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WORKING WITH NATURE

TRAINING MANUAL ON INTEGRATING NATURE-BASED SOLUTIONS FOR INFRASTRUCTURE PLANNING AND DEVELOPMENT

2024

Working with Nature:
Training Manual on Integrating Nature-based Solutions for Infrastructure Planning and Development

This training manual is an output of the research project entitled **" Incorporating Green Strategies Towards Sustainable Infrastructure Planning and Development: Mainstreaming Nature-based Solutions and Spatial Planning for a Resilient Butuan City"** of the **WWF Philippines.** This project is part of WWF's Sustainable Infrastructure in Asia Program (SIPA), an initiative under the Organization for Economic Cooperation and Development (OECD).

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Preface

This training manual is carefully crafted for planners and stakeholders involved in infrastructure development in the Philippines. This is also meant to guide decision-makers in determining appropriate nature-based solutions for linear infrastructure planning that can protect, restore, and even enhance biodiversity and ecosystem services in their areas of jurisdiction.

In preparation for this manual, we, the technical consultants on Nature-based Solutions (NbS) and Geographic Information Systems (GIS) from the University of the Philippines Los Banos Foundation, Inc., led a series of data-gathering activities for the Sustainable Infrastructure Programme in Asia (SIPA) Project led by the World Wildlife Fund for Nature (WWF PH). We intended to ensure that the manual is applicable in the Philippine context by incorporating everything we learned about infrastructure planning and development in the Philippines. This manual aims to help the end users form strategies in mainstreaming NbS in infrastructure planning. Beyond mainstreaming, this manual will also be helpful for each training participant to appreciate the importance of remote sensing and mapping as a decision support tool to answer concerns on risks, appropriateness of choice, and sustainability of NbS projects.

This manual is organized into six modules. The first three modules dwell on the socio-political aspects of the project. It answers the following questions: 1) what is the socio-ecological condition in the area?; 2) what national and local policies impact infrastructure planning and environmental concerns?; and 3) who are the actors in the area?

Modules four and five teach the fundamentals of spatial analysis for analyzing risks and ecosystem services. Risk maps and ecosystem services maps will help the training participant identify appropriate NbS that answer the impending challenges in their locality as a decision-support tool. The sixth and final module is on NbS Action Planning to train participants on identifying and implementing NbS Projects that complement present and potential infrastructure.

By using this manual, participants can expect that their learning experience during the training workshops held by WWF Philippines will be enhanced. By providing them with a written guided process and a set of learning activities, each participant will leave the training workshop with an appreciation of their natural resources and ecosystem services and knowledge on creating sustainable infrastructure development plans and projects that account for the importance of ecosystem services and green spaces. We hope that the participants will find it useful in crafting infrastructure plans that incorporate the ideals of sustainability. We hope that this will be the start of creating mechanisms towards green cities and municipalities.

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Acknowledgment

This training manual is an output of the project *"Incorporating Green Strategies towards Sustainable Infrastructure Planning and Development: Mainstreaming Nature-based Solutions and Spatial Planning for a Resilient Butuan City".* The project is part of WWF's Sustainable Infrastructure in Asia Program (SIPA), an initiative under the Organization for Economic Cooperation and Development (OECD).

Crafting a training manual that consciously takes note of the local context entails the careful search for not only relevant data but also identifying the right people to tap. Achieving a level of specificity for this manual was made possible through extensive consultations and workshops with local stakeholders, fostering a shared understanding and facilitating informed decision-making. The collaborative efforts of the city government, regional authorities, community groups, environmental organizations, and other stakeholders involved in infrastructure planning and implementation have been instrumental in ensuring the manual's accuracy and effectiveness.

With this, we wish to acknowledge the support that WWF Philippines and WWF US provided in this project.

We also acknowledge the project participants who patiently accommodated our interviews and requests. The training manual was formed through their valuable contributions in building the pool of necessary data to craft this manual.

- Butuan City Local Government Unit and the Barangay Councils of the following Barangays: Ampayon, Anticala, Bancasi, Pagatpatan, San Vicente, Taguibo, Villa Kananga
- Caraga State University – College of Forestry and Environmental Science
- Caraga State University – College of Engineering and Geo-Sciences
- Department of Public Works and Highways Region XIII
- Department of Science and Technology Region XIII
- Department of Environment and Natural Resources Region XIII
- National Economic Development Authority Region XIII
- National Economic Development Authority Central Office
- Department of Agriculture Region XIII
- PAGASA Caraga Butuan Station
- Friendship Goals Society Caraga-Butuan Inc.

