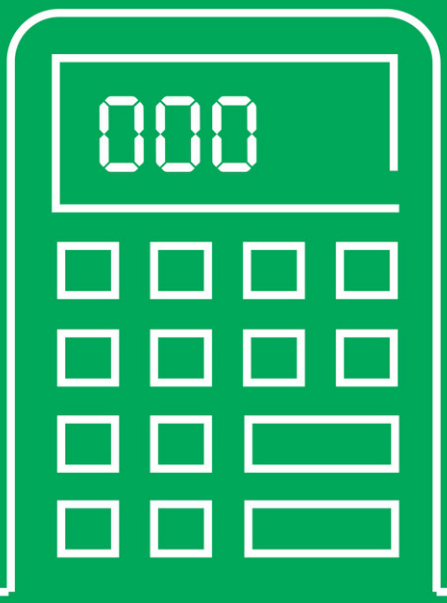
ENVIRONMENT AND NATURAL RESOURCE ACCOUNTING (ENRA)

Communities For Resilience (CORE)



TRAINING MANUAL

Environment & Natural Resource Accounting Training Manual

About the CORE Series

The Communities for Resilience (CORE) is a flagship capacity-building program of the Climate Change Commission (CCC). CORE aims to help poor and highly vulnerable communities adapt to climate change and reduce their risk to extreme weather events and natural hazard impacts.

CCC developed a compilation of user-friendly manuals intended to increase competencies of national and local government institutions, civil society, private sector, and local communities on disaster risk management; climate change adaptation and mitigation; and mainstreaming of climate change and disaster risk reduction in local development planning and decision-making.

Dubbed as the CORE series, these tool kits were demonstrated in several pilot cities and municipalities to converge efforts on local climate action, and to integrate lessons learned from its implementation. These will also continue to undergo a series of enhancements based on current updates and innovations relevant to building resilient communities, and will not necessarily be limited to a step-by-step guide of modules and manuals.

Similarly, other tools will be developed in the future as part of the series in the form of videos, best practice case studies, etc.

This initial set of seven manuals was reviewed and vetted by the Commission's National Panel of Technical Experts (NPTE) in November 2017.

The CORE Series are available at www.climate.gov.ph.

Acknowledgment

This publication is part of the CORE Series initiated by the Climate Change Commission (CCC). This series of toolkits is based on scientific research, available literature and relevant works.

This module is a result of the collaboration between the **Climate Change Commission (CCC)** and the **Global Green Growth (GGGI)** with the technical support of the Resources, Environment and Economics Center for Studies (REECS), Inc.

We would also like to acknowledge the Commission's National Panel of Technical Experts (NPTE), whose members contributed competent technical guidance and informed discussions that brought various perspectives into focus.

SECRETARY EMMANUEL M. DE GUZMAN
Executive Director, Climate Change Office
Vice-Chairman, Climate Change Commission
Bulwagan Ninoy, Ninoy Aquino Parks and Wildlife Center
North Avenue, Diliman, Quezon City 1101

Website: www.climate.gov.ph
Email: info@climate.gov.ph
Telephone: (63 2) 426-2948/ (63 2) 426-2950
Telefax: (63 2) 925-8954

ISBN: 978-621-95649-9-1

Preface

Efforts to defeat poverty and promote social justice will be difficult to sustain unless measures are undertaken to help poor and highly vulnerable communities adapt to climate change. Changes in temperature and precipitation patterns, sea level rise, and extreme weather events can easily undermine development gains that the country has attained in recent years.

The Philippines posting the highest average increase in sea level since 1901 immediately puts at risk 13.6 million Filipinos living in coastal areas across the archipelago. Studies from the Philippine Atmospheric, Geophysical and Astronomical Services Administration and the University of the Philippines have also shown that current and future shifts in temperature and rainfall regimes will have significant impacts, mostly adverse, on our agriculture, forestry, water and coastal resources, health, and urban areas – bearing serious implications on our food and water security, energy sufficiency, human security, and ecological and environmental stability.

Meanwhile, destructive weather events will continue to pose a direct threat on our people and overall socio-economic development. From our country's experience with typhoons Yolanda (2013), Pablo (2012), Sendong (2011), Ondoy (2009), and Frank (2008), we already know that reconstruction costs take a substantial chunk off of our national budget. This challenge even becomes more daunting as we center rebuilding efforts on making communities more resilient to both sudden and slow onset of the impacts of climate change.

The country has already made progress in confronting climate change since the enactment of the Philippine Climate Change Act in 2009 and the Philippine Disaster Risk Reduction and Management Act in 2010. For its part, the Climate Change Commission (CCC) has been very active in promoting climate change action on both domestic and international fronts. But much remains to be done.

As early as 2009, the United Nations Office for Disaster Risk Reduction identified three non-climatic factors responsible for the continuing escalation of disaster risks worldwide, most notably in developing countries. These are poor urban governance, vulnerable rural livelihoods, and declining ecosystems. Because of inherent "multidimensional inequalities," the poor and highly vulnerable communities end up experiencing more the adverse impacts of climate change.

It is in this context that CCC's Communities for Resilience (CORE): Convergence Program is conceptualized and implemented. The Commission understands that building resilience requires a whole-of-society approach and that the starting point for this is the integration of disaster risk reduction and climate change adaptation and mitigation into the development policies, plans and programs of the national government and local government units (LGUs), especially in areas that are highly susceptible to the impacts of climate change.

The CORE initiative specifically aims to strengthen the planning capacity and overall resilience of LGUs along the country's 18 major river basins– areas which are sensitive to temperature changes, rain-induced floods, drought, sea level rise, extreme weather events, and other water- and weather-related hazards. All in all, the CCC is bringing its flagship capacity-building program on climate change to 48 provinces, 56 cities, and 777 municipalities that are vulnerable to climate change, with the goal of covering all the 80 provinces and 1745 LGUs and cities as it rolls-out the CORE initiative.

The CORE program neither aims to reinvent the wheel nor duplicate past and ongoing efforts by other government and non-government actors in the disaster and climate change communities. Rather, it seeks to build on existing partnerships, adopt tested tools and methodologies, and harmonize different approaches from various sectors, including non-government organizations, private sector and the academe.

State Universities and Colleges, in particular, will be tapped for their resources and expertise on research, tools development, and capacity building. Under the CORE program, regional academic institutions will undergo training in science- and risk-based action planning for climate change to strengthen their capacities in guiding local decision makers and LGU planners on Vulnerability and Risk Assessment, Environment and Natural Resource Accounting, Natural Resource Assessment, Greenhouse Gas Inventory, Climate Change Expenditure Tagging, Geographical Information System, and in accessing financing windows that support climate change initiatives.

This publication is one of those training manuals. The menu of methodologies and tools being offered under the CORE program is intended to raise national awareness and competence on climate change actions among national and local government institutions, civil society, private sector, and communities, including students from Grades K to 12. To LGUs, it is hoped that this would serve as a useful and practical guide as they prepare or enhance their Local Climate Change Action Plans (LCCAP).

SEC. EMMANUEL M. DE GUZMAN
Vice Chairman and Executive Director
Climate Change Commission

Contents

List of Tables

List of Figures

Acronyms

ANI	Adjusted National Income
ANS	Adjusted National Savings
CC	Climate Change Commission
CCDRA	Climate Change and Disaster Risk Assessment
CDP	Comprehensive Development Plan
CDRVA	Climate and Disaster Risk Vulnerability Assessment
CLUP	Comprehensive Land Use Plan
CORE	Communities for Resilience
CVM	Contingent Valuation Method
DENR	Department of Environment and Natural Resources
EDP	Environmentally Adjusted Gross Domestic Product
EEA	Experimental Ecosystem Accounting
ENI	Environmentally Adjusted National Income
ENRA	Environment and Natural Resource Assessment
FDES	Framework for the Development of Environment Statistics
GDP	Gross Domestic Product
GNP	Gross National Product
GGGI	Global Green Growth Institute
GHG	Greenhouse Gas
GIS	Geographic Information Systems
GVA	Gross Value Added
LCCAP	Local Climate Change Action Plan
LCEs	Local Chief Executives
LGUs	Local Government Unit(s)
MEB	Material Energy Balance
M & E	Monitoring and Evaluation
NCCAP	National Climate Change Action Plan
NEDA	National Economic Development Authority
NNP	Net National Product
NRA	Natural Resource Assessment
NSCB	National Statistical Coordination Board
PEENRA	Philippine Economic, Environmental and Natural Resources Accounts
PET	Potential Evapotranspiration
REECS	Resources, Environment and Economics Center for Studies
SNA	System of National Accounts
SUCs	State Universities and Colleges
TEEB	The Economics of Ecosystems and Biodiversity
ToT	Training of Trainers
UN SEEA	United Nations System of Environmental and Economic Accounting
VRA	Vulnerability and Risk Assessment
WTA	Willingness to Accept

Definition of Terms

Ecosystem - is a dynamic complex of plant, animal, and micro-organism communities, and their non-living environment interacting as a functional unit.

