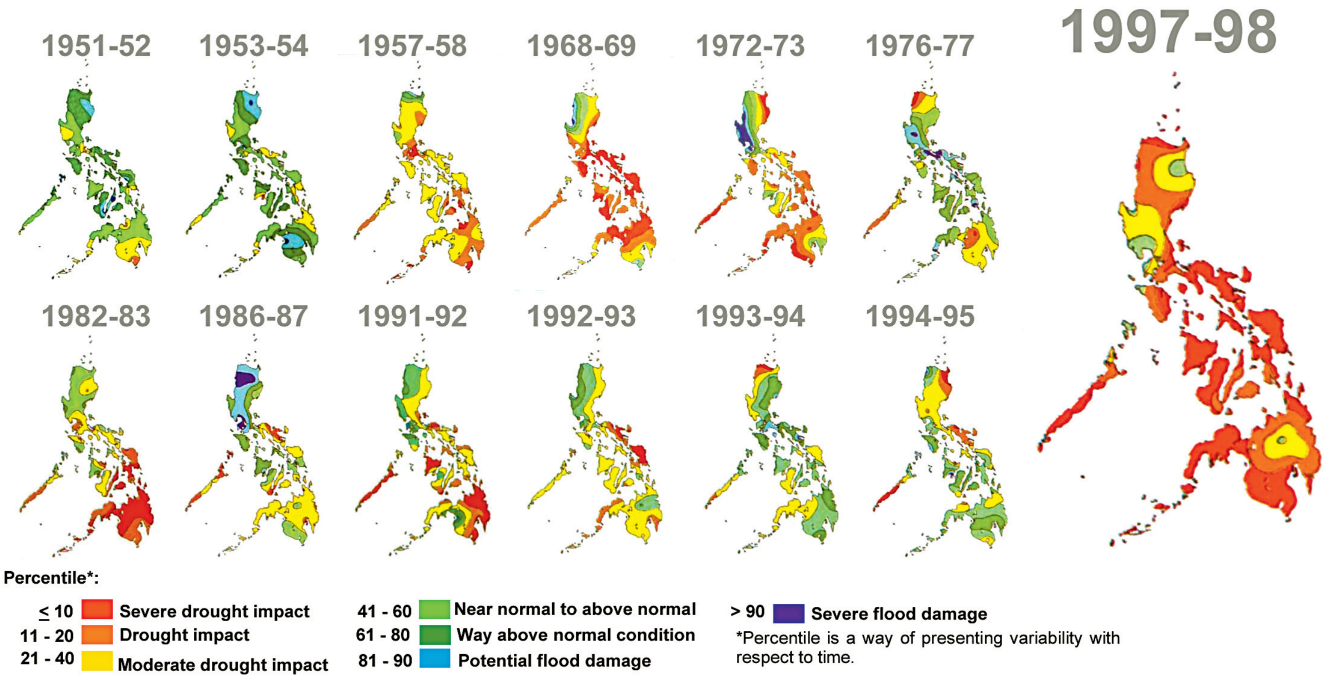
The key outputs here include a list, map or matrix of sectors, people, places, livelihoods, and resources.

In the forestry sector, the likely impact areas include natural forests, protected areas, agroforestry areas, reforestation and tree plantation areas, CBFM areas, soil and water resources, and flora and fauna.

2. Prioritization of key impact areas could be based on the frequency of being affected by climate related disasters and average extent or cost of damages sustained from past climate related disaster events as reported in various documents. If records are absent the key impact areas can be ascertained by through participatory workshops involving key stakeholders in the area of study. Participants to the workshop should include among others representative from people, places and resources that are likely to be vulnerable to climate change. A preliminary list of prospective participants could be prepared by the study team but will need to be finalized with the active participation of the key stakeholders. Ranking of the likely impact areas can be done by consensus of the stakeholders participating in the process.

   The key output of this activity is a list or a map (e.g. Figure 20) of priority impact areas identified in a workshop to be conducted. Top priority impact areas are those areas with the highest average frequency of being affected by climate related disasters and highest average extent or cost of damages sustained from past climate related disaster events as shown in various reports and documents and/or as identified by the stakeholders.

Fig. 20: Extreme Climate Variability in the Philippines:
Twelve-month (April-March) Rainfall During El Niño



Source: PAGASA (2000)

3. Selection of appropriate scale and level of assessment based on the nature of impacts and risks, and on what key impacts areas are to be examined.

   a. To assess the impacts of climate change on people and places due to hydrometeorological hazards, using the watershed as the unit of assessment is appropriate.

   b. In assessing the impacts on resources such as flora and fauna, and ecosystem functions, ecosystem is a more logical unit of assessment.

   c. For the integration of the assessment of climate change impacts, risks, vulnerabilities and adaptation across sectors, places, ecosystems and resources, the LGU can be an appropriate unit for the horizontal as well as vertical integration.

DATA COLLECTION/GATHERING

Identification of the data needed for the assessment of climate change impacts, vulnerabilities and adaptation.

Key data will need to be gathered from primary and secondary sources.

Table of data needed for the assessment of climate risks, vulnerability and adaptation for watershed and forestry sector.

Data	Possible Source	Period
Biodiversity		
List of rare, endangered and threatened (RET) plants and animals	PAWB	Latest
Maps of known habitats of RET plants and animals	PAWB, CI	Latest
NIPAS areas Map	PAWB, FMB	
Conservation Priority Areas	CI	
Watersheds		
Maps of major watersheds	DENR, BSWM	Latest
Forest cover and land use land cover maps	NAMRIA, DENR	Latest, past time periods, historical
Municipal boundary map	NAMRIA	Latest
Provincial boundary map	NAMRIA	Latest
Geohazard maps	DENR, NDRRMC, PDRRMC, MGB, BSWM, PHIVolcs, Manila Observatory, NEDA, NAMRIA, DA-BAR	Latest
Flood prone map		Latest
Landslide prone map		Latest
Soil erodibility map		Latest
Mineral land claim map		Latest

Forest Management		
Forest plantation Maps	DENR (PENRO, CENRO, FMB)	Latest, historical
Upland crop production areas Map	NAMRIA, DENR	Latest
Key policies and programs on SFM, reforestation, CBFM, IFMA/SIFMA, NIPAS, ICZM	DENR	Latest
CBFM Location Maps	CENRO,FMB	
CBFM Project Profiles	CENRO, FMB	
IFMA, SIFMA Map	FMB	

Bamboo Production		
Bamboo production areas	ERDB, WRI, INBAR, FAO	Latest
Inventory data on volume of bamboo resources	ERDB, CFNR	Latest
Employment generated by bamboo industry	ERDB, NEDA	Latest
Poverty incidence map per province	NEDA, NCSB	Latest

Fruit Production		
Fruit production areas	BAS	Latest , historical
Volume and value of production per fruit	BAS	Latest , historical
Employment generated by fruit industry	BAS	Latest , historical

Climate		
Historical daily rainfall	PAGASA	1960-present
Historical average daily temperature	PAGASA	1960-present
Historical typhoon (at least signal no. 2) passage	PAGASA	1960-present
Most damaging typhoons	PAGASA	1960-present
Historical wind velocity	PAGASA	1960-present
Projected daily rainfall and temperature, wind, and extreme weather events	PAGASA	2020, 2050, 2080

Others		
Population density map per province	NEDA, NCSB	Latest
GDP per capita per province or region	NEDA, NSCB	Latest
HDI per province or region	NEDA, NCSB	Latest
Water requirements by sector (domestic, commercial, industrial, agricultural/fishery) per province	NWRB	Current, projected (2020, 2050)

The key output of this activity is the scale and level of assessment that will be used in the study area.

ASSESSMENT OF THE PRESENT VULNERABILITIES AND KEY RESPONSES

The present vulnerabilities and key responses need to be assessed as a benchmark in assessing the vulnerabilities to future climate conditions and the adaptation needed to cope with climate change.

1. Prior to the assessment of vulnerabilities to present climate conditions, the climate related hazards in the area of study must be identified. This can be done through:

   a. Review of existing reports (of DENR i.e., FMB, PAWB and MGB; LGUs, NDRRMC, PDRRMC, MDCC, PAGASA, NCSB) of climate related disasters and extreme events such as typhoons, floods, droughts and landslides in the area of study. It may also include increase in temperature (change in maximum and minimum temperature), frost in high elevation, excessive rains, and delayed or early onset of rainy season.

   b. Interview of key informants (NDRRMC, PDRRMC, MDCC, LGU executives, planners, government agencies)

   c. Participatory workshops and FGDs involving representatives from local communities, farmer groups, women and youth groups and other local groups.

   The key output of this activity is a list of climate related hazards at least over the last 30 years.

2. Identification of people, places, resources and sectors vulnerable to current climate through:

   a. Review of existing reports (of LGUs, NDRRMC, PDRRMC, MDCC, DENR, PAGASA, NCSB) on the damages and the people, places and sectors affected by climate related disasters and extreme events such as typhoons, floods, droughts and landslides in the area of study.

   b. Interview of key informants (DENR, DA i.e., BAS and BAR; NDRRMC, PDRRMC, MDCC, LGU executives, planners, government agencies)

   c. Participatory workshops and FGDs involving representatives from local communities, farmer groups, women and youth groups and other local groups.

The key output of this activity is a matrix of the people, places, resources and sectors that are affected by climate related hazards yearly over the last 30 years.

3. Identification of the key past and present responses to climate related hazards

    a. Interview of key informants (NDRRMC, PDRRMC, MDCC, LGU executives, planners, government agencies, local community leaders)

    b. Participatory workshops and FGDs involving representatives from local communities, farmer groups, women and youth groups and other local groups.