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Acronyms

CCA	Climate Change Adaptation
CCC	Climate Change Commission
CSO	Civil Society Organization
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
DOST	Department of Science and Technology
DPWH	Department of Public Works and Highways
DRRM	Disaster Risk Reduction and Management
EA	Ecological Assessment
EEA	European Environment Agency
EbA	Ecosystem-based Adaptation
ES	Ecosystem Services
FMR	Farm-to-Market Road
GIS	Geographic Information Systems
IEC	Information, Education, and Communication
InVEST	Integrated Tool to Value Ecosystem Services and their Trade-offs
IUCN	International Union for the Conservation of Nature
LGU	Local Government Unit
MC	Memorandum Circulars
NbS	Nature-based Solutions
NEDA	National Economic Development Authority
NCIP	NCIP National Commission on Indigenous People
NGO	Non-Governmental Organization
OECD	Organization for Economic Cooperation and Development
PAGASA	Philippine Atmospheric Geophysical and Astronomical Services Administration
PDP	Philippine Development Plan
QGIS	Quantum Geographic Information System
RA	Republic Act
RDC	Regional Development Council
SDG	Sustainable Development Goals
SEPLS	satoyama-Satomi, a Japanese concept also known as socio-ecological landscapes and seascapes
SIPA	Sustainable Infrastructure Programme in Asia
TWC	Technical Working Committee
WWF	World Wildlife Fund for Nature

Working with Nature:
Training Manual on Integrating Nature-based Solutions for Infrastructure Planning and Development

I. PURPOSE

The Training Manual on Integrating Nature-based Solutions (NbS) for Infrastructure Planning and Development was meticulously crafted to offer comprehensive guidance during the delivery of WWF's Training Program, which is in line with the objectives of the Sustainable Infrastructure Programme In Asia (SIPA). This training manual will serve as an accompaniment to participants attending WWF Philippines' training workshops on Integrating Nature-based Solutions for Infrastructure Planning and Development, which will teach them how to seamlessly integrate NbS into infrastructure projects, with a primary focus on linear infrastructure.

This manual serves as a practical tool for prioritizing ecosystem services, comprehending socio-cultural contexts, navigating stakeholder and policy intricacies and dynamics, identifying suitable NbS options, and designing NbS elements. It aims to enable workshop participants to gain the knowledge of seamlessly integrating NbS into existing infrastructure plans and future developments, ensuring sustainability and resilience in infrastructure projects.

This training manual is tailored to nurture the thought capacities of training participants to see the unique needs of their community by providing a framework and options to use as they see fit. In this way, they will choose NbS recommendations that are highly relevant and the most appropriate for their local context. As such, this training manual includes ways to account for local conditions, including climate variations, geographical features, biodiversity, and socio-economic factors.

Training participants can maximize the utility of this manual, which offers a comprehensive overview of Nature-based Solutions (NbS) customized to address the community's distinct challenges. Serving as a valuable resource, it also contains instructions on facilitating stakeholder familiarization with these solutions. By providing a structured framework for NbS comprehension and implementation, the manual aims to capacitate learners with informed decision-making. Its methodologies foster collaboration and consensus-building among diverse stakeholders, enhancing the effectiveness of NbS implementation and cultivating a sense of collective ownership and responsibility, driving sustainable infrastructure development within local communities.

II. INTRODUCTION TO SUSTAINABLE INFRASTRUCTURE PROGRAMME IN ASIA (SIPA)

The World Wildlife Fund (WWF) collaborates with the Organization for Economic Cooperation and Development (OECD) for its Sustainable Infrastructure Programme in Asia (SIPA), assisting governments in integrating natural capital and ecosystem services into sustainable infrastructure planning. To uphold WWF's commitment to this collaboration, the project "Incorporating Green Strategies Towards Sustainable Infrastructure Planning and Development: Mainstreaming Nature-based Solutions and Spatial Planning for a Resilient Butuan City" was initiated, with this training manual and training-workshop as one of its outputs. The initiative aimed to mainstream Nature-based Solutions (NbS) in infrastructure planning across the Philippines, using Butuan City, Agusan del Norte, as a case study to

demonstrate its feasibility. Users of this training manual will be able to note that Butuan City's socio-ecological conditions will be used as examples. But with careful thought, the consultant made sure that the processes indicated in this manual will be suitable for use in local government units within the Philippines.