Ecosystem Accounting - is a coherent and integrated approach to the assessment of the environment through the measurement of ecosystems, and measurement of the flows of services from ecosystems to economic and other human activity.

Ecosystem Asset - Naturally occurring entities that provide environmental "functions" or services.

Ecosystem Condition - is the capacity of that ecosystem to yield services, relative to its potential capacity.

Ecosystem Services - are the benefits provided by ecosystems that contribute to make human life both possible and worth living.

Environment and Natural Resources Accounting - integrating complex biophysical data, tracking changes in environment, and linking those changes to economic and other human activity.

Environmental Goods and Services - environmental products are goods and services that are produced for the purpose of preventing, reducing, and eliminating pollution and any other degradation of the environment (environmental protection - EP), and preserving and maintaining the stock of natural resources, hence safeguarded against depletion.

Exchange Value - the quantified worth of one good or service expressed in terms of the worth of another. In political economy and especially Marxian economics, exchange value refers to one of four major attributes of a commodity, i.e., an item or service produced for, and sold on the market. The other three aspects are use value, economic value, and price.

Gross Value Added - (GVA) in economics, is the measure of the value of goods and services produced in an area, industry, or sector of an economy. In national accounts, GVA is output minus intermediate consumption; it is a balancing item of the national accounts' production account.

Land Accounting - Land accounting that measures the change in the land and its attributes resulting from the impacts of human and natural activities.

Market Value - the highest estimated price that a buyer would pay and a seller would accept for an item in an open and competitive market; the amount for which something can be sold in a given market.

Natural Capital – from the definition of the Wealth Accounting and the Valuation of Ecosystem Services (WAVES), natural capital is the world's stocks of natural assets, which include geology, soil, air, water, and all living things. It is from this Natural Capital that humans derive a wide range of services, often called ecosystem services, which make human life possible. Natural capital includes all of the resources that we easily recognize and measure, like minerals, energy, timber, agricultural land, fisheries, and water. It also includes the ecosystem services that are often "invisible" to most people, such as air and water filtration, flood protection, carbon storage, pollination of crops, and habitats for wildlife. These values are not readily captured in markets, so how much these contribute to the economy are not really known. These services are often taken for granted, and humans don't know what it would cost if these are lost.

Natural Resource Accounting - is an accounting system that deals with stocks and stock changes of natural assets comprising biota (produced or wild), subsoil assets (proved reserves), water and land with its aquatic and terrestrial ecosystems.

Non-Market Value - Most environmental goods and services such as clean air and water, and healthy fish and wildlife populations, are not traded in markets. Its economic value –how much people would be willing to pay for these- is not revealed in market prices.

Physical Accounts - refer to the natural resource and environmental accounting of stocks and changes in stocks in physical (non-monetary) units, for example, weight, area, or number.

Resource Rent - in economics, rent is a surplus value after all costs and normal returns have been accounted, i.e., the difference between the price at which an output from a resource can be sold and its respective extraction and production costs, including normal return.

Total Economic Valuation - total of the values including direct, indirect, option, and existence values of the natural resources; a concept in cost-benefit analysis that refers to the value derived by people from a natural resource, a man-made heritage resource, or an infrastructure system, compared to not having it. It appears in environmental economics as an aggregation of the (main function based) values provided by a given ecosystem. Those include use and non-use values.

Valuation - appraising or estimating the worth of something having economic or monetary value.

Wealth Accounting – is the measure of the value of all the assets of worth owned by a person, community, company, or country. Wealth accounting is measuring the physical and total market value of all the physical and intangible assets of the entity.

Willingness to Accept (WTA) - is the minimum amount of money that a person is willing to accept to abandon a good or to put up with something negative, such as pollution.

Willingness-to-Pay - is the maximum amount an individual is willing to sacrifice to procure a good or avoid something undesirable. The price of any goods transaction thus is any point between a buyer's willingness to pay and a seller's willingness to accept.

I. Introduction

1.1 Overview of the Module

The conduct of Environmental and Natural Resource Accounting (ENRA) is recommended to establish a baseline of resources and ecosystem services, provide basis for appropriate pricing of these resources and ecosystem services, to inform policy, initiate green income accounts, and monitor the impact of climate change adaptation on local economic development. The ENRA can also be used as a tool to support local actions that address the prevalence of poverty among communities living within various land-use zones in supposedly resource-rich areas. It is recognized that marginalized people are dependent on resources found within these areas. These residents are vulnerable to human-induced and natural disasters. Only when their vulnerable status is decreased can natural resources truly serve its purpose of providing resilience against the adverse impacts of climate change.

The goal is to develop an accounting framework at the local level to produce an estimate of the contribution of natural resources to local economic and other human activities. This estimate, for instance, the local Gross Domestic Product (GDP), should reflect or indicate sustainability of natural resources, and the contribution of ecosystem services in the local economy. A provincial, island, or municipal GDP, much less "green" GDP, is uncommon, and a review of literature revealed that none exists in the country. Readers may refer to the dissertation of Castillo (Castillo, 2001) for a review of natural resources accounting frameworks and related studies, and why is there a need for local environment and natural resources accounts.

Much of the efforts towards development of environment and natural resources accounts in the country were undertaken through the United States Agency for International Aid (USAID)-funded ENRAP projects, but its scope was either national, sectoral, or site-specific accounts, and much remains to be done. Inputs from environmental scientists, other social scientists and ecologists are needed to come up with physical estimates of regulating, cultural and supporting ecosystem services, after which, a valuation follows. Nonetheless, the accounts developed are flexible for future adjustments to include additional sectors and even ecosystem services.

What is important is that the accounts can be used for local planning and decision-making. Whether it is municipal or provincial is largely defined by the scope of decision-making. Much of the decision-making is at the municipal level, so much so that the ENRA was designed for use at the municipal level.

At the end of the Communities for Resilience (CORE) Initiative training program, trainers will be able to:

- Acquire basic understanding of the application of ENRA in climate change adaptation and mitigation planning;
- Acquire basic skills to apply selected tools for ENRA development;
- Acquire basic skills to build the accounts of selected natural resources;
- Acquire an overview of linking ENRA to municipal accounts.

1.2 Brief Description

The entire CORE Initiative Training of Trainers (ToT) is designed to be experiential with technical inputs from resource persons on the methodologies and exercises from cases. The ToT demonstrates a mix of participatory and adult learning approaches. The training will involve lectures and simple group interaction exercises

1.3 Relevance of the Module for Trainers

Local development planning that integrates climate change resilience needs to account the impact of local economic and human activities on its natural capital, including flow of ecosystem services. Natural capital is especially important to local government units because it makes up a large share of its total wealth. Ecosystem services on the other hand, help sustain the flow of natural resource inputs to economic and other human activities. Local managers and planners however, have limited expertise

in measuring and accounting natural capital to support its decisions toward sustainable local development. Local managers and planners need inputs from experts to develop local environmental-economic accounts. However, local experts in environment and natural resource accounting are in short supply, such that there is a need to train a cadre to support these local managers and planners.

1.4 Summary of Topics

In view of the level of participants, this Module for Trainers covers the foundations, origins, and concepts of environment and natural resource accounting, and the various frameworks presently accepted as international standards, such as the United Nation System of Environmental and Economic Accounting (UN SEEA) Central Framework, and the currently suggested Experimental Ecosystem Accounting (EEA) Guidelines. The ToT also covers methods and tools of physical and monetary accounting, and integrating the accounts in local development plans and programs. Participants are to experience at least one standard tool, and learn from cases of ENRA in the Philippines. The main topics covered are summarized in Table 1.

Table 1. Topics covered in the ToT with corresponding objectives and training approaches

Topics Covered	Objective	Approach
Foundations of ENRA		
• Economic foundations of ENRA	At the end of the module, participants will acquire basic knowledge of the economic foundation of ENRA.	Prior to the lectures, there will be a diagnostic examination to gauge the knowledge of participants. There will be a written examination after the Module. Lecture-discussion and exercises.
• Use of ENRA for score-keeping and policy development		
Environment and Resource Accounting		
• Introduction to the UN System of Economic and Environmental Accounting	At the end of the session, participants will acquire basic knowledge of UN SEEA.	Lecture-discussion in plenary.
• Economic valuation approaches and Discounting	At the end of the session, participants will acquire basic knowledge of valuation approaches.	Lecture-discussion prepared exercises.