The key output of this activity is a matrix of key responses to climate related hazards each year over the last 30 years.

ASSESSMENT OF IMPACTS AND VULNERABILITIES TO CLIMATE CHANGE

1. Fundamental to the assessment of impacts of and vulnerabilities to climate change is the description of future climate. Particularly it will be essential to describe changes in temperature, rainfall, among other climate parameters. Other climate parameters like solar radiation, wind velocity and relative humidity are useful in assessing impacts of climate change on agricultural and fruit crop production. Further it is of importance to have information on the frequency of extreme rainfall events such as 24-hr rainfall of at least 100 mm, at least 150 mm, at least 200 mm, at least 250 mm, and at least 300mm which useful in assessing the impacts of climate change through the increasing frequency of landslides and droughts

   Future climate conditions are mostly derived from results of GCM runs scenarios. The resolutions of these GCMs are coarse and not necessarily suitable for small scale climate change impact assessment. Hence GCM results must be downscaled to finer resolutions that are more appropriate for local scale such a community, a watershed or an LGU. Through PAGASA, downscaled GCM generated future climate can be accessed for use in the assessment of certain climate change impacts.

   The key output of this activity is a map or summary matrix of the likely changes in climate.

2. Assessment of climate change impacts

   a. Once the future climate is available, the potential impacts of climate change can be assessed using any or all of the methods below.

      i. Modeling and simulation are usually useful in assessing impacts of climate change on water, soil erosion, land use, land cover and growth of plants. Some of the models that may be useful under Philippine setting include BROOK hydrologic model, USLE, and other similar models.

         For the assessment of the impacts of climate change on water resources, simulation of changes in the water balance of the watershed can be used. The choice of the model should be based on the ability of the model to factor into the calculation of the water balance the effects of the changes in rainfall and temperature, and the availability of data that will be needed to run the model. Simple models like the BROOK hydrologic models can be used for this purpose. To assess the impacts of climate change, water balance for the baseline climate condition will be calculated and compared with the water balance for the future climate scenario. Changes in the total streamflow, peak flow and low flow may be calculated as indicators of the impacts of climate change. Other changes in the other components of the water balance such as evapotranspiration and infiltration may also be compared to determine how future climate may affect the water resources in a watershed.

ii. Surveys, interviews, FGDs and participatory workshops are commonly used in assessing the impacts of climate change on local community, livelihoods, and properties including farms, houses, infrastructure and schools.

iii. GIS analyses will be useful in both the assessment of biophysical and socioeconomic impacts of climate change and in mapping the likely locus of potential impacts of future climate conditions.

iv. Expert judgment and qualitative analysis are useful in cases where there is no sufficient baseline or existing information database that will render modeling and simulation infeasible and in cases where there is no ample time to conduct actual field surveys, interviews, FGDs and participatory workshops.

The key output of this activity is a description of what the impacts of climate change are described either through GIS maps or through narrative description.

3. Assessment of future vulnerabilities

In combination with the results of the assessment of the present vulnerabilities, the projected climate and it's likely impacts could be used in determining areas in the forests, biodiversity, local communities, and livelihoods that will be vulnerable to climate change. The assessment of vulnerabilities is generally based on the frequency of occurrence of climate related hazards, the population, properties and forest resources exposed or sensitive to hazards, and the adaptive capacity of those that will likely be affected by the hazards. In general, vulnerability can be expressed as follows:

$$V = P \times E/AC$$

where

V = vulnerability
P = probability that hazard will occur or the frequency that the hazard occurred in the past years
E = population, properties or forest resources that are exposed to hazards
AC = adaptive capacity of the area that could be indicated by the HDI or the poverty incidence of the area

Following the general equation above, vulnerabilities to climate change can be estimated quantitatively based on the risks involved that will be the basis for formulating adaptation responses.

However, in broad strokes, vulnerabilities to climate change can be assessed by identifying the sectors, people and places that are exposed to past, present and projected climate related hazards. This can be done with the aid of GIS by preparing an overlay showing the location of sectors, people and places sensitive to climate change and an overlay showing the area covered by climate related hazards. The vulnerable sectors, people and places are those in areas that intersect with the areas that are likely to be affected by climate related hazards.

Through FGDs, participatory workshops, or expert judgment the results of the identification of the vulnerable people and places can be validated. If desired, vulnerabilities can be stratified into low, moderate and high following arbitrarily set values for stratification based on the magnitude and frequency of occurrence of climate hazards and on the assessed adaptive capacity of the impact areas.

DETERMINE ADAPTATION MEASURES NEEDED TO COPE WITH CLIMATE CHANGE

Formulation of climate change adaptation plan for the people and places at greatest risk will involve the following activities.

a. Identification and assessment of existing adaptation measures of vulnerable people and in vulnerable places through secondary information analysis, participatory workshops for the design of the workshops) and focus group discussions. Specifically, the key output of this activity is an adaptation matrix of adaptation measures implemented by sectors in areas affected by past climate hazards:

Adaptation Category	1982-83			1997-98			2004		
	Flood	Drought	Typhoon	Flood	Drought	Typhoon	Flood	Drought	Typhoon
Physical/Infra									
Biological									
Technological									
Economic									
Political/institutional									

Current adaptation matrix (one matrix each for measures initiated by local, LGU initiative, national, international)

b. Determination of current and future adaptation deficit should also be assessed with the participation of the key stakeholders. Through participatory workshops and FGDs, the current adaptation deficit should be evaluated as the adaptation needed in addition to measures that were implemented to keep the damages (this is the recorded damages from past hazards) below the acceptable amount of damages. In like manner, the future adaptation deficit should be evaluated as the additional adaptation measures needed to augment current adaptive capacity so as to keep the impacts and damages of future climate hazards (this will be based on the estimated potential damages) below the acceptable level of impacts and damages. A matrix of recommended adaptation measures should be developed:

Adaptation Category	2030			2050			2080		
	Flood	Drought	Typhoon	Flood	Drought	Typhoon	Flood	Drought	Typhoon
Physical/Infra									
Biological									
Technological									
Economic									
Political/institutional									

Future adaptation matrix (one matrix each for measures initiated by local, LGU initiative, national, international)

Appropriate forestry programs and policies are likely to affect the vulnerabilities as well as the adaptive capacities in the forestry sector. Specifically, forestry policies and programs will reduce the adverse climate change impacts on the forests, contribute in reducing the adverse impacts of climate change on forest dependent communities, enhance the capacity of the dependent communities to adapt to climate change and to recover from the damages resulting from climate change, and enhance the resiliency of forest ecosystems amid climate change. It will therefore be essential to assess how these policies and programs will enhance or diminish the adaptive capacity as well as how they will increase or reduce the vulnerability of the forestry sector to climate change. The following table illustrates how forestry policies can be assessed, using EO No. 263 as an example.

c. Adaptation measures may be categorized as economic, physical and infrastructural, biological, technological or social.

d. Assessment of adaptation options must be made to ensure maximum benefits and minimum adverse impacts are achieved during implementation. Ideally, adaptation options should be weighed in terms of availability of resource requirements, availability of expertise to implement adaptation, acceptability of the adaptation option to prospective implementers, and minimum adverse impacts.

Policy Issuances	Brief Policy Description	Indicators of readiness of policies		
		Reduce adverse impacts to forests	Reduce adverse impacts to communities	Enhance capacity of communities to adapt to climate change
EO No. 263 – The Community-Based Forest Mgmt. Program (CBFM) July 29, 1995	Integrated and unified different upland community programs and projects to ensure the sustainable development of forestlands resources and social justice	Section 3. Participating organized communities may be granted access to the forestland resources under long term tenurial agreements, provided they employ environment -friendly, ecologically-sustainable, and labor-intensive harvesting methods.		Section 11. Within 6 months after signing of this Order, the DENR in consultation with government financial institutions such as DBP, LBP, GSIS, SSS, shall effect the creation of favorable financing mechanisms for access by communities and organizations in the pursuit of the CBFM strategy and its sub-strategies such as community training and empowerment, enterprise dev.t, agroforestry dev.t, tree plantations, and other non-forest-based alternative livelihood systems.