III. RATIONALE FOR THE TRAINING

Sufficient and functional infrastructures are essential inputs to economic development. When properly planned and built, infrastructures can reduce logistical costs, enhance the movement of human capital, and create high rates of returns on private investment (Vagliasindi, 2022; Aschauer, 1989, as cited in the Penn Wharton Budget Model, 2018).

Infrastructures are catalysts of local business expansion and foreign direct investment, and as a result, the local economy benefits from it. This is the reason why the Philippine Government has heavily invested in infrastructures in recent years through the Build-Build-Build and Build-Better-More Programs. Highways and expressways have been built extensively all over the Philippines since 2017. Additional road networks and railways are still in the pipeline. In addition, the Philippine Government invested in infrastructures and institutional measures to enhance resilience towards natural and man-made hazards.

While infrastructures are needed for economic development and to enhance resilience, building roads, bridges, dikes, and the like has environmental costs and can worsen climate change (Thacker et al., 2021). In the absence of sustainable measures, infrastructures can lead to habitat loss and negative economic impacts (Bliss-Ketchum, 2019; Tian et al., 2020). The Philippines also remains the country with the highest disaster risk among 193 countries assessed in the 2023 World Risk Report, revealing that the country remains very vulnerable to the effects of natural hazards despite constructing mitigative measures in place. One way to address climate risk challenges while enabling sustainable development is by tapping Nature-based Solutions (NbS).

Nature-based Solutions or NbS are strategies that are sustainable as they allow the local governments and communities to work with nature. One may ask, how does this work? How it works will be discussed during this training.

Understanding and prioritizing existing ecosystems and natural habitats can create ways to restore, protect, and enhance them. It can also help mitigate climate change impacts, reduce disaster risks, and promote ecosystem restoration (Seddon et al., 2020). Mainstreaming NbS in infrastructure planning will lead to sustainable solutions that address social, economic, and ecological challenges (Cohen-Shacham et al., 2016; Maes & Jacobs, 2017; Ommer et al., 2022).

Combining NbS as a green solution with engineered grey solutions can address both economic challenges and climate risks. Necessary infrastructure will still be constructed while nature provides various benefits to the locality. By incorporating NbS, infrastructure projects can minimize environmental impacts and maximize benefits for communities, contributing to a sustainable future.

IV. EXPECTED LEARNING OUTCOMES (ELO)

After the training, the participants are expected to:

1. Define the important concepts related to mainstreaming NbS;
2. Identify the present ecosystem services in the training participants' locality;
3. Distinguish the various policy and institutional frameworks related to infrastructure planning and NbS
4. Generate the list of key stakeholders who have a role in infrastructure planning and sustaining NbS;
5. Identify appropriate NbS based on priority ecosystem services and risks and
6. Generate an action plan that mainstreams NbS with present and planned infrastructure.

V. TRAINING DELIVERY

The training is meant to be delivered in a face-to-face setup, where the resource persons and the training participants are together in one meeting room. Since several important concepts need to be explained, training delivery will be led by resource persons who will help simulate a classroom experience. Each module in this training manual will involve a discussion of the concepts, complemented by activities meant to help training participants achieve the expected learning outcomes.

At the end of the training, there will be an assessment activity to verify if the expected learning outcomes of the training have been achieved.

VI. INTENDED USERS OF THE TRAINING MANUAL

The intended learners of this course are those involved in local development and sectoral planning, including municipal/city/barangay officials who are part of committees on planning and development. Stakeholders from the national and regional government agencies, academic institutions, and civil society organizations will likewise benefit from this training manual.

With the need to align local strategies towards the achievement of Sustainable Development Goals and the recognition of nature-based solutions to mitigate and adapt to climate change and disaster risks, knowledge of ecosystems and ecosystem services is important. This will help local planners and stakeholders identify solutions that they see as appropriate to the existing ecosystems in their area and will promote biodiversity conservation, mitigating and adapting to climate risks, and building resilience of local communities.