Topics Covered	Objective	Approach
• Land Resource Accounting	At the end of the session, participants will acquire basic knowledge of the methodology on accounting and valuing land resources.	Lecture-discussion prepared exercises.
• Forest Resource Accounting	At the end of the session, participants will acquire basic knowledge of the methodology on accounting and valuing forest resources.	Lecture-discussion prepared exercises.
• Fishery Resource Accounting	At the end of the session, participants will acquire basic knowledge of the methodology on accounting and valuing fishery resources.	Lecture-discussion prepared exercises.
• Environmental Waste Disposal Services	At the end of the session participants will acquire basic knowledge of the methodology on accounting and valuing EWDS.	Lecture-discussion prepared exercises.
Developing Municipal ENRA		
• Development of Physical Account • Physical Accounts for Uplands/Forests • Physical Accounts for Agriculture and Urban • Physical Accounts for Coastal and Marine	At the end of the session, participants will have an overview of different tables and maps of physical accounts of environment and natural resources	Lecture and case presentation (Case: Siargao Island and San Vicente ENRA)
• Social Accounting Approach to Generating the Municipal Accounts • SAM Accounting matrix • Simple monetary accounts of the Physical Accounts	At the end of the session, participants will acquire basic knowledge of social accounting methodology.	Lecture and case presentation with discussion.

Topics Covered	Objective	Approach
• Estimating Generating Gross Value Added	At the end of the session, participants will acquire basic knowledge on using social accounting data in building a municipal account.	Lecture-discussion in plenary followed by an exercise.
ENRA and Climate Change		
• Use of NRA and ENRA for Local CC Mitigation & Adaptation Planning	At the end of the module, participants will gain understanding on how NRA-ENRA can be used in CC adaptation and mitigation planning.	Lecture-discussion followed by an Experts' panel discussion.
• Use of NRA-ENRA in policy development		Lecture-discussion followed by small group discussions on CC policy implication of ENRA.
• Module Evaluation		There will be self-evaluation and written examination to gain progress from the result of the diagnostic to knowledge after the training sessions. The participants will also be asked to evaluate the training program and suggest improvements.

II. Manual Content

2.1 What is ENRA?

Environmental and natural resource accounting deals with measuring and valuing the stocks and stock changes of natural assets comprising biotic and abiotic resources, including subsoil assets, water and land with its aquatic and terrestrial ecosystems. Valuation in natural resources and its capital is emphasized in order to be linked to indicators of economic growth in order to support policy and decisions at the national and local level.

This module covers orientation on various economic indicators such as GPD, Net National Product (NNP), and NNS, which are used as indicators of economic growth, and its inadequacy as measures of growth, hence must be adjusted. Discussions on sustainability of environmental and natural capital and use of alternative measures of economic growth, in view of the goal of sustainable economic growth and climate change resilience are covered by lectures. Historical discussions on environmental accounting and it origins provide the backdrop to the current demand for ENRA. Part of the discussion includes how the UN SEEA frameworks came about.

This includes presentation of various approaches used in different countries prior to the development of an internationally-accepted standard of environmental and natural resource accounting. The general categories of approaches include:

- Identification and reclassification of environmental expenditures;
- Physical resource accounting approaches;
- Depreciation of marketed natural resources (Adaza, 1992), including macro-economic aggregate adjustment (El Serafy and Lutz); and
- Full environmental and natural resource accounts with valuation, which is the approach promoted by The Economics of Ecosystem and Biodiversity (TEEB)

This section includes presentation of the UN SEEA Central Framework and the UN SEEA Experimental Ecosystem Accounting Guide, both of which are linked to the System of National Accounts.

UN SEEA Central Framework

The System of Environmental and Economic Accounting (SEEA) Central Framework is a multi-purpose conceptual framework that describes the interactions between the economy and the environment, and the stocks and changes in stocks of environmental assets.

- Using a wide range of information, the SEEA Central Framework provides a structure to compare and contrast source data and allows the development of aggregates, indicators, and trends across a broad spectrum of environmental and economic issues. Particular examples include the assessment of trends in the use and availability of natural resources, the extent of emissions and discharges to the environment resulting from economic activity, and the amount of economic activity undertaken for environmental purposes.
- At the heart of the SEEA Central Framework is a systems approach to the organization of environmental and economic information that covers, as completely as possible, the stocks and flows that are relevant to the analysis of environmental and economic issues. In applying this approach, the SEEA Central Framework integrates the accounting concepts, structures, rules, and principles of the System of National Accounts. In practice, environmental-economic accounting includes the compilation of physical supplies and use tables, functional accounts (such as environmental protection expenditure accounts), and asset accounts for natural resources.
- The integration of information concerning the economy and the environment requires an interdisciplinary approach. The SEEA Central Framework brings together, in a single measurement system, information on water, minerals, energy, timber, fish, soil, land and ecosystems, pollution and waste, production, consumption, and accumulation. Each of these areas has specific and detailed measurement approaches that are integrated in the SEEA Central Framework to provide a comprehensive view.
- The concepts and definitions that comprise the SEEA Central Framework are designed to be applicable across all countries, regardless of the level of economic and

statistical development, economic structure, or composition of the environment.

- The SEEA Central Framework also provides a foundation for related topic and theme-specific statistical publications. There has already been substantial work on the topics of water and fisheries, a publication on energy is under development, and there are future plans for publications covering the topics of agriculture and land.
- The SEEA Central Framework is accompanied by two related parts: the SEEA Experimental Ecosystem Accounts, and SEEA Extensions and Applications. The expected content of these parts is outlined later in this section.

UN SEEA Experimental Ecosystem Accounting

- SEEA Experimental Ecosystem Accounting extends the range of flows measured in physical and non-monetary terms. The SEEA Central Framework focuses on the flows of materials and energy that either enter the economy as natural inputs, or return to the environment from the economy as residuals. Many of these flows are also included as part of the physical flows recorded in ecosystem accounting (i.e., flows of timber to the economy). In addition, SEEA Experimental Ecosystem Accounting includes measurement of ecosystem services that are generated from ongoing ecosystem processes (such as the regulation of climate, air filtration, and flood protection) and from human engagement with the environment (such as through recreation activity).
- SEEA Experimental Ecosystem Accounting considers environmental assets from a different perspective compared to the SEEA Central Framework. Environmental assets, as defined in the Central Framework, "are the naturally occurring living and non-living components of the Earth, together comprising the biophysical environment that may provide benefits to humanity." This scope is broader than the physical asset boundary used in the System of National Accounts (SNA) which is limited to assets that have an economic value in monetary terms. Thus, for example, in the SEEA all land is included regardless of its value. This broad scope encompasses two complementary perspectives on environmental assets. The first perspective, which the SEEA Central Framework's focus, deals with environmental assets in terms of individual resources (i.e., timber, fish, minerals, land, etc). The second perspective, which the SEEA Experimental Ecosystem Accounting's focus, considers the biophysical environment through the lens of ecosystems in which various biophysical components (including individual resources) are seen to operate together as a functional unit. Thus, ecosystem assets are environmental assets seen from a systems perspective.

2.2 Why is ENRA important in the CORE Initiative?

As the national government pushes towards increasing autonomy in local governance, local government units (LGUs) are compelled to look at its internal resources if it can support the local economy. Compounding the pressure is the threat of climate change hazards that pose continuing threats to communities' resilience. Always, many economic production activities are severely hampered by such calamities increasingly degrading natural resources. It therefore imposes upon the municipality to have continuing information on the status of its resources, including all forms of local capital to sustain the local economy and strengthen community resilience. Knowing the condition and extent of LGU's its natural capital will help define alternatives when climate change hazards weaken its capacity. Beyond organizing the information, creating the link to local economy will help build concrete actions.

Accounting of the environment and natural resources is essential because the productivity of the ecosystems and its natural resources are linked to the productivity of economic production entities. The municipality must have an accounting of its natural resources in order to know if its economic activities can be sustained through local production to meet consumption needs. The results of accounting form the basis of every development plan. Consequently, effective policy responses must be exhibited at all levels of governance. As bulk of decision making and direct control over natural resources are being

exercised at the municipal level, a municipal account serves as a tool for decision-making and policy implementation.

This sub-topic discusses in brief detail the inadequacies of economic growth measures, and identifies the missing components of these indicators. This includes explanations on:

- How depreciation measures neglect other forms of capital such as a nations' stock of water, soil, air, non-renewable resources, and wildlands;
- Natural and environmental resources as generally not included in balance sheets;
- Failure of cleanup costs to take into account previous environmental damages; and
- Non-trading of many environment and natural resource goods and services in markets.

These constitute the main basis for the development of environment and natural resources accounting methods that are intended to be linked to economic indicators.