COASTAL

INTRODUCTION

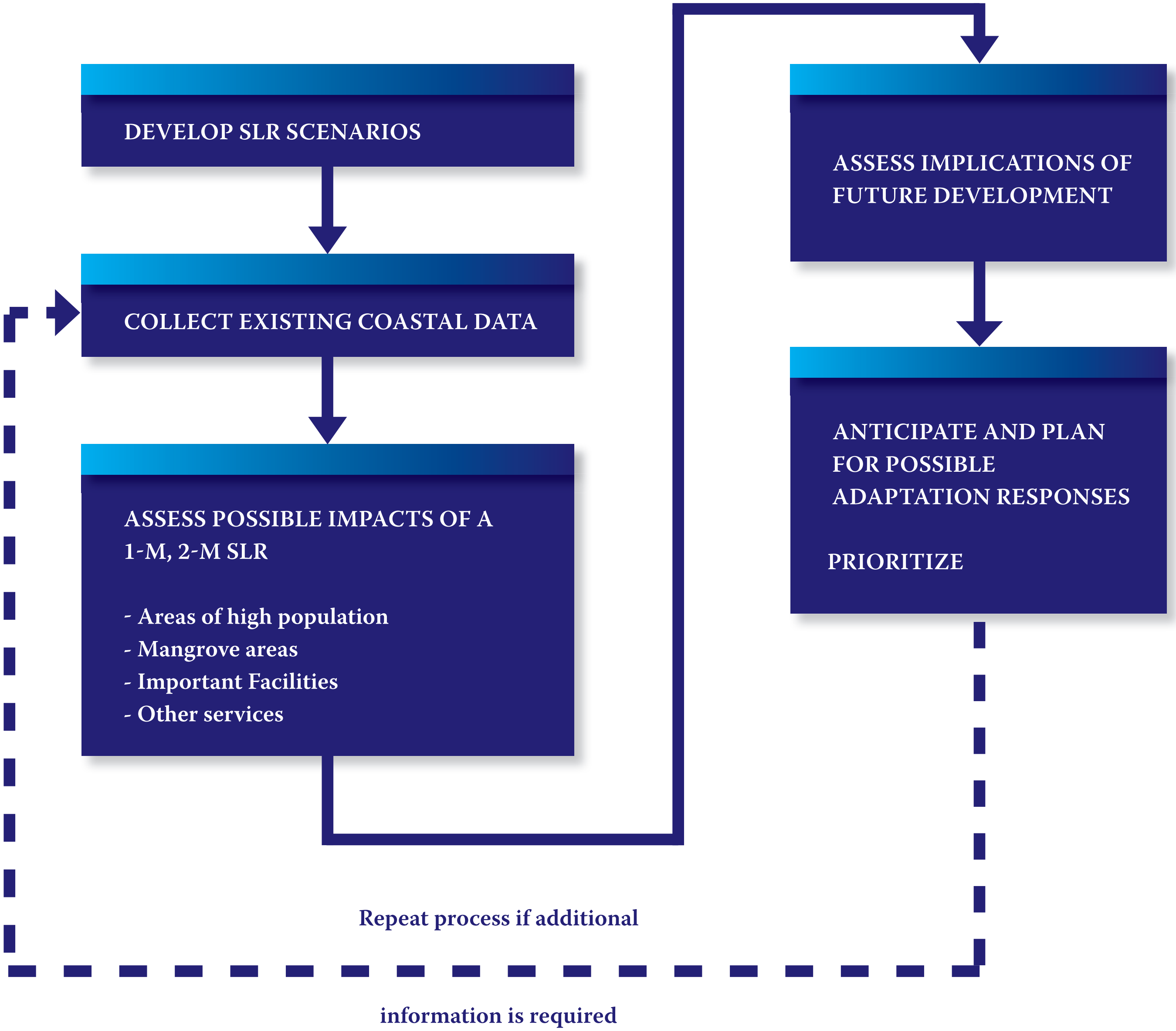
This section provides guidance on how to do the assessments of impacts, vulnerability and adaptation measures to address climate change in the coastal sector in local communities/LGUs.

Steps are provided in order that the practitioners/responsible staff in the local government units are able to do a meaningful assessment of impacts, vulnerability and responses to sea level rise in order to inform planning and decision-making in the LGU levels.

WHY THE COASTAL SECTOR IS A KEY SECTOR?

Uncertainties in sea level rise predictions create a need to assess a range of scenarios within the vulnerability assessment. These scenarios need to embrace the range of likely change. The objective of the assessment is to focus attention on critical issues concerning the coastal zone, rather than to supply precise predictions. A rapid assessment to highlight possible impacts of a SLR scenario can initially be done as a screening procedure and identify information/data gaps, which can be either qualitative or semi-quantitative. Vulnerability and risk assessment of a coastal area to SLR may include any or all of these impacts: flooding, erosion and coastal wetland loss.

STEPS FOR DEVELOPING THE COASTAL V & A ASSESSMENT



Source: Perez, 2005

HOW TO DEVELOP SEA LEVEL RISE (SLR) SCENARIOS

Sea level rise scenarios are generally easier to develop than climate change scenarios because unlike climate change, only one variable, sea level, is involved. Furthermore, there is high confidence that sea level will rise. Most coastal modelers recommend using incremental scenarios of 0.5 and 1.0 metres of sea level rise above 1990 levels by 2100 to capture global (what is sometimes referred to as "eustatic") sea level rise. This is essentially the average global increase in sea level resulting from increased GHG concentrations and it follows the IPCC scenarios of a 0.3 to 0.65m SLR.

Sea Level Scenario: 1m for the year 2020
2m for the year 2050

It is important to note that regional rates of sea level rise can vary. This is the result of regionally differing rates of thermal expansion of the oceans as well as regional differences in atmospheric circulation, which can affect relative sea levels. In addition, many coastal areas are either subsiding or being uplifted.

However, finer resolution DEMs or topographic maps are always a problem. We may start with a 1m SLR for the year 2020 and up to 2m by 2050 depending on the initial findings (screening) for the area of study.

COLLECTION OF EXISTING COASTAL DATA

Develop a checklist of needed data

Data Need	Possible Source
• Topographic surveys, digital elevation models (DEM)	NAMRIA, MGB, Other Mapping Agencies
• Aerial/remote sensing images – topography/land cover	NAMRIA, DPWH, LGU engineering departments
• Coastal geomorphology classification	MGB
• Evidence of subsidence	Engineering
• Magnitude and damage caused by flooding	Civil Defence/NDRRMC
• Coastal erosion	
• Population density	Planning, NEDA
• Activities located on the coast (cities, ports, resort areas and tourist beaches, industrial and agricultural areas)	Planning and Development Office, Treasury Office
• Development plans	Planning Office

The existing data is often scattered, and compiling all the information described shown here can be a considerable effort.

Furthermore, some of these data will not be available.

However, once assembled, a coastal database provides a basis for more informed decisions and helps to identify critical data gaps.

b) Screening assessment

Using existing data, a screening assessment should be undertaken which will highlight possible impacts of a 1-meter rise in sea level as well as key data gaps. It only aims to identify susceptibility with limited consideration of possible responses. These results will enable a subsequent more comprehensive vulnerability assessment, including a preliminary assessment of the ability of society to respond to the projected changes. Screening assessments can be qualitative or semi-quantitative.

Ideally, impact assessments should consider all biophysical and socio-economic impacts, but in practice the objectives of any impact assessment study for an activity or project should reflect the time and resources that are available. Hence, it is important at an early stage to rank the relative importance of potential impacts as (1) not relevant, (2) low, (3) medium or (4) high, together with relevant comments, in a matrix – an example of which is shown below. If change factors other than sea level rise are considered, the process needs to be repeated with those factors. In each case, this could be the outcome of a screening assessment as already discussed.

The resulting matrix is useful to focus resources on the major potential impacts. It is also illuminating if a ranking is not possible or problematic, because this would suggest that a broad, but general assessment is necessary, with a goal of achieving such a ranking in subsequent analysis.

Screening Assessment Matrix: Biophysical vs. Socio-Economic Impacts
Rank the relative importance of potential impacts as (1) not relevant, (2) low, (3) medium or (4) high

Biophysical Impact of Sea-Level Rise	Socio-economic impacts							
	Tourism	Human Settle-ments, Infra	Agri	Water Supply	Fisheries	Financial Services	Human Health	Coastal Resources
Inundation Flooding								
Erosion								
Salinization								
Others...								

HOW TO ASSESS POSSIBLE IMPACTS OF 1M – 2M SLR

a) Sensitivity Analysis:

Guide questions:

How do I know if the Coastal Sector in my province is vulnerable to climate change?

(i) In what ways will my sector be affected?
(ii) What is it in my sector that makes it vulnerable to such impacts?

Complete the following matrix to describe the sensitivity of areas, population and resources to erosion, inundation /flooding, salt-water intrusion

Sensitivity screening	Location:	Population:	Resources:
Erosion			
Inundation /Flooding			
Salt-water intrusion			
Others (e.g. subsidence)			

For example:

Four impacts may be considered: (i) Increased storm flooding; (ii) Beach/bluff erosion; (iii) Wetland and mangrove inundation and loss; and, (iv) Salt water intrusion. Their relative importance will vary from site to site, depending on a range of factors.

b) Vulnerability Assessment - Assess vulnerability based on general characteristics:

Increased storm flooding	Beach erosion	Wetland and mangrove inundation and loss	Salt water intrusion
• Describe what is located in flood-prone areas. • Describe historical floods, including (i) location, magnitude and damage, the response of the local people, and (iii) the response of government. • How have policies towards flooding evolved?	• Describe what is located within 300 m of the ocean coast. • Describe beach types. • Describe the various livelihoods of the people living in coastal areas such as commercial fishers, international-based coastal tourism, or subsistence lifestyles. • Describe any existing problems of beach erosion including quantitative data. These areas will experience more rapid erosion given accelerated sea-level rise. • What existing coastal infrastructure might be impacted by such recession?	• Describe the wetland areas, including human activities and resources that depend on the wetlands. For instance, are mangroves being cut and used, or do fisheries depend on wetlands? • Have wetlands or mangroves being reclaimed for other uses, and is this likely to continue? • Are these wetlands viewed as a valuable resource for coastal fisheries and hunting or merely thought of as wastelands?	• Is there any existing problem with water supply for drinking purposes? • Does it seem likely that salinization due to sea-level rise will be a problem for surface and/or subsurface water?

The following matrix can be used to compile responses.

General Characteristics	Location	Current Condition	SLR Scenario 1m, 2m	Remarks
Low lying areas				
Small islands with limited resource base usually tied to coastal ecosystems				
Reclaimed lands on river delta				
Areas subjected to various coastal hazards such as tropical cyclones, storm surges, subsidence, liquefaction, etc.)				
Size of population, coastal resources,/habitats to be affected				
Values of damage to land and property				
Uniqueness of resources (e.g., coastal plain, coral reef atoll, river delta or wetlands				
Others (e.g. facilities such as ports, fish landings				

HOW TO ASSESS IMPLICATIONS OF FUTURE DEVELOPMENTS

Examples:

- New and existing river dams and impacts on downstream deltas
- New coastal settlements
- Expansion of coastal tourism
- Possibility of transmigration

Estimates of the storm surge elevations are raised over time by the relative sea level rise scenario (i.e. global rise plus estimated subsidence) and converted to the corresponding land areas threatened by these different probability floods.