MODULE 1: Understanding and contextualizing NbS

Purpose of the Module:

This module is designed to help environmental professionals, local environmental planners, and policymakers understand and contextualize **Nature-based Solutions (NbS**).

The main goal of this module is to provide an understanding of the concepts pertaining to NbS that will help train participants to appreciate and subsequently promote sustainable development practices that leverage natural processes in addressing key societal challenges such as climate change, water security, and biodiversity loss.

Understanding NbS is necessary in identifying ways to solve societal challenges, such as climate change and disaster risks, that may impact infrastructure development. Likewise, knowledge on NbS will be useful in avoiding further environmental degradation caused by construction of infrastructures. By unpacking the concept of NbS and related terminologies (e.g., ecosystems, ecosystem services), this module will help project planners and implementers craft strategies that promote green linear infrastructure development. To be more specific, it is important to provide project planners and implementers with knowledge on NbS so that they can choose solutions that:

1. advocate for ecosystem-based strategies that promotes biodiversity and human well-being;
2. protect, restore, and enhance ecosystems;
3. increases resilience of communities; and
4. complement with linear infrastructure development goals.

Learning Outcomes:

By the end of this module, participants are expected to learn the following:

1. Define the principles and benefits of NbS;
2. Identify the present ecosystem services in the training participants' city, municipality, province, and region; and
3. Determine local terminology/ies that are synonymous with the concept of NbS.

What are Nature-based Solutions?

The International Union for the Conservation of Nature (IUCN)[1] defines NbS as solutions to "*address societal challenges through actions to protect, sustainably manage, and restore natural and modified ecosystems, benefiting people and nature at the same time*".

Meanwhile, the European Commission (EC) explains that NbS are "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience." (European Commission, 2024).

NbS also covers the concepts of ecosystem-based adaptation, "natural infrastructure" (intact ecosystems), and green infrastructure. The beauty of applying NbS to build climate resilience and make linear infrastructures sustainable is that it is capable of addressing other challenges and offering co-benefits through maintained and enhanced flow of ecosystem services (ES) (European Commission, 2015; Cohen-Shacham et al., 2016; Albert et al., 2019; Bush & Doyon, 2019). As such, Understanding NbS involves knowing the present ecosystems and ecosystem services in an area.

In working with nature towards a climate-resilient infrastructure, it is important that one is aware of the natural capital stock in a municipality, city, region, or even watershed. Effective and appropriate NbS must be based on what is natural: what are native or endemic species of trees and shrubs in a certain ecosystem – be it a terrestrial (i.e., forest, grassland), freshwater, marine, or subterranean ecosystem. NbS is a step toward conservation and restoration while building climate resilience, mitigating disaster risks, protecting communities, and improving human well-being.

The IUCN NbS Framework

NbS can help solve **societal challenges through the protection, sustainable management, and restoration of ecosystems**. This is illustrated in Figure 1. The following are the seven societal challenges that NbS addresses:

1. Climate change mitigation and adaptation
2. Disaster Risk Reduction
3. Economic and social development
4. Human health
5. Food security
6. Water security
7. Environmental degradation and biodiversity loss

These challenges are familiar to the Philippines as they are perennial problems that the national and local governments need to address and allocate budget and human resources to. Year-on-year, we hear news of the impacts of climate change and hazards to the Philippines. We still need continuous and inclusive economic and social development. Health, hunger, and access to clean water are still problems that we are facing. By working with nature – enabling it to regulate the climate and provide food, clean air, water, and livelihood opportunities – it may facilitate sustainable and inclusive development in the Philippines.

[1] IUCN is a union of governments and civil society organizations that pioneered this concept and developed the Global Standard for Nature-based Solutions.

Figure 1. The IUCN NbS Framework

The IUCN NbS Global Standard

Reviewing the discussion from Module 1, Nature-based Solutions (NbS) are actions meant to contribute to solving societal challenges through ecosystems. When ecosystems are protected, sustainably managed and restored, communities on a small scale, and countries at a larger scale can benefit from the biodiversity. Human well-being will also be addressed.