2.3 Processes in ENRA

Overview of Process

The process of developing ENRA spins from the conceptual framework of the economy and environment linkage. The conceptual framework provides the main rational for the valuation method and natural resource accounting. The tools used in developing the environment and natural resources accounts at the municipal level includes focus group discussions, key informant interviews, household surveys, map analyses, and modelling of natural resource processes. Applying these tools require expertise from physical, biological, and social science disciplines working on forest, agriculture, coastal and marine, and water sector. Data collection requires field surveys, sampling, discussions with local managers and planners, conduct of workshops, household interviews, and analyses of remote sensing data and mapping. Details of each methodology are provided in separate reports by experts who undertook data collection and analysis of results.

The Conceptual Framework

It is recognized that economic activities use the environment and natural resources (ENR) for inputs in production activities, and as sink of its byproducts. Figure 1 shows the link of environment and natural resources to economic and other human activities. For purposes of clarity, ENR is disaggregated into the different major ecosystems that provide services to these human activities. In the context of economic activities, ENR is distinguished from ecosystems. The former are treated as source of natural capital, whereas the latter provide both natural resources and services needed not only in economic but also other human activities. Terrestrial, aquatic, and marine ecosystems provide renewable and non-renewable resources to support economic activities and also provide ecosystem services, which in most cases are not accounted in economic valuation. Ecosystems' goods and services enter almost all economic production, consumption, aesthetic, and/or cultural needs, and are therefore essential to sustain the well-being of communities. However, the ability of ecosystems to sustain its inputs is governed and influenced by natural processes, climatic changes, extreme or natural calamities, and by human exploitation activities.

Changes due to normal natural processes are of less concern because its effects are regulated and steady. Of greater concern is the exploitation caused by economic and human activities. In the case of renewable resources, the harvest or draw down is replenished by natural growth, provided that sufficient mass or growing stock of resources remains after each event of human exploitation. If human exploitation of the resource exceeds its rate of recovery, the resource stock declines. Once the renewable resource stock declines beyond the threshold or its ability to recover, the result is depletion. In the case of non-renewable resources, recovery takes a longer gestation period so that over the human horizon, it trends towards depletion. The stock of non-renewable resources can rapidly decline if human exploitation intensifies and where exploitation technologies are resource-intensive and inefficient, thereby not maximizing the extraction of the vital resource. Ecosystem capacity is also impacted by byproducts and wastes of human and economic activities, such that if waste discharges exceed its assimilative capacity, the ability to provide inputs is reduced. In turn, a compromised assimilative

capacity produces negative amenity such as air, land, and water pollution, thereby reducing human welfare. Thus, the usefulness of natural resource assessment is in documenting the link of economic and human activities via the drivers and pressures of ecosystem change, and measuring the impacts on the state of the ecosystem.

A forward-looking process of assessment begins with identifying the **DRIVERS (D)** of changes in ecosystems and its provision of services. These drivers are largely dictated by population dynamics, including migration and technological changes. Among the many drivers are agriculture, forestry, fisheries, mineral production, housing and settlements, manufacturing and processing, and urbanization coupled with transportation and energy demands. The intensification of these drivers increases the pressures on the ecosystems and its services. The **PRESSURES(P)** come through different means such as clearing of vegetation, land conversion, logging, farming, infrastructure development, water use and abstraction, waste water discharges, release of pollutants, solid waste discharges, reclamation, expansion of plantations, intensified transportation, discharge of sediments to water bodies, and the likes.

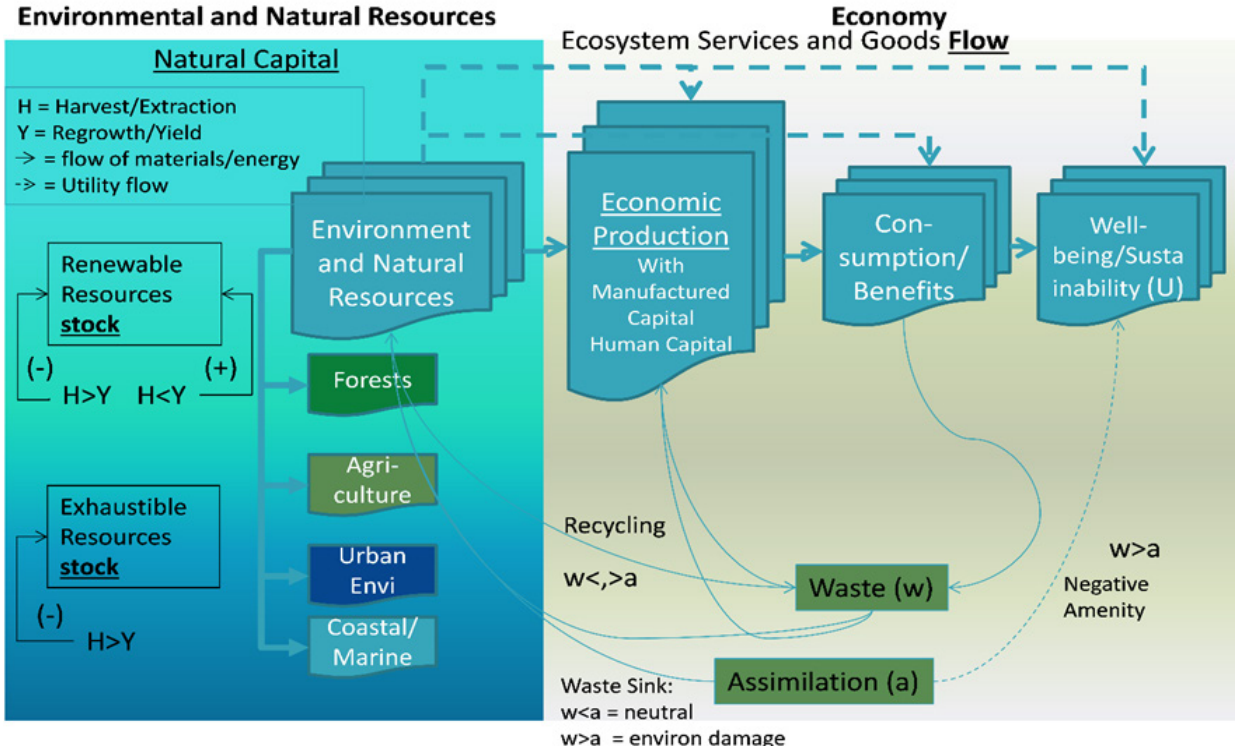


Figure 1. Schematic framework of the NRA

The key element of NRA is to measure the current **STATE (S)** of the ecosystem and its ability to provide ecosystem services in the face of these pressures. The assessments also identify **IMPACT (I)** indicators (i.e., declining, increasing, or sustaining the quantity, quality, and trend) in both physical and monetary terms to provide managers, policy and decision makers with information to make the appropriate **RESPONSES (R)** in order to sustain or conserve the ecosystem and its services. The biological, physical, and monetary accounts developed through the natural resource assessment become the information system that serves as basis for solutions in terms of plans, programs, and legislations at the local, sub-national, and national scale. The information system combines spatial (i.e., maps, images) and time series information (both cross section and panel data), and are presented in appropriate scale, form, and structure understandable for meeting economic growth targets, climate change adaptation measures, assessment of different aspects of resiliency, poverty alleviation, and food security. Thus, natural resource assessment is an essential step in development planning, especially green development.

Physical Processes Modelling

In implementing the framework, the natural resource assessment has both spatial and temporal dimensions. The spatial dimension of the assessment covers natural resources from the "ridge to the reef" –including those in the upland, lowland, coastal and marine ecosystems, or in terms of areas covered such as forests, agriculture, urban, and coastal and marine areas. The temporal dimension requires assessing the changes in condition and capacity of these resources and ecosystems over time. Table 2 summarizes the components that link drivers and associated pressures of ecosystem change to the state and impacts on natural resources. The table is further extended so that data requirements, assessment tools and techniques for NRA are listed:

Table 2. Drivers of ecosystem change and its impact accounts

Drivers of ENR and Ecosystem Changes	Pressure Accounts	State Accounts	Impact Accounts (Ecosystem Services, Condition, Capacity)	Data Needs, Tools and Techniques
(The contents of each cell are illustrative)				
Terrestrial/ Land-based Drivers (Upland and Lowland Ecosystems)				
Agriculture	Clearing of vegetation (Logging, slash and burn, cultivation)	Land cover extent	Land cover change, siltation	Land cover map, two periods
	Monoculture cropping	Pesticide residues	Acid soils and pollution	Land use map
	Irrigation systems and discharges	Water and soil resources	Sedimentation, eutrophication, water deficits	Water balance; Water quality assessment
	Large-scale agriculture discharges	Water resources	Algal bloom, etc.	Water balance; Water quality assessment
	Small-scale farming erosion	Soil erosion/ Surface run-off	Anaerobic conditions reduce oxygen level, leading to fish kills;	Land use maps
				Total suspended solids, soil erosion
		Nutrient and sediment deposits	Increasing alkalinity, thereby promoting anaerobic conditions	