These areas are mapped and overlayed with exposure, in terms of the average population density for the coastal area and the vulnerability, in terms of poverty scoring.

Lastly the estimated level of flood risk is used to calculate the areas flooded.

Flood risk is calculated as areas subjected to:

- Increase in flood levels due to rise in sea level
- Increase in populations in coastal floodplain, or can be qualified as increase of poor people

HOW TO ASSESS ADAPTATION TO SEA LEVEL RISE IMPACTS

a) Identify adaptation options:

Different responses to sea level rise (SLR) can be made within an Integrated Coastal Zone Management (ICZM), Environmental Impact Assessment or Disaster Risk Reduction and Management, envisioned to be part of a continuous management process, which ideally aims to integrate responses to all existing and potential problems of a coastal zone, including minimizing vulnerability to long-term effects of climate change.

Generally, the responses can be classified as:

- Planned retreat (i.e., setback of defenses, relocation)
- Accommodate (i.e., raise buildings above flood levels, convert agriculture lands to aqua culture, set up early warning systems)
- Protect (i.e., hard and soft defenses such as seawalls, beach nourishment, mangrove rehabilitation/reforestation, indigenous plants to prevent erosion, etc.)
- Structural or physical strategies (e.g., flood protection such as dikes, storm shelters, evacuation centers, etc.)
- Non-structural strategies (e.g. Set back policies/buffer zone, regulatory, early warning, forecasting)

b) Adaptation Assessment

There is a need to evaluate selected adaptation measures as to their appropriateness

Guide Questions and suggested adaptation assessment matrix (add more rows as necessary to the matrix to cover all adaptation measures):

What can be done to reduce the vulnerability of my Sector to Climate Change and/or counter the adverse impacts on my Sector?

i. What adaptation measures are applicable to the situation?
ii. What existing policies /management will support the adaptation objectives?
iii. Which can be done with ease (need criteria for evaluation such as cost and benefit, robustness of option - that is good for sustainable development even without Climate Change)
iv. Planning and implementation analysis: What will be done, who will do it, what are the resources needed, time frame, monitoring scheme)
v. What are the technical, financial and technological needs?
vi. What could hinder the successful implementation of the adaptation scheme?

Adaptation Strategies/ Measures	Cost	Benefits	Focal Point	Resources needed	Rank
Planned Retreat					
Accommodation					
Protection					
Structural or Physical Strategies					
Non-Structural Strategies					

Some possible measures to enhance the capacity of the coastal sector to adapt to climate change, variability and extremes (Source: Perez, 2003)

ADAPTATION MEASURES	CAPACITY ENHANCING MEASURES
• Modification of setback policies to address climate change /sea level rise • Conduct research studies on salt water intrusion, fisheries and aqua culture • Strengthening of the Disaster Management Program • Improved typhoon warning system • Flood prevention / protection • Shoreline stabilization /Preparation of hazard and vulnerability maps to floods and to probable sea level rise • Stop further conversion of mangrove into fishpond development • Putting in place Integrated Coastal Management (ICM) and expansion of Coastal Environment Program (CEP) • Massive upland and coastal reforestation, including the expansion of community-based mangrove reforestation program • Information, education and communication (IEC), awareness program • Monitoring sea level rise and climatological data: Tidal gauge stations (costly) vs. indigenous methods (staff gauges) • Installation of Geographical Information System	• People empowerment in the management of coastal resources • Inventory and survey of coastal resources • Provincial environmental and natural resource accounting • Require industries to install desalination facilities for water sources, instead of groundwater withdrawal. • Regulation of installation of water pumping systems • Expansion of coverage for artificial reefs, marine sanctuary, marine reserves. • Strengthening of coordination between Department of Environment and Natural Resources (DENR) and local government units (LGUs) • Appropriate land use and zoning • Strict monitoring and enforcement of mining laws (sand and corals) and other coastal management policies, laws and regulations • Formulation of comprehensive coastal development plan • Develop / Improve watershed management, including identifying and developing potable water sources • Reactivate/ re-orient Environment and Natural Resources Committee (ENRC) in the coastal municipalities. • Implementation of Poverty Alleviation Program • Strengthening / enhancement of integrated waste management program, including adoption of coastal clean-up movements • Provision of alternative livelihood and resettlement program

HEALTH

INTRODUCTION

This section provides guidance on how to do the assessments of impacts, vulnerability and adaptation measures to address climate change in the health sector in local communities/LGUs.

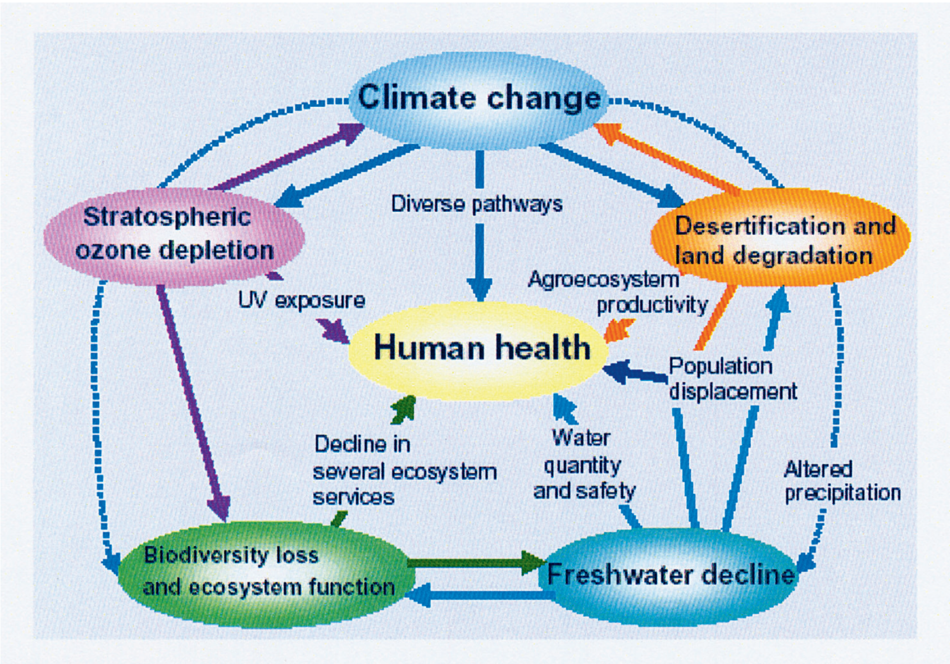
Steps are provided in order that the practitioners/responsible staff in the local government units are able to do a meaningful assessment of impacts, vulnerability and responses to health issues in order to inform planning and decision-making in the LGU levels.

WHY THE HEALTH SECTOR IS A KEY SECTOR?

Health as a sector integrates and determines climate change impacts on human population. It goes through a complex process that has both direct and indirect effects. We will consider health here as articulated by diseases that are sensitive to climate change (indirect); this takes into consideration diseases that are spread with the facility of a vector that is affected by climate (change) and its major weather parameters. The body itself (direct) can be affected by climate change.

In the Philippines, diseases should also be considered as to its epidemic potential/possibility; the endemicity of certain diseases that recur (ie. dengue, cholera, malaria); the double burden of illness where we still have the infectious diseases in children; and the older lifestyle diseases.

Health is likewise a cross cutting sector, one that interacts with the other sectors (ie. forestry, agriculture) and as such it should consider multi-factorial conditions that may modulate its impacts. These areas of interface become the areas where both possible gaps and constraints arise.



From: WHO meeting on Climate Change and Health Maldives, Dec 1-5, 2003

STEPS FOR DEVELOPING THE HEALTH V & A ASSESSMENT

HOW TO DEFINE THE SCOPE AND PURPOSE

The Intergovernmental Panel on Climate Change (IPCC), in its Second Assessment Report, defines vulnerability as "the extent to which climate change may damage or harm a system." It adds that vulnerability "depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions" (Watson et al. 1996: 23).

In the Philippine health sector, the early vulnerabilities identified are the following:

- Changing disease patterns
  - Double burden of disease : infectious and lifestyle
- Climate sensitive diseases
  - Emerging and re-emerging diseases: multiple drug resistant tuberculosis, malaria
- Health Infrastructure
  - Human Resource constraints
  - Physical Resource constraints
- Non-health determinants
  - Disasters
  - Socio-economic (Poverty)
  - Geographical set up (multiple island archipelago) (McMichael AJ and Woodward A.I (2000))
- Isolated Island Cities and Municipalities
  - Dependency level for resources (Woodward A.Hales S and Weinstein P (1998))
- Information
- Technology

This manual will consider how to formulate an adaptation response to these vulnerabilities. Consider the following vulnerable populations to health effects:

- Far flung barangays (mountainous or coastal) – with risk hazards that will increase with extreme climate change
- Those populations that have least access to health services and are in dense/congested – urban slums (space vs. access)
- Areas that are endemic to certain 'climate sensitive' diseases (ie. malaria - multi-drug resistant strains) on top of a bad health system (inadequate resources – financial and human to respond)
- Those that are culturally challenging – resistant to health education or change in their behavior towards health brought by culture - beliefs

The **timeframe of 1970-2009 is used as the baseline for diseases recording** from the NEC specifically the NESSS and so it limits the coverage to 13 epidemic prone diseases and further scopes this to those that are climate sensitive. For the SNC, NESSS data was utilized dating form 1987-2009.