Studies prove that NbS can assist with climate change mitigation and adaptation needs. As cited from the IUCN Issues Brief (2020), Griscom, et al. (2017) stated that NbS has the capability to supply up to 37% climate change mitigation. Beck et al. (2018) asserted that healthy and sustainably managed mangrove areas are capable of mitigating risks brought by flooding for more than 18 million people around the world. Another good example of NbS preventing biodiversity loss is through forest landscape restoration. In the Philippines, this can be in the form of a national greening program that incorporates the principles of ecosystem-based seedling identification for tree planting efforts.

While NbS is promising, for years it has been implemented without an agreed framework or standard to ensure its effectiveness. A standard is important to prevent unanticipated negative outcomes or misuse, such as introduction of alien invasive species or funding planting efforts of species that will not survive in the environment where it will be planted. Another crucial factor for success or failure of an NbS is the present social and economic factors. Without proper socio-economic context, projects that may have been successful in one area may fail when implemented in another area. These are among the reasons why standards are needed. When standards are also in place, it will be easier for funding agencies, decision-makers, and stakeholders to assess the feasibility of an NbS.

As a response, the IUCN Global Standard for NbS was put in place. The IUCN Global Standards is a useful guide – not mandate but to help governments, communities, business and NGOs implement NbS projects that are strong, effective and ambitious in scale. It also ensures that NbS projects are sustainable and they safeguard biodiversity and human well-

being. Accordingly, the Standard follows an iterative systematic learning framework that is designed to support users to apply, learn, and continuously strengthen and improve the effectiveness, sustainability, and adaptability of their chosen NbS project. **Figure 6 shows the IUCN Global Standards for** NbS.

The IUCN Global Standard for Nature-based Solutions consists of eight criteria and their associated indicators, which address the pillars of sustainable development (biodiversity, economy and society) and resilient project management. The eight criteria are as follows:

- ***Criterion 1: NbS effectively address societal challenges***

  The purpose of this criterion is to ensure that the NbS is designed as a response to a societal challenge(s) that has been identified as a priority by those who are or will be directly affected by the challenge(s). All stakeholders, especially rights holders and beneficiaries of the NbS, must be involved in the decision-making process used for identifying the priority challenge(s) (Criterion 5).

- ***Criterion 2: Design of NbS is informed by scale*[2]***

  The purpose of this Criterion is to encourage NbS designs that recognise the complexity and uncertainty that occur in living dynamic land/seascapes. Scale applies not only to the biophysical or geographic perspective but also to the influence of economic systems, policy frameworks and the importance of cultural perspectives.

- ***Criterion 3: NbS result in a net gain to biodiversity and ecosystem integrity***

  NbS derived as goods and services from ecosystems, therefore strongly depend on the health of an ecosystem. Biodiversity loss and ecosystem change can have significant impacts on the functioning and integrity of the system. Therefore, NbS design and implementation must avoid undermining the integrity of the system and instead, proactively seek to enhance the functionality and connectivity of the ecosystem. Doing so can also ensure the long-term resilience and durability of the NbS.

- ***Criterion 4: NbS are economically viable***

  The return on investment, the efficiency and effectiveness of the intervention, and equity in the distribution of benefits and costs are key determinants of success for an NbS. This Criterion requires that sufficient consideration is given to the economic viability of the intervention, both at the design stage and through monitoring the implementation.

- ***Criterion 5: NbS are based on inclusive, transparent and empowering governance processes***

  This criterion requires that NbS acknowledge, involve and respond to the concerns of a variety of stakeholders, especially rights holders. Good governance arrangements are proven to not only reduce an intervention's sustainability risks, but also to enhance its social 'license to operate'. Conversely inadequate governance provision

[2] Presence of Protected Areas present legal and funding opportunities to co-implement NbS programs. In designing NbS projects, protected areas must be considered. There may also be a better appreciation of NbS if the project is related to nationally recognized national resource management systems.

for otherwise well-intended actions can adversely affect the legitimacy of benefit and cost sharing arrangements.

At a minimum, NbS must adhere to and align with the prevailing legal and regulatory provisions, being clear on where legal responsibilities and liabilities lie. However, as often is the case with natural resources, basic compliance will need to be complemented with ancillary mechanisms that actively engage and empower local communities and other affected stakeholders.