Drivers of ENR and Ecosystem Changes	Pressure Accounts	State Accounts	Impact Accounts (Ecosystem Services, Condition, Capacity)	Data Needs, Tools and Techniques
Forestry	Logging: Clearing and erosion	Timber and non-timber resources; Land cover and soil erosion control	Land cover change	Land cover map; Timber and non-timber assessment
			Rising methane, nitrates, phosphates	
	Slash and burn (Kaingin): Clearing and erosion	Land cover and soil erosion control	Shallowing of water bodies	Remote sense data, FGDs, and HH surveys
	Infrastructure: Clearing and concreting of open areas	Soil erosion, flooding, sediment transport	Water bodies-level rise resulting to flooding of coastal settlements	Remote sense data, FGDs, site visits, and surveys
			Flooding of coastal settlements	Hydrologic modelling, precipitation, and other climate data
Housing and Settlements	Clearing and concreting of uplands and lowlands	Sediment load	Reduction of population of aquatic life	Locations of settlements; land use maps
	Abstraction of water	Seasonal volume of surface water	Increase in population of species (invasive species)	Supply and Use data on water (Supply and Use Accounts)
	Waste water/ effluent discharges	Chemical deposits in water bodies		Field surveys, and remote sensing
	Land development with infrastructures and discharge systems	Volume of Solid wastes		Land use maps, field surveys, and household surveys
		Soil erosion/ Surface run-off		Sediment modelling

Drivers of ENR and Ecosystem Changes	Pressure Accounts	State Accounts	Impact Accounts (Ecosystem Services, Condition, Capacity)	Data Needs, Tools and Techniques
Livestock and poultry	Waste water discharges	Bio-chemical composition of water bodies	Reduction in water quality/ Eutrophication	Sources and Production; ES used
	Solid wastes	Depth of water bodies	Shallowing of water bodies bed	
		Increasing alkalinity	Reduction of water bodies biodiversity and wildlife	
Mining	Open-pit mining: Clearing and soil erosion, sediment transport	Sediment loads	High concentration	Sources and Production; ES used
	Discharge of mine tailings	Chemical deposits in water bodies		Monitoring reports on discharges
Services	Waste water discharges	Chemical deposits in water bodies		
	Transport intensification	Chemical deposits in water bodies		
	Expansion of commercial centers	Air and water quality	Air and water pollution impacting health and work hours	
Energy	Drilling, release of toxic chemicals	Air and water quality	Land cover change, erosion and sedimentation, air and water quality	Air and water quality sampling, soil erosion and sedimentation modelling
Manufacturing and Processing	Extraction of natural resource inputs, release of byproducts to air, soil, and water	Air, soil and water quality, and land productivity	Land cover change, erosion and sedimentation, air and water quality	Air and water quality sampling, soil erosion, and sedimentation modelling
Transportation	Vehicle discharges; Intensified road infrastructures	Chemical deposits in water bodies	Air and water pollution, congestion	Air and water quality sampling

Drivers of ENR and Ecosystem Changes	Pressure Accounts	State Accounts	Impact Accounts (Ecosystem Services, Condition, Capacity)	Data Needs, Tools and Techniques
Tourism	Construction of infrastructure for resorts	Solid wastes		
	Waste water/ effluent discharges	Easements and flood regulation		
Urbanization	Clearing and concreting of uplands: Rapid water flow and sediment discharges	Soil erosion control	Sedimentation	
	Reclamation programs and projects: Landscape change, water bodies area reduction	Rate of sediment flows	Shallowing of some areas	Bathymetry
	Waste water discharges disposal	Chemical deposits in water bodies		
	Intensified infrastructures, highways bordering water bodies			
Fishery	Uncontrolled open-capture fishery and extensive use of efficient gears	Fishery species stock		
	Expansion of cage culture	Habitat quality		
	Excess feeds deposition	Fish kills		
	Expansion of mariculture	Mangrove conversionaland cover change	Mangrove extent decline	Mangrove mapping

Drivers of ENR and Ecosystem Changes	Pressure Accounts	State Accounts	Impact Accounts (Ecosystem Services, Condition, Capacity)	Data Needs, Tools and Techniques
Navigation/ Transportation	Intensified transportation: Congestion and habitat disturbance	Habitat quality		
	Transportation infrastructure: Landscape change	Water quality		
	Waste water discharges	Chemical deposits		
Expansion of coastal settlements	Foreshore infrastructure development			
	Clearing of coastal/mangrove vegetation			
	Introduction of exotic species			
	Introduction of invasive species	Fish composition		
Natural Drivers				
Precipitation	Flooding	Water level, inundated areas and duration	Loss of productive areas	
Sea Level Rise	Tidal intrusion and salinization of farms	Water level, inundated areas and duration; habitat condition	Loss of habitat, reduced productivity	
Storm Surge	Tide intrusion and flooding			
Drought	Reduced water availability			

Drivers of ENR and Ecosystem Changes	Pressure Accounts	State Accounts	Impact Accounts (Ecosystem Services, Condition, Capacity)	Data Needs, Tools and Techniques
Others				

Accounting Process

Figure 2 below summarizes the processes of environment and natural resources accounting, which is similar in many ways with ecosystem accounting processes. These processes are briefly discussed during the training process.

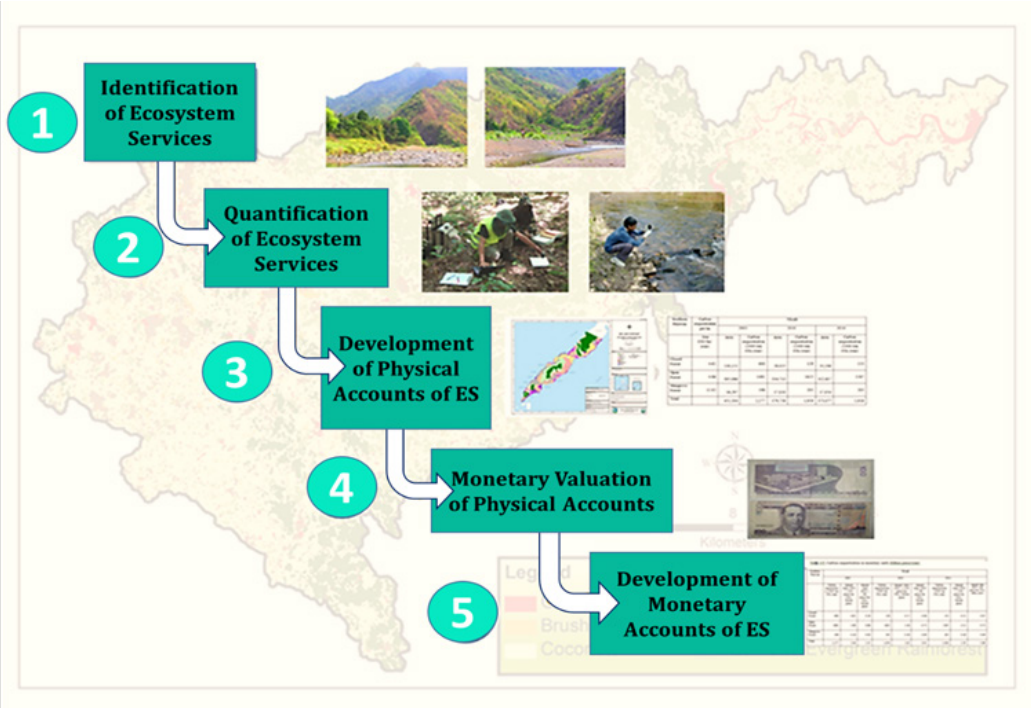


Figure 2. Simplified environment and natural resources accounting process

Familiarization on Ecosystem Goods, Ecosystem Services, Ecosystem Assets, and Ecosystem Condition

Participants need to fully understand and distinguish ecosystem and ecosystem services. This is presented through a PowerPoint presentation of ecosystem goods, ecosystem services, ecosystem assets, ecosystem condition, and categories of ecosystem services and examples. Figure 3 summarizes the relations of environmental goods, services, assets, and ecosystem services and its link to economic accounts.