The actors considered are those **clients** who have had cases recorded as they went for check up to the sentinel data gathering points (hospitals) where the NESSS is set up. **Assigned personnel recording the diseases and treatment personnel (doctors)** are part of the actors. Training for the NESSS personnel (RESU/PESU/MESU) has already been done for those that have sentinel hospitals.

Likewise the **complementing PAGASA data personnel** are those in the gathering points in provincial meteorological offices. Arrows represent reporting and feedback, where for health personnel reporting and feedback can happen as soon as the provincial level so that adaptive responses can be made rapidly.

The accompanying analysis and results can be utilized in the provincial investment plan for health (PIPH). The burden of these climate sensitive diseases as calculated (for the present scenario) can be the basis for the adaptive responses in the PIPH. This can likewise be projected so that long term budgets and adaptation can be programmed

Personnel			
Health			
Municipal Epidemiology Surveillance Unit (MESU) →	Provincial Epidemiology Surveillance Unit (PESU) → ←	Regional Epidemiology Surveillance Unit (RESU) → ←	National Epidemiologic Surveillance System ←
Provincial Met Office (Staff)	→ ←	Pagasa National Office (Staff)	

DATA COLLECTION / GATHERING

Baseline data presently comes from two sources for the data on sentinel diseases at the Department of Health/National Epidemiology Center. These are:

A) **Notifiable Disease Reporting** - passive system but has a wide coverage.
The information is limited by reports coming in from rural health units and selected hospitals.
Further, there are no case definitions used by reporting units. Currently, this is being enhanced into the Philippine Integrated Disease and Response System (PIDSR) but they are still at the training phase.

B) **National Epidemic Sentinel Surveillance System** - actively monitors 13 diseases of epidemic potential.
The system uses case definitions so the consistency is high.
However, reporting units (sentinel sites) are not as widespread as the NDR. This is the national module of the PIDSR.

Data sources from the **National Epidemic Sentinel Surveillance System (NESSS)** are available for the last 20-50 years on five of the notifiable diseases which are deemed climate sensitive:

Malaria
Dengue
Schistosomiasis
Leptospirosis
Filaria

We will only use the NESSS which has more robustness due to its available case definition **but the NDR – through the FHSIS can act as far second backup/proxy** but is less reliable for its being passive and having inadequate case definition.

NESSS data will show:

- Trends of diseases by year and month
- Risk factors for disease transmission upon investigation of cases
- Information to formulate hypotheses for disease causation
- Clustering of cases in a geographical area
- Estimates of the effectiveness of intervention measures
- Demographic characteristics of cases – age, gender
- Vaccination status of cases with EPI diseases
- Estimates of case fatality ratios (CFR)

NESSS data will not show

- Incidence rates
- Prevalence rates

HOW TO DESCRIBE CURRENT DISTRIBUTION AND BURDEN OF CLIMATE-SENSITIVE HEALTH DETERMINANTS

Below is a **working matrix to guide us in our health V&A assessment** in the areas using the climate sensitive diseases as the identified vulnerability.

Climate Change and Health V&A Assessment Flowchart			
Step 1 **Identify/Screen Health Vulnerability in area/ community**	**Step 2** **Conduct analysis (Quantitative/ Qualitative)**	**Step 3** **Identify action to be taken**	**Step 4** **Evaluate and feedback**
• Presence of Diseases (determine climate sensitivity; consider epidemic potential) ‣ Consider number of cases, occurrence of disease	• Utilize sentinel sites NESSS/ MET for weather parameters • Focused Group Discussions/KII	• Preventive (adaptation) over curative (mitigation) parameters • Prioritize measures ‣ Efficiency versus effectiveness ‣ Cost/Timeframe ‣ i.e. Information drives/mass screening, smearing for febrile people, fast lane for Dengue • Policy formulation for health impacts- climate change compliance /resilience	• Utilize statistical analysis and correlate adaptation measures • Identify indicators of success (intermediate and long term) • Refine flowchart to incorporate other factors (i.e. socio-economic)
• Availability of response mechanisms ‣ health infrastructure (human and financial/infra – health centers/ hospitals			
• Occurrence of extreme weather events (quantity and quality)			

We know that the usual category for looking at changing disease patterns refer to social health determinants; in this section we have added the environmental health dimension of climate and categorized this vulnerability under it.

However, classification/ graduation of climate sensitivity has not been done as parameters for this have not been laid out. This will need further disease transmission dynamics studies in order to know the indicators of how one disease can be more climate sensitive than others.

This is where we specifically used the lens of **looking at diseases** to focus on **'climate sensitive'** ones. These are diseases which are mediated by the changes in climate parameters. So diseases that are brought by vectors –water borne, vector borne and those that become engaged with the host-vector life cycle (ie. Dengue and malaria, schistosomiasis, typhoid, cholera among others) have seen to figure in this section, as their transmission is affected by changed in weather.

HOW TO ASSESS IMPACTS OF AND VULNERABILITIES TO CLIMATE CHANGE

- Project both the disease incidence and the trends versus the four weather parameters into future scenarios covering 20 years (2020) and 40 years (2050).

- Array these against the four weather parameters projected within the same timeframe. The average/mean daily and monthly recordings of the four variables of weather (temperature, rainfall, relative humidity/precipitation and wind) which will be reflective of climate in the long term will be arrayed with the average monthly/annual number of cases of the 'sentinel diseases' deemed climate sensitive; initially these are Dengue, Malaria, Filariasis, Schistosomiasis and Cholera.

- Quantitative analysis using a linear regression model will try to establish association and trends.

- This will be looked at historically and the same disease trends/averages will be projected into the timeframe future scenarios of 2020 and 2050.

- Historical validated NESSS data (1987-2009) as baseline and projected to the timeframes 2020 and 2050; official NESSS sentinel sites (hospital) gathering; Met office correlation from the same sites (radius from hospital 50 km) will be identified as earlier reported.

The following table details the methodology:

<table>
<tr><th colspan="2">Methodology</th></tr>
<tr><th>Quantitative</th><th>In Process</th></tr>
<tr><td>❖ Gather Data from NEC/HIS DOH - (30-50 years) of NESSS diseases; culled out from Pilot areas of district hospital (sentinel site)
❖ Climate Sensitive (five): Malaria, Dengue, Schistosomiasis, Filaria and Cholera and get the average year on number of cases
❖ Array them against climate data (50 years) from MET stations nearest to the district hospitals from where data was gathered
❖ Do correlation using statistical analysis (Linear regression) between factors –diseases and weather parameters (Temperature, Humidity…)
❖ Feature statistically significant correlations (trends) towards essential diseases as possible sentinels</td><td>❖ Hypothesis:
➢ The notifiable diseases – Dengue, Malaria, Cholera, Filariasis and Schistosomiasis are NOT sensitive to climate change.
❖ Variables for relationship testing
➢ Temperature
➢ Rainfall
➢ Relative humidity/Precipitation
➢ Wind
❖ Data Requirements and Sources
➢ Number of cases reported for dengue, malaria, cholera, filariasis, schistosomiasis, and other selected diseases by quarter from 1987-2007
(Data source: National Epidemic Sentinel Surveillance System)
➢ Quarterly average of temperature (°C), rainfall (mm/day), relative humidity (%), and wind speed (mps) recorded from 1987-2007 (Data source: PAGASA)
❖ Data Analysis
➢ Determine if linear relationship exists among selected notifiable diseases and climate change variables
➢ For variables with existing linear relationship, quantify the relationship to determine how changes in climates affect occurrences of notifiable diseases
❖ Measure of Relationship
❖ Pearson Correlation
➢ Measures the strength of a linear relationship between two quantitative variables
➢ There is a positive relationship if generated value is close to +1; negative relationship if close to -1, and no relationship if zero.
❖ Linear Regression
➢ Quantifies the linear relation between variables when the value of one variable are affected by changes in the values of the other variables
➢ Helpful in assessing how well the dependent variable can be explained by knowing the value of independent variable/s
➢ Helpful in identifying which variable is most effective for estimating the dependent variable
❖ Data Processing and Analysis Software
➢ Statistical Package for Social Sciences (SPSS)</td></tr>
</table>

HOW TO DETERMINE ADAPTATION MEASURES NEEDED TO REDUCE POTENTIAL NEGATIVE HEALTH IMPACTS

This can be done with a validating initial round of **qualitative analysis - ground exercise of consultation** of key stakeholders

The provincial investment plans for health (PIPH) of the areas was likewise reviewed as additional substantiation material for possible adaptation strategies which can be identified and corroborated.

The consultation was done in plenary using a **general survey question guide** with the following:

a. What are the immediate past and existing disease occurrences (whether outbreak proportion or not but was otherwise noticeable)
b. How many of the population were affected (percentage or specific if available)
c. What were the responses of the LGU/concerned agencies to the noticeable increase in the diseases (human and financial)
d. What were the cross sector responses
e. What were the weather conditions prevailing at the time of the increased incidence
f. What other contribution factors outside of the weather could have been present at the time

The following table details the methodology:

Methodology	
Qualitative	**In-Process**
❖ Consultation/Focused Group Discussions in the areas for validation of data (questionnaire) ➢ Health personnel ➢ Community	❖ Guide Questions (General Survey) ➢ What are the immediate past and existing disease occurrences (whether outbreak proportion or not but was otherwise noticeable) ➢ How many of the population were affected (percentage or specific if available) ➢ What were the responses of the LGU/concerned agencies to the noticeable increase in the diseases (human and financial) ➢ What were the cross sector responses ➢ What were the weather conditions prevailing at the time of the increased incidence ➢ What other contribution factors outside of the weather could have been present at the time

GAPS, CONSTRAINTS AND BARRIERS

The V & A assessment for the health sector has its inherent constraints and barriers.