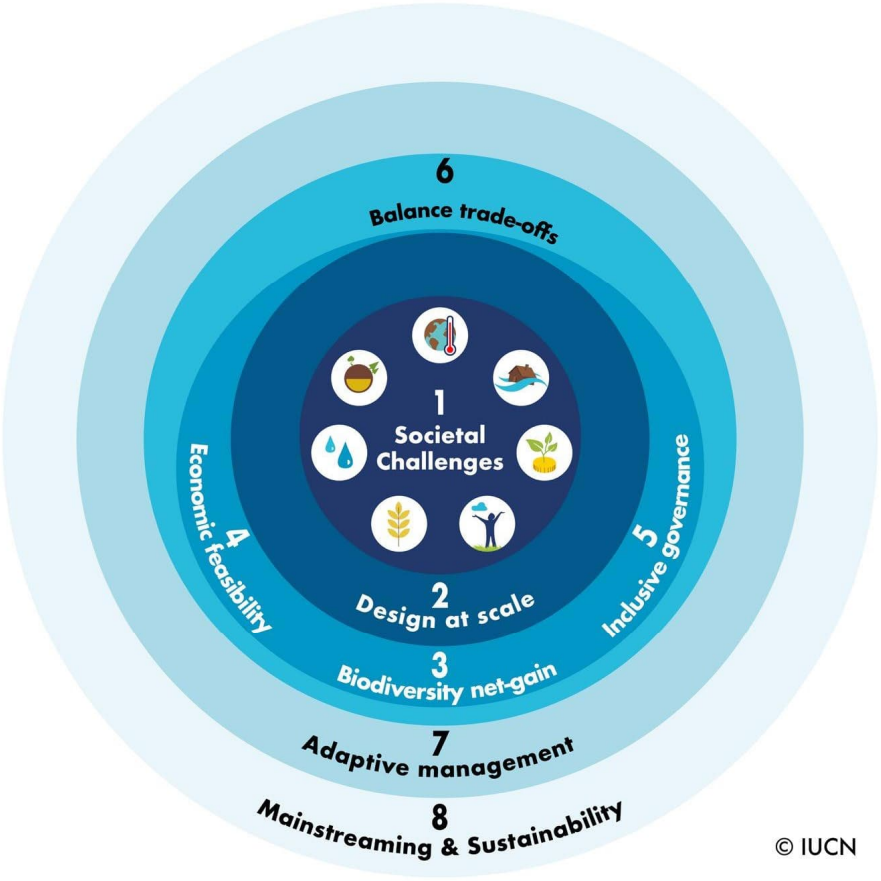


Figure 6. The IUCN Global Standards for Nature-based Solutions

- ***Criterion 6: NbS equitably balance trade-offs between achievement of their primary goal(s) and the continued provision of multiple benefits***

Trade-offs in land and natural resource management are inevitable. Ecosystems provide a wealth of different benefits and not everyone values each of them in the same way. While tradeoffs cannot be avoided, they can be effectively and equitably managed. This Criterion requires that NbS proponents acknowledge these tradeoffs and follow a fair, transparent and inclusive process to balance and manage them over both time and geographic space.

- ***Criterion 7: NbS are managed adaptively, based on evidence***

  This Criterion requires that NbS implementation plans include provisions to enable adaptive management as a response to uncertainty and as an option to effectively harness ecosystem resilience. A degree of uncertainty is inherent when managing most ecosystems due to their complex, dynamic and self-organising nature. This also means that ecosystems have greater resilience which confers a wider range of options to respond to unanticipated social, economic or climate events.

- ***Criterion 8: NbS are sustainable and mainstreamed within an appropriate jurisdictional context***

  This Criterion requires that NbS interventions are designed and managed with a view to long-term sustainability and that they take account of, work with and align with sectoral, national and other policy frameworks.

NbS-Related Concepts

Related to the concept of NBS is ecosystem-based adaptation and satoyama-satomi. According to IUCN (2017), **Ecosystem-based Adaptation (EbA)** *"is a nature-based solution that harnesses biodiversity and ecosystem services to reduce vulnerability and build resilience to climate change*". Meanwhile, **satoyama-satomi, a Japanese concept also known as socio-ecological landscapes and seascapes (SEPLS), refers to landscapes and seascapes management that manifests the important connection of ecosystems with humans (Saito** et al., 2020). Inherent in SEPLS is the unique set of indigenous knowledge and practices that can be found in each of these, depending on the presence of species, the biodiversity status of the area, and the cultural