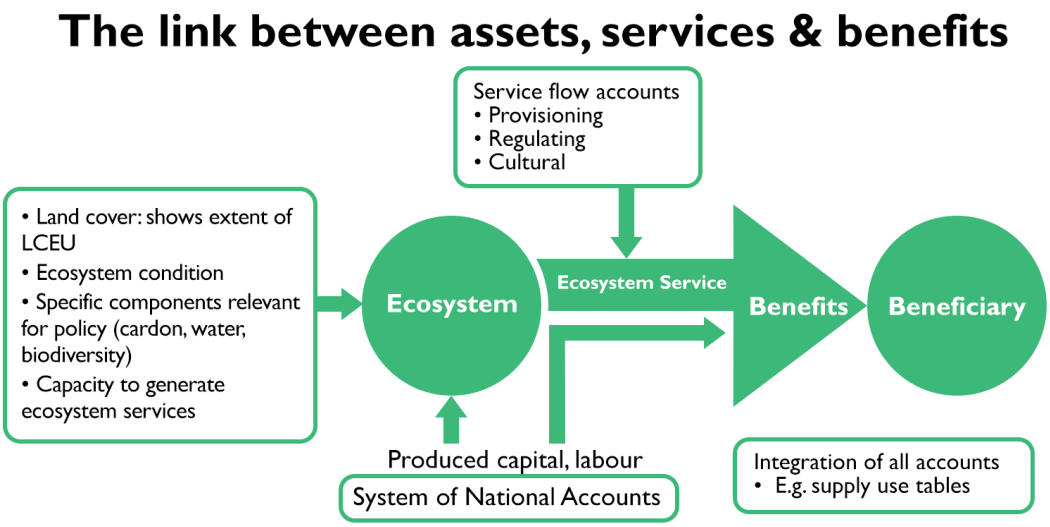


Figure 3. Overview of environmental goods, services, benefits and ecosystems

Physical Accounting Approaches

Prior to the development of the UN SEEA, several countries developed methodologies on physical accounting. Among those that are discussed:

- Material Energy Balance (MEB) approaches, which analyzes material flow between environment and economy;
- Framework for the Development of Environment Statistics (FDES), promoted by the UN Statistical Division that aims to measure the emission of certain residuals of economic activities and its impact on the quality of environment, media; and
- Natural Resource Accounting approaches by various entities, an approach that complements MEB.

Monetary valuation and accounting

The training provides an orientation on valuation methods that range from market to non-market, but the discussion on valuation emphasizes exchange values, in view of the UN SEEA's use of market or exchange value approaches. . Nonetheless, non-market valuation methods, and its differences with market approaches are explained. Figure 4 shows the valuation process which applies to other environment and natural capital.

Valuation

The appropriate valuation approach differs by type of ecosystem service since different ecosystem services contribute to economic and other human activities linked to benefits and well-being in different ways.

In the context of comparing values of ecosystem services with values in the national accounts, the objective is to value the quantity of ecosystem services at market prices that would have occurred if the services had been freely traded and exchanged. This market price reflects consumers' marginal willingness to pay for the ecosystem service at market equilibrium quantity of services. In the case of ecosystem services not traded in a market, alternative approaches to establish a price for the ecosystem, in line with SNA accounting principles, need to be found.

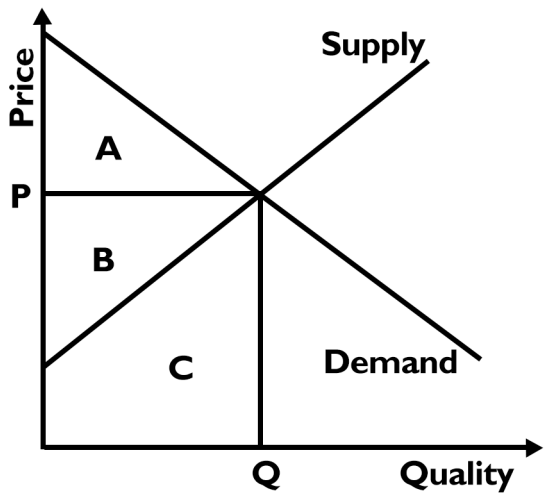


Figure 4. Basic supply and demand curve

For national accounting purposes, the focus of valuation is on the area of producer surplus plus costs of production, i.e., areas B and C. This reflects a concept of exchange value in which, while different consumers may have been willing to pay different prices for a good or service, in practice all consumers pay the same price P. Thus, the total outlays by consumers and the total revenue of the producers is equal to the area B plus C, or equivalently, is equal to P times Q. For accounting purposes, this approach to valuation enables a consistent recording of transactions between economic units since the values for supply and use of products are the same.

1. Consider economic considerations that apply to each of the different broad types of ecosystem services, and then discuss specific approaches that have been developed for the valuation of quantities of ecosystem services:
    a. Provisioning services
    b. Regulating services
    c. Cultural services
2. Identify the most appropriate approach for pricing of ecosystem services:
    a. Valuation of ecosystem services that focus on the measurement of direct and indirect use values (relatively fewer studies including the non-use and option components of total economic value);
    b. Valuation approaches that focus on the extent to which consumers are willing to pay for ecosystem services; and
    c. Valuation approaches that measure the value of degradation of ecosystem services separately (i.e., restoration cost, value of ecosystem resilience, some revealed preference studies):
        i. Combine these approaches which reflect assumptions regarding future degradation, with approaches used to value the current level of ecosystem services; or
        ii. Develop valuation methods that do not require assumptions about current and future use of the ecosystem.
3. Valuation Approaches
    a. Pricing using the unit resource rent - under this approach to valuation, the unit resource rent represents an estimated price for the ecosystem service.
    b. Replacement cost methods - these estimate the value of an ecosystem service based on the costs that would be associated with mitigating actions if it would be lost, as in the case of constructing a water purification plant if the water filtration service of an ecosystem supplying groundwater to an aquifer used for drinking water is impaired.
    c. Revealed preference methods - these determine the value of an ecosystem service based on observations of related market goods.
        i. Production function methods estimate the contribution of ecosystem services to production processes in terms of its contribution to the value of the final product being traded in the market.
        ii. Hedonic pricing methods analyze how environmental qualities affect the price people pay for market products or assets.
        iii. Averting behavior methods are used as an indirect method to evaluate the willingness of individuals to pay for improved health or to avoid undesirable health consequences.
        iv. Travel cost methods are often used to value ecosystem services associated with recreational sites. These methods estimate the value of the ecosystem services based on the amounts consumers may be willing to pay, as reflected in the costs of visiting a recreational site (i.e., transport costs, travel time, visiting time).
    d. Stated preference methods are designed to capture information on people's willingness to pay for ecosystem services without observing an actual payment or transaction.
        i. Contingent valuation studies typically ask respondents to state

a value they attribute to a certain ecosystem asset, ecosystem characteristic or ecosystem service, or the value they place on a project that will preserve that asset, characteristic or service.

ii. Choice experiments ask respondents to select from a range of available options with varying levels of ecosystem services, and corresponding prices for the associated bundle of services.

e. Approaches to modelling exchange values

i. Benefit transfer - much work on valuation has focused on the valuation of ecosystems and ecosystem services in smaller, more targeted settings for specific ecosystems or in relation to particular events, for example the valuation of damages caused by oil spills. There are three main types of approaches to benefit transfer:

- Value transfers
- Benefit function transfers; and
- Meta-analysis' function transfers.

Approaches in Monetary Accounting

1. One way of bringing this information together is to create combined presentations that combine measures in physical terms for ecosystem services and ecosystem assets with standard economic measures, such as value added, income, and employment.

2. A second way of considering ecosystem accounting in monetary terms is to bring together valuations of stocks and flows of ecosystem assets into an ecosystem asset account following the standard asset account structure, outlined in the SEEA Central Framework.

3. A third approach is to use valuations of ecosystem services and ecosystem assets in monetary terms to augment the standard national accounts and aggregates.

A suggested approach is to combine physical measurements and monetary values for use in local planning and decision i.e., integrating physical and monetary accounts into local municipal or provincial accounts.