- Not all the personnel may have training up to the level of the municipality/province
- Not all hospitals in the provinces have NESSS training, or not sentinel hospitals
- We will be missing cases that do not go to the hospital (those that are not so severe)
- The NESSS data is not a rate, it is a trend since it counts cases at a certain time (does not have a denominator ie. population)
- The meteorological office may not be present in the province or may be very far (next province)

Part III

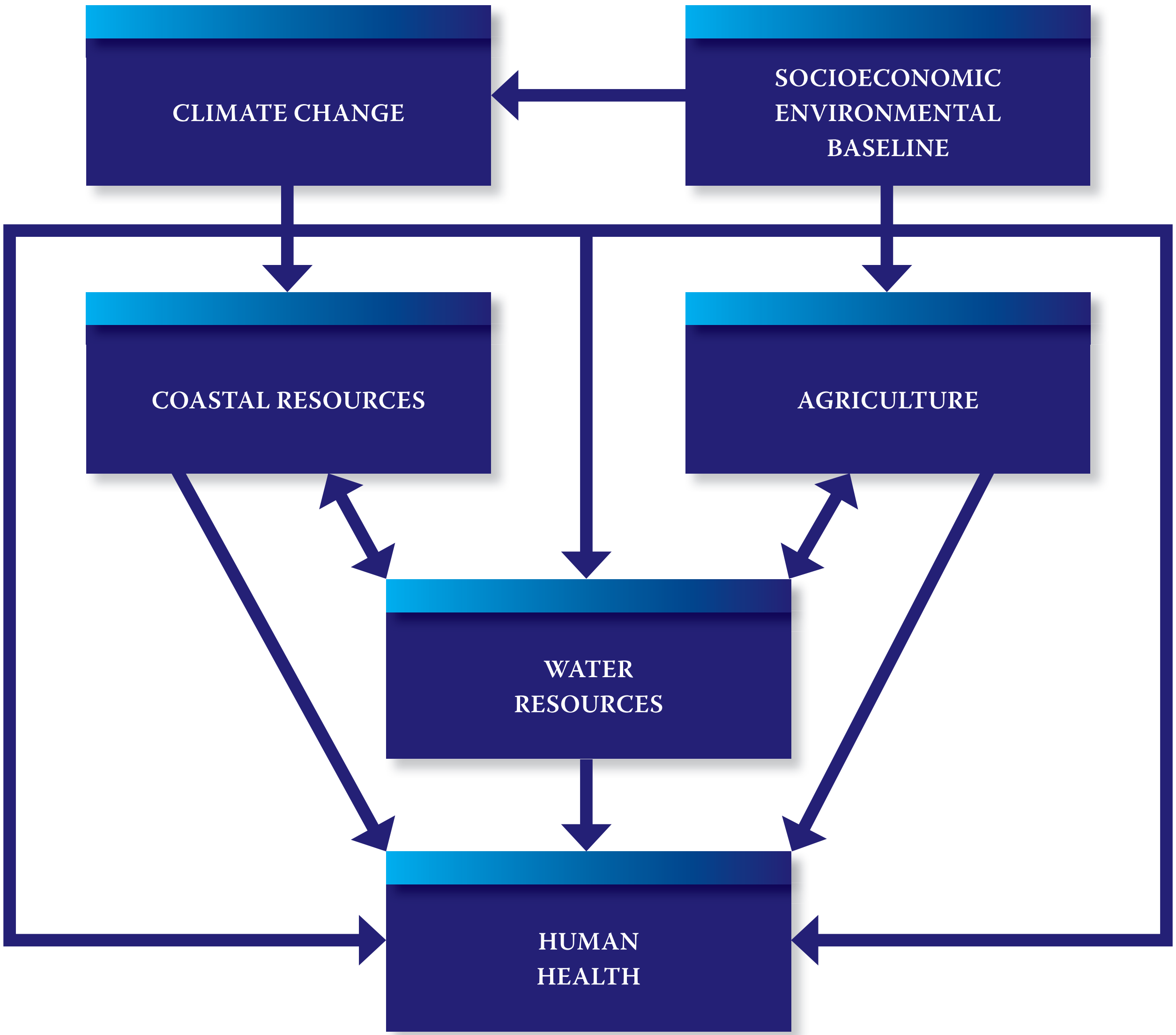
INTEGRATION AND PRIORITIZATION

INTEGRATION

To produce a comprehensive vulnerability and adaptation (V & A) assessment, the individual sectoral data collected from the preceding chapters needs to be viewed in a holistic and coordinated approach for the development and implementation of adaptation options / strategies. This approach also needs to be incorporated when prioritizing adaptation options so that an adaptation measure selected by one sector does not create a negative impact on another sector e.g. promoting aquaculture as a way to ensure food security (agriculture) does not further deplete coastal resources (fish fry/ stock from the sea; mangroves cut to provide areas for fishponds).

- Impacts do not happen in isolation
    - Impacts in one sector can adversely or positively affect another
    - Some sectors are affected directly and indirectly
    - Others just indirectly
    - Sometimes a change in one sector can offset the affect of climate change in another sector
- In addition, integration is necessary for ranking vulnerabilities and adaptations

RELATIONSHIPS AMONG CLIMATE CHANGE, WATER SUPPLY AND AGRICULTURE



TYPES OF INTEGRATION

There are 2 main types of integration:

1) **Cross-Sector Integration**

Cross-sector integration links two or more related sectors and is a good way to initially approach integration.
Various qualitative methods, including expert judgement can be used and descriptive tables compiled to identify the links between sectors.

e.g. Simple integration of climate change impacts			
Climate change	First order impacts	Second order impacts	Responses/feedbacks
Drier climate	Water supply ↓	Agricultural production ↓	Increased demand for water for irrigation, potentially further reducing water supplies.
Wetter climate	Vegetation cover ↑ Standing water ↓	Human health ↓	Wetter conditions increase potential for disease transmission. One possible response is increased use of pesticides, which has the potential to harm natural vegetation.

Another way to display qualitative results is through figures for a more visual representation:

2) **Multi-Sector Integration**

Multi-sector integration is concerned with a much broader scale, generally an entire economy or system. The aim is to understand how a society as a whole may be affected by climate change.

Integrated assessment methods and economic models can be used in this type of approach.

To be effectively applied, multisector integrations need to be as comprehensive as possible, i.e., covering as many affected sectors, regions and populations as possible. In addition, it is helpful, although not necessary, that a common indicator be used, such as the number of people affected or monetary impact, which allows for direct comparison of magnitude and summing of impacts across sectors.

There are both relatively simple and more complex methods for quantitatively combining results across many sectors, regions or affected groups.

Simple quantitative integration involves listing of impacts using a common indicator, often monetary units. This is particularly appropriate for economic sectors because they place a monetary value on goods and services. Results from non-economic sectors, such as human health or biodiversity, can be expressed in monetary terms, but because these sectors are not market sectors (they are not typically traded in markets), such monetary valuations can be complicated to develop, involve much uncertainty and may not be meaningful to all potential users of results.

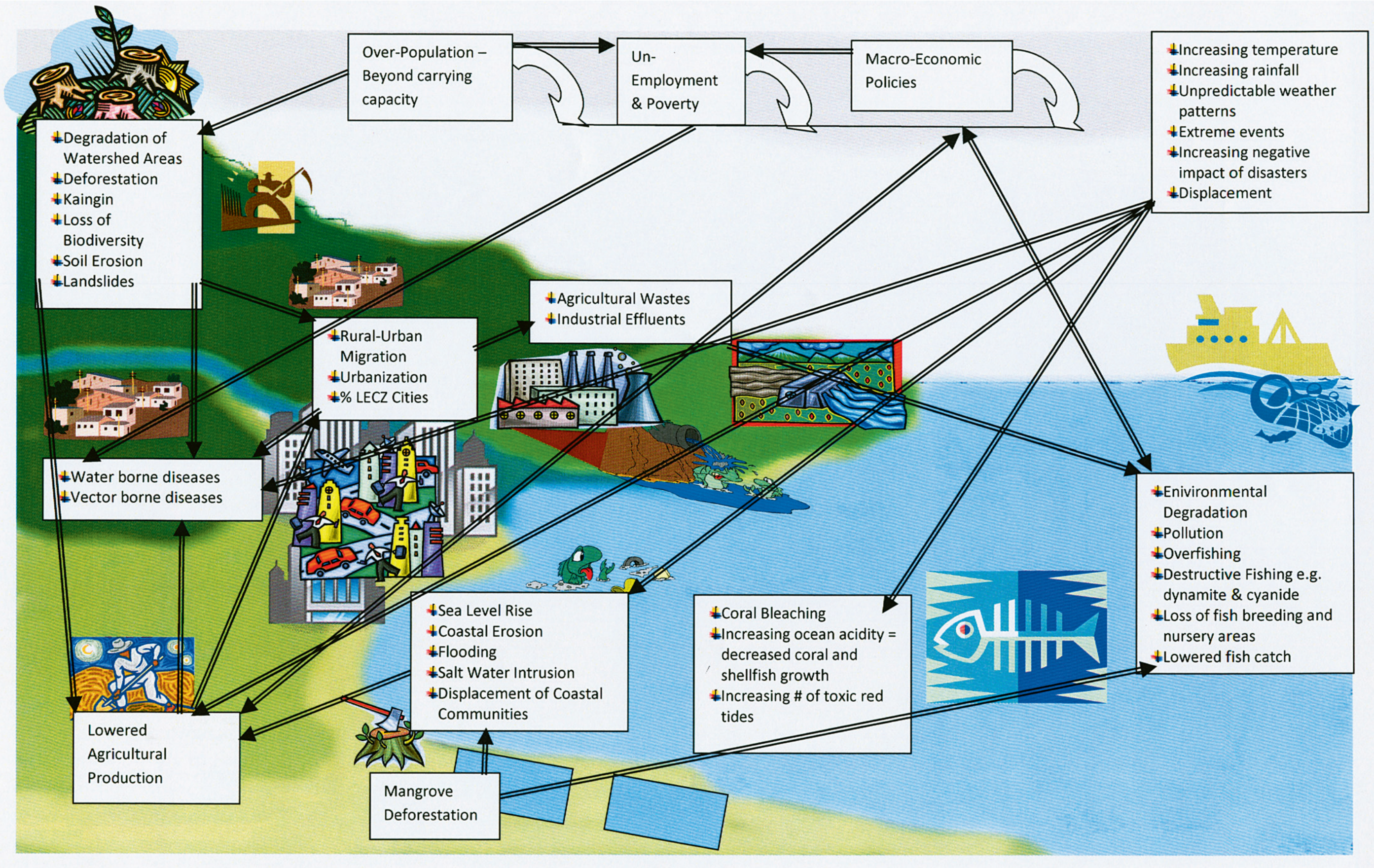
A much more complex method is to apply macroeconomic models. Such models have been used to examine integrated impacts of climate change on whole countries. The advantage of applying these models is that they can identify how costs of damages from or adaptation to climate change can reverberate throughout a country's economy.