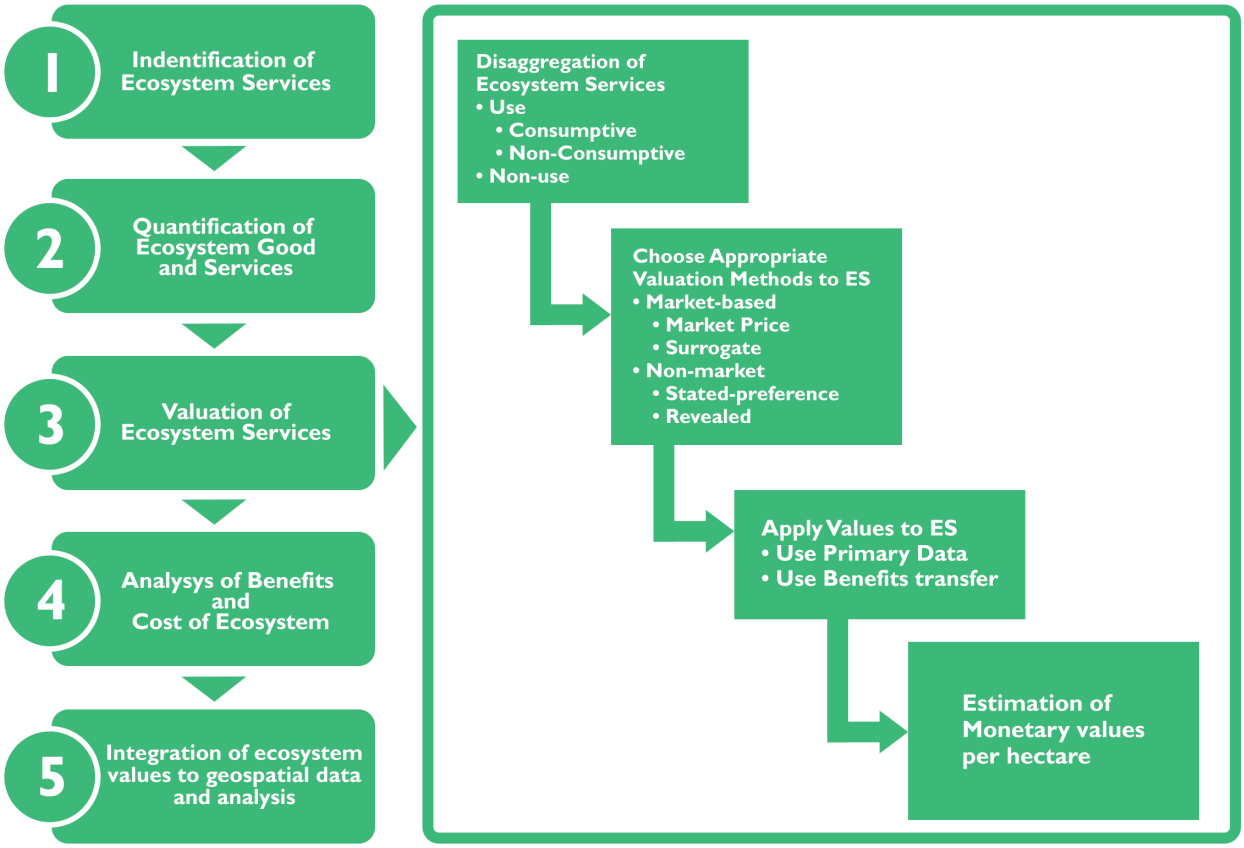


Figure 5. Framework for valuation of environment goods and services

The choice of valuation method is defined by the natural capital or ecosystem services being valued and its connection with economic and other human activities, i.e., tourism and recreation. The following valuation methods are discussed:

1. If goods are connected with market transactions: market valuation;
2. If the use of natural assets is not connected with market transactions, valuation methods include: welfare approaches based on Willingness to Pay/ Willingness to Accept (WTP/WTA), Hedonic Property prices, Wage-risk, travel cost method and related methods. Other indirect methods are indirect cost measurement, opportunity cost approach, defensive expenditures, prevention costs, and damage cost approaches. Figure 6 shows a dichotomy of valuation methods.

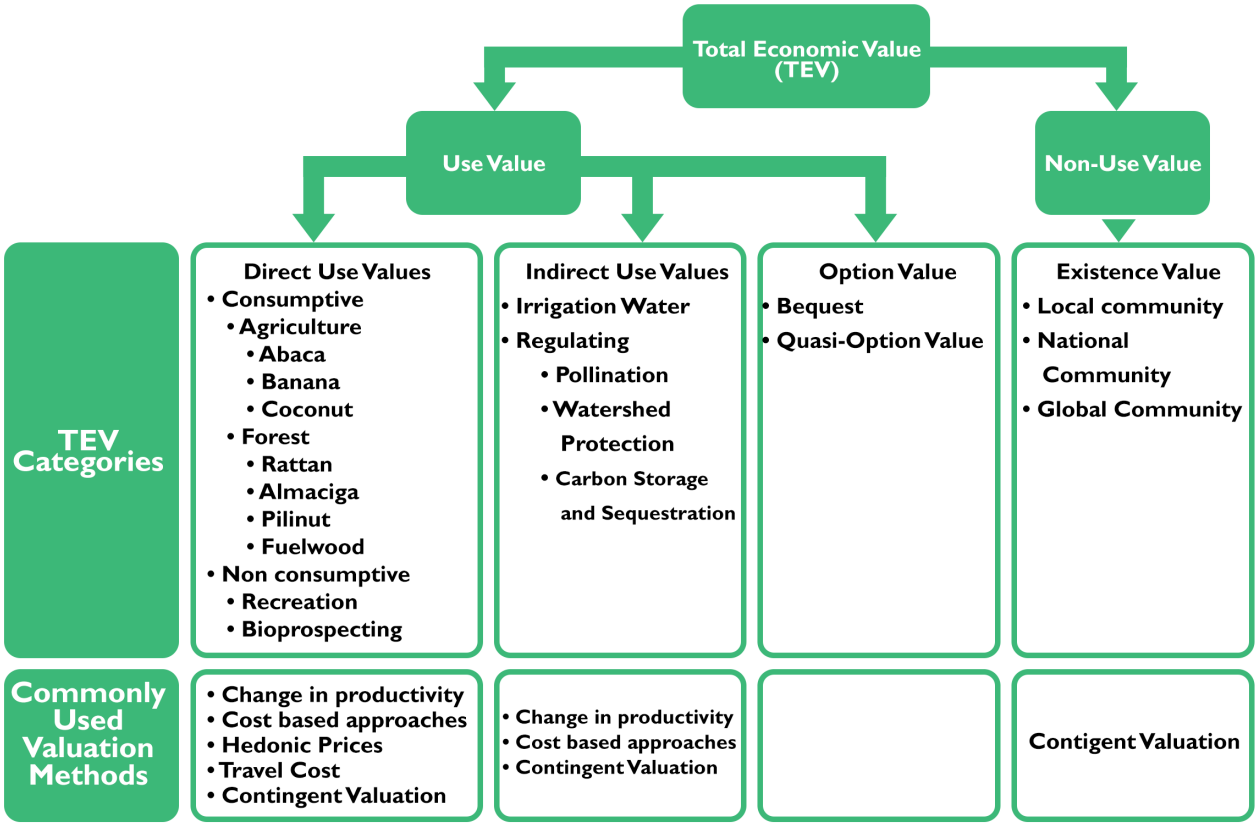


Figure 6. Typology of valuation methods applied in ENRA

2.4 Case Analysis of Environment and Natural Resource Accounts

In order to reinforce learning of the tools, methods, and processes of environmental capital including ecosystem accounting, case examples in the Philippines are used. The following cases are to be presented and analyzed during the training.

Simultaneous with KIIs is collection of secondary data. Secondary data refers to data that is collected by another project or previous research, other than the current user. Common sources of secondary data for developing the accounts include censuses, information collected by government departments, organizational records, and data originally collected for other research purposes. KIIs and secondary data collection are undertaken through visits, and progress as the team comes in contact with local sources of information.

Case 1: ENRA of municipalities in Siargao Islands
One key case to demonstrate methods on data collection and development of ENRA are the nine (9) municipalities in Siargao Islands. This demonstrates the conduct of ground collection methods such as Key Informant Interviews, Focus Group Discussions, Household Surveys, and Coastal Resource Assessment.

The case analysis uses the example of Del Carmen in Siargao Islands as model that to include accounts for different sectors.

Case 2: ENRA of San Vicente, Palawan
The ENRA of San Vicente, also developed by REECS, used a different approach to develop accounts and integration into local economic and government accounting system. The accounts took the approach based on expenditure and savings.

Case 3: Ecosystem Accounts for Southern Palawan
The Wealth Accounting and Valuation of Ecosystem Services (WAVES) of the World Bank piloted the ecosystem accounting guidelines of the UN SEEA Experimental Ecosystem Accounting. The accounts include provisioning services, and regulating services from forest to coastal ecosystems. The training demonstrates how regulating services of ecosystems are developed.

Case 4: Ecosystem Accounts for Laguna Lake Basin
The ecosystem accounts in the Laguna Lake Basin were also developed through the WAVES project of World Bank. The ecosystem accounts focused on fisheries, water pollution, water supply, sedimentation, and soil erosion. The training uses the example of sedimentation and water accounts, particularly in modelling to develop the physical accounts.

2.5 Tools for ENRA

ENRA has spatial and temporal dimensions of the natural resource assessment that require various tools to construct the accounts. Maps of the extent of natural resources that include land area, land use, and land cover, are derived through image processing and analysis. Land Use Change Analysis are performed to determine the difference in terms of resource stock within the period covered, and relate it to the municipality's socio-economic characteristics. Following spatial data collection, socio-economic information and other pertinent data are collected through key informant interviews, focus group discussions, conduct of household surveys, market and establishments' survey. Details of each method are described in the next sections

Key Informant Interviews and Secondary Data Collection

Key informant interviews are informal and formal interviews with people who know what is going on in the locality. The purpose of key informant interviews is to collect information from a select group of people—including community leaders, professionals, or residents—who have firsthand knowledge about the locality. KIIs are avenues for knowing where to gather key information on the municipality such as socio-economic profile, population and number of households, and business activities that include reports of programs and projects previously implemented. These include officially reported income and expenditure statements, comprehensive land use plans, legislative agenda, maps, agricultural production, fishery, and urban-focused information such as solid waste management plans. The information gathered through these activities feeds into the synthesis and summary that form part of municipal accounts development.

Simultaneous with KIIs is collection of secondary data. Secondary data refers to data that is collected by another project or previous research, other than the current user. Common sources of secondary data for developing the accounts include censuses, information collected by government departments, organizational records, and data originally collected for other research purposes. KIIs and secondary data collection are undertaken through visits, and progress as the team comes in contact with local sources of information.

Focus Group Discussions

A more in-depth approach to collecting information about economic activities and status of resources is through focus discussions. A focus group maybe defined as a group of interacting individuals having some common or varied background and characteristics brought together by a facilitator, who uses the group and its interaction as a way to gain information about a specific or focused issues. FGDs have multiple purposes:

- Initial opportunity for the project team to get to know the locality;
- Systematically obtain socio-economic and spatial information, and economic activities, as well as environment and natural resource issues in the locality;
- Orient participants who are key sector representatives of the project's intention; and
- Inform key sector representatives of possible applications of the gathered data in land use and other municipal plans.

Household Surveys

Household surveys collect detailed and diverse socio-demographic data pertaining to household characteristics, income and expenditure, economic and other household activities, perceptions and attitudes pertaining to issues, and knowledge of local conditions. The survey includes cultural information which influence behavior, as well as social and economic change.

The household survey is designed to gather information regarding the socio-economic profile of project areas, and the households' utilization/ management of natural resources available in their communities. Duration of a survey is approximately one to two (2) hours per household. Local enumerators are hired to administer the survey questionnaire. An on-site pilot testing of the household survey is done prior to the actual run of the said activity.

The survey team is composed of the project's research associates who serve as coordinators that provide orientation and training to checkers and enumerators, manage household surveys in assigned areas, and check the quality of accomplished household survey forms. Checkers who are responsible for checking the quality of accomplished household survey forms, are also hired. Enumerators' tasks are to guide and assist respondents in completing the household survey questionnaire and ensure collection of household data.

Determination of Sample Size for Household Survey

The Census of Population and Housing is the key source to estimate sample size. The census provides only household size per municipality/city, population per municipality/city, and population per barangay.

Household survey size per municipality/city is computed using the equation below with the following parameters: a) Confidence Interval of 90%; and b) Margin of Error of 6%.

$$\frac{\frac{z^2 \times p \times (1-p)}{e^2}}{1 + \left(\frac{z^2 \times p \times (1-p)}{e^2 \times N}\right)}$$

Where z is the z-score of corresponding confidence interval; p is the normal distribution set at 50% (most conservative assumption); e is the margin of error; and N is the household size.

Market Surveys

Market surveys give information on commodities traded in the locality. It provides a glimpse of marketing practices of local producers, particularly farmers and fishers. The survey is conducted to supplement information obtained from FGDs and Household Surveys. This includes survey of commodities either sourced from local produce or imported to the municipality by traders, whether the marketed commodity is raw or processed, the geographic origin of a commodity, source i.e., trader, farmer, others markets, method of purchase, volume sold per day, unit of measurement, number of market days per week, months, or days, unit price, total sales. The market survey was conducted in all 12 municipalities including Abuyog. Information obtained from market surveys are useful in estimating the value of environmental or ecosystem goods and services.

Survey of Business Establishments

Survey of Business Establishments is a rapid assessment of the types and number of businesses operating in the locality. This is undertaken by the project mainly to complete the picture of local economic transactions linked to natural resource use. The types and number of businesses provide ideas and link to causal factors associated with natural resource decline. Unlike Philippine Statistics Authority censuses

of businesses in the Philippines, the survey was a rapid approach. The first stage is to obtain the list of businesses from the local government unit. This is followed by a walk through the area to validate and obtain information on the use and destination of natural resource products. While market and port surveys require site visits to determine the current availability and prices of locally-produced and marketed products, as well as imported basic commodities, the rapid survey of business/commercial establishments is simply limited to getting a sense of what economic activities are taking place in the municipality.

Spatial Modelling

- Spatial models are used to quantify ecosystem flows. Spatial inputs include:
- Digital Elevation Model (DEM) to define the stream and create sub-catchments;
- Soil Loss based on Rainfall Erosivity (R), Soil Erodibility (K), Slope Length (L), and Slope Steepness (S) factors, based on the Revised Universal Soil Loss Equation (RUSLE);
- Annual Average Rainfall, Potential Evapotranspiration (PET)/Rainfall ratio;
- Streamflow for flow regionalization.

Geographic Information System (GIS)

The delineation of units should be undertaken in concert with the development of spatial databases in Geographic Information Systems (GIS). These databases could contain information such as soil type and status, water tables, rainfall amount and pattern, temperatures, vegetation, biodiversity, slopes, altitude, etc., as well as potential information on land management and use, population, and social and economic variables. This information may also be used to assess flows of ecosystem services from given spatial areas to relevant beneficiaries.

Given the spatial diversity and heterogeneity of ecosystems, ecosystem asset accounts generally need to be developed within a GIS context. Although specific datasets need to be determined on a country basis, there are a number of basic resource accounts that are fundamental to ecosystem accounting and typically need to be developed in each country. These include among others:

- Land accounts;
- Carbon accounts;
- Water accounts;
- Soil and nutrient accounts;
- Forest accounts; and
- Biodiversity accounts.

Regulating services will generally have a high spatial variability. For instance, both marine flood risk and mitigation of flood risk by a protective ecosystem, vary as a function of local topography and distance from the sea. The spatial aspect of regulating services means that the generation of regulation services is best measured within a GIS context. In GIS, the processes and/or components of the ecosystem that support the supply of regulating services need to be recorded, as well as the relevant features of the physical or socio-economic environment in which the service is generated. The required resolution depends on the specific ecosystem service.

Spatial inputs may include:

- Historical Remote Sensing/Satellite Imagery;
- Topographic map;
- Digital Elevation Model (DEM);
- Land cover/Land use/Vegetation Map
- Soil type
- River network map

III. References

Resources, Environment and Economics Center for Studies 2013. Natural Resource Assessment of Siargao Island, Surigao Del Norte as Part of Demonstrating the Climate Change Commission's Ecotown Framework Main Report. Submitted to the USAID as part of project report

Resources, Environment and Economics Center for Studies 2013. The Municipal Income Accounts and the Final Asset and Municipal Accounts of San Vicente, Palawan. Final Report submitted to Global Green Growth Initiative and Climate Change Commission

Resources, Environment and Economics Center for Studies (date). ENRAP Shelf. A compilation of report of the Environment and Natural Resource Accounting Project in the Philippines supported by the USAID.

UN et al., 2009. System of National Accounts 2008. 2009: New York

UN et al., 2014a. System of Environmental-Economic Accounting 2012, Experimental Ecosystem Accounting. 2014, United Nations: New York, USA

UN et al., 2014b. System of Environmental-Economic Accounting, Central Framework. 2014: New York, USA.

Reading Material

1. View Youtube Video: Ecosystem Accounting in National Accounts: From the local to the global – Clarke (https://www.youtube.com/watch?v=lkf8_dqGaQE)
2. Other Reading Materials (https://drive.google.com/drive/folders/0B6ryv7mIA46WV2diZmRKeXduWVU)
3. UN SEEA Central Framework Manual (http://unstats.un.org/unsd/envaccounting/seeaRev/SEEA_CF_Final_en.pdf)
4. UN SEEA Experimental Ecosystem Accounting Manual (http://unstats.un.org/unsd/envaccounting/workshops/eea_forum_2015/12.%20SEEA%20EEA%20Tech%20Guid%20Exp%20Forum%20Draft%20Deliv%202.c%203Apr2015.pdf)

Bulwagan Ninoy, Ninoy Aquino Parksand Wildlife Center,
North Avenue, Quezon City, Philippines

Tel/Fax No.: (02) 925-8954
Website: www.climate.gov.ph