Summary

At a minimum integration should at least qualitatively identify linkages and possible direction of impacts.

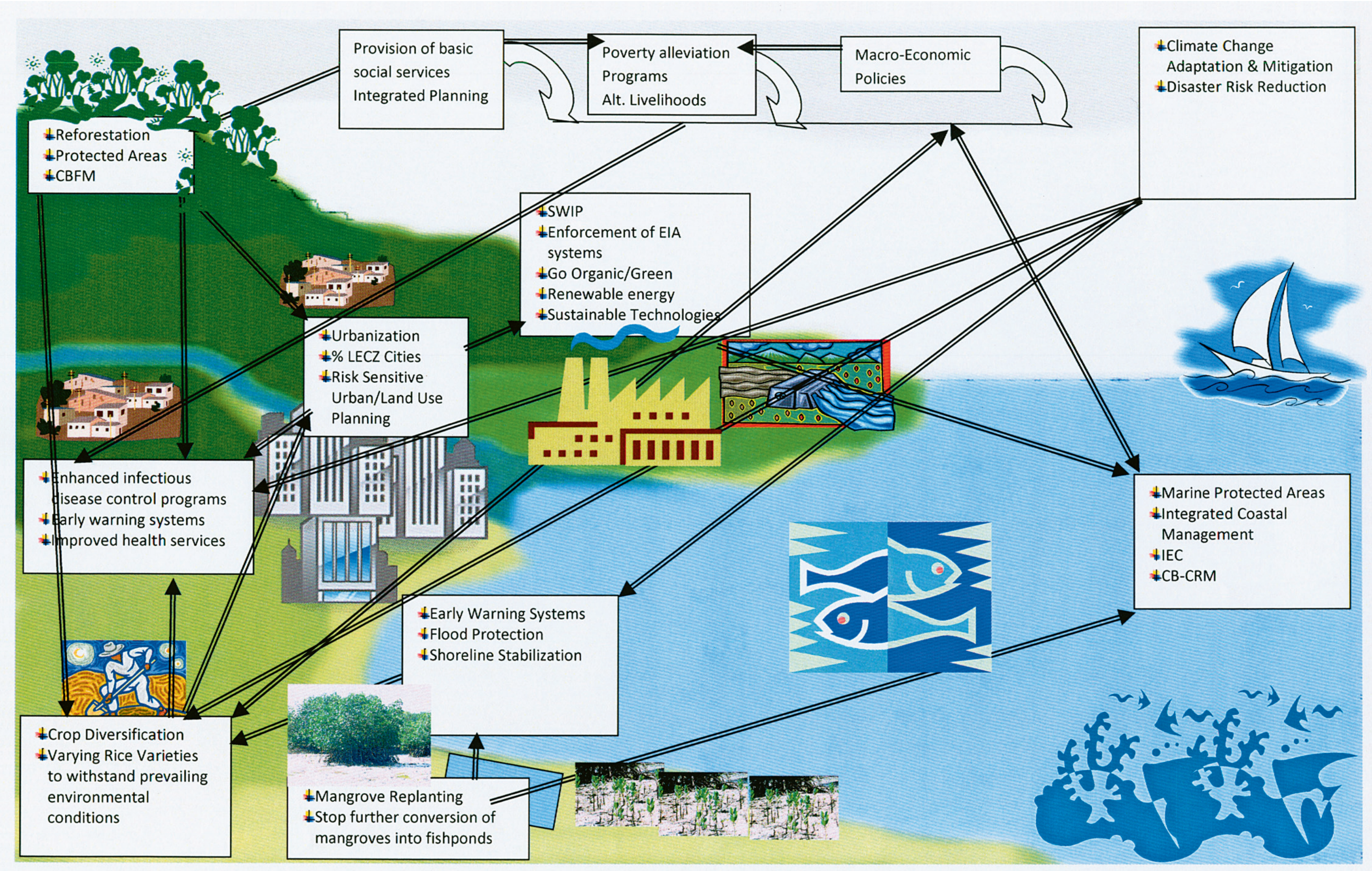
A disadvantage is that models must be built for each application. These can be complicated and expensive to undertake.

Philippine Vulnerabilities Cross Sector Integration



Adapted from Taylor, S.E. 2000

Philippine Adaptation Measures Cross Sector Integration



Adapted from Taylor, S.E. 2000

PRIORITIZATION

It is important to design integrated adaptation strategies that sufficiently identify trade-offs, synergies and conflicts among key sectors.

The V & A assessment identifies existing vulnerabilities and adaptation strategies together with potential additional vulnerabilities and strategies to cope (adaptation measures). The previous section deals with integrating these strategies across sectors to assist in producing a shortlist i.e. eliminating from the list those that have adverse impacts in other sectors. Ranking of vulnerabilities can also help to prioritize adaptation measures.

The shortlist of adaption strategies can be prioritized based on:

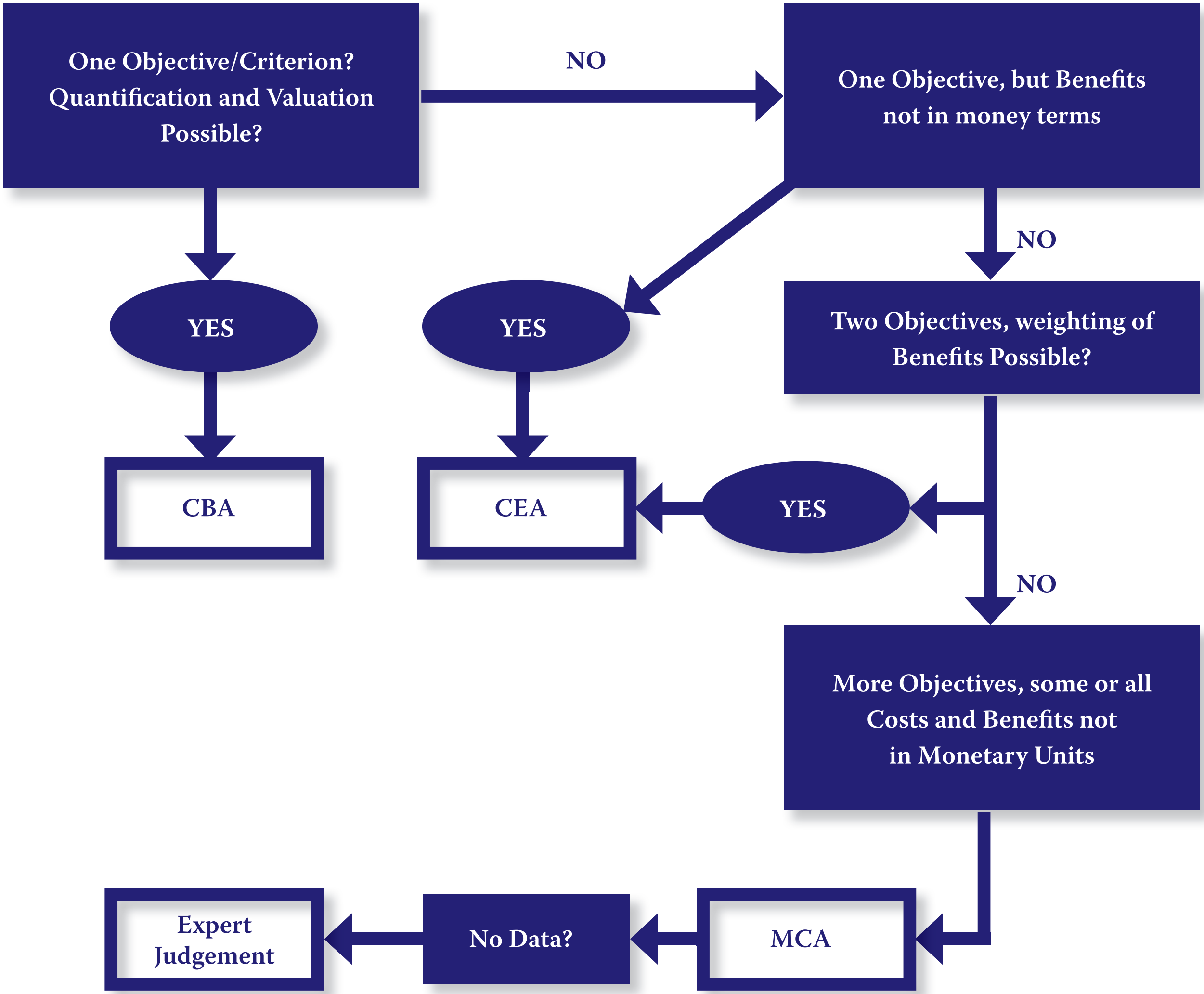
a) How likely they are to be effective (efficacy)
b) How easy they are to implement (feasibility)
c) How acceptable they will be to those affected by them (acceptability)

Feasibility and acceptability might be based on considerations of cost through cost-benefit studies but non-financial and qualitative criteria can also be as important e.g. availability of technological expertise; social and cultural considerations.

It is especially important to involve all stakeholders including policy makers in this process to reduce conflict but also to gain maximum information in prioritizing local issues.

TOOLS FOR PRIORITIZATION

How to Choose a Tool for Prioritization (UNFCCC Guidelines):



- MCA – Multi-Criteria Analysis – normally used for ranking of options
- CBA – Cost Benefit Analysis
- CEA – Cost Effectiveness Analysis – only produces a ranking

a) **Multi-Criteria Assessment**

Matrices are the best way to assist in ranking e.g.:

Options	Effectiveness	Feasibility	Acceptability	Cost	Score
A	**3**	**2**	**1**	**2**	**8**
B	**2**	**4**	**4**	**4**	**14**
C	**5**	**1**	**2**	**3**	**11**

Hypothetical example of a multi-criteria assessment. Criteria are arbitrary. Scores are given on a 1-5 scale and added without weighting in the final column. Weights can be applied to columns to reflect relative importance of criteria.

This is the best known and used method for involving stakeholders especially at the grassroots level. The criteria/indicators to assess the options should also be chosen in a participatory manner for maximum results.

b) **Cost Benefit Analysis**

- Estimate all benefits and costs in a common metric to determine whether benefits > costs
- Monetary values often used

!

- Difficulty: what to do about nonmarket benefits or uncertainties
- Difficulty: requires much data and analysis

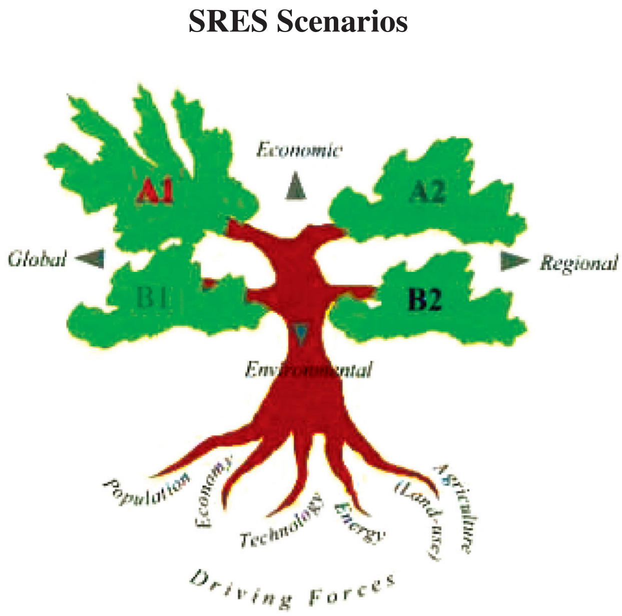
Part IV

ANNEXES

Storylines for the Emission Scenarios

The IPCC published a new set of scenarios in 2000 for use in the Third Assessment Report (Special Report on Emissions Scenarios - SRES). The SRES scenarios were constructed to explore future developments in the global environment with special reference to the production of greenhouse gases and aerosol precursor emissions. The SRES team defined four narrative storylines (see Figure 21), labelled A1, A2, B1 and B2, describing the relationships between the forces driving greenhouse gas and aerosol emissions and their evolution during the 21st century for large world regions and globally. Each storyline represents different demographic, social, economic, technological, and environmental developments that diverge in increasingly irreversible ways.

Fig. 21: Schematic illustration of the four SRES storylines



In simple terms, the four storylines combine two sets of divergent tendencies: one set varying between strong economic values and strong environmental values, the other set between increasing globalization and increasing regionalization. The storylines are summarized as follows (Nakicenovic et al., 2000):

- A1 storyline and scenario family: a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies.

- A2 storyline and scenario family: a very heterogeneous world with continuously increasing global population and regionally oriented economic growth that is more fragmented and slower than in other storylines.

- B1 storyline and scenario family: a convergent world with the same global population as in the A1 storyline but with rapid changes in economic structures toward a service and information economy, with reductions in material intensity, and the introduction of clean and resource-efficient technologies.

- B2 storyline and scenario family: a world in which the emphasis is on local solutions to economic, social, and environmental sustainability, with continuously increasing population (lower than A2) and intermediate economic development.

List of Links to Online Information Sources

IPCC

The Fourth Assessment Report (AR4) contains reports of three working groups (WGs) and a synthesis report under the following link:
http://www.ipcc.ch/ipccreports/assessments-reports.htm

National Communications to the UNFCCC

Under the UNFCCC, developing countries are obliged to submit so-called National Communications. These normally include information on climate change impacts and adaptations in the particular national contexts. Most countries have published at least one National Communication.
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

National Adaptation Programmes of Action

NAPAs (national adaptation programmes of action) provide a process for Least Developed Countries (LDCs) (and only for them) to identify priority activities that respond to their urgent and immediate needs with regard to adaptation to climate change. They normally include information on climate change impacts and possible adaptation measures.
http://unfccc.int/cooperation_support/least_developed_countries_portal/submitted_napas/items/4585.php

World Bank Climate Portal

The World Bank Climate Portal provides a rich variety of country specific climate change information.
http://sdwebx.worldbank.org/climateportal/

Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat

World Population Prospects: The 2008 Revision,
http://esa.un.org/unpp

CRED/OFDA International Disaster Database

The EMDAT database provides global disaster statistics, including country-level disaster profiles.
http://www.em-dat.net/

Disaster Risk Index

A country-by-country tool to assess disaster risk, developed by UNEP's Global Resource
http://gridca.grid.unep.ch/undp/

Glossary of Terms

Adaptation is defined by the IPCC as, "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Smith et al., 2001, p. 881). Note that the definition includes observed as well as anticipated future changes in climate. Thus, adaptation can be happening in response to perceived change in climate or in anticipation of future change in climate.

> ***Autonomous adaptation*** is considered to be adaptations made by affected entities, such as individuals, societies or nature, in response to observed or perceived changes in climate.
>
> ***Anticipatory or proactive adaptation*** is made to reduce risk from future changes in climate.

Baseline Climate. Climatic conditions that are representative of the present day or recent climatic trends for a given period of time in a specific geographic area. It describes average conditions, spatial and temporal variability and anomalous events over the baseline period.

Exposure essentially answer the question of who or what is at risk to climate change (i.e., what is *exposed* to climate change) and the change in climate. So, it includes:

- The population (e.g., people, species) that can be affected by climate change
- Settlements and infrastructure that can be affected by climate change
- Natural resources that can be affected by climate change
- The nature of climate change itself, e.g., change in sea level, temperature, extreme events.

Forecast/Prediction. When a *projection* is designated "most likely" it becomes a forecast or prediction. A forecast is often obtained using physically-based models, possibly a set of these, outputs of which can enable some level of confidence to be attached to projections.

Impact of climate change is typically the effect of climate change. For biophysical systems it can be change in productivity, quality, or population numbers or range. For societal systems, impact can be measured as change in value (e.g., gain or loss of income) or in morbidity, mortality, or other measure of well-being (Parry and Carter, 1998).

Projection. The term "projection" is used in two senses in the climate change literature. In general usage, a projection can be regarded as any description of the future and the pathway leading to it. However, a more specific interpretation has been attached to the term "climate projection" by the IPCC when referring to model-derived estimates of future climate.

Risk is the compounding effect of the hazard (climate change, variability and extremes), exposure and vulnerability.

Scenario is a coherent, internally consistent and plausible description of a possible future state of the world (IPCC, 1994). It is not a forecast; rather, each scenario is one alternative image of how the future can unfold. A projection may serve as the raw material for a scenario, but scenarios often require additional information (e.g., about baseline conditions). A set of scenarios is often adopted to reflect, as well as possible, the range of uncertainty in projections. Other terms that have been used as synonyms for scenario are "characterization", "storyline" and "construction".

Climate Change Scenarios – describe plausible future changes in climate variables and are usually measured with respect to baseline climatic conditions and are derived primarily from climate model simulations combined with (observed) climate baselines.

Sensitivity is defined by the Intergovernmental Panel on Climate Change (IPCC) as "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. Climate-related stimuli encompass all of the elements of climate change, including mean climate characteristics, climate variability, and the frequency and magnitude of extremes. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea-level rise)" (McCarthy et al., 2001, p. 6).

Vulnerability is defined by the IPCC as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity" (McCarthy et al., 2001, p. 6). The greater the exposure or sensitivity, the greater is the vulnerability; the greater the adaptive capacity, the lower is the vulnerability. An assessment of vulnerability must consider all these components to be comprehensive.

Annex IV: References

BACKGROUND / PURPOSE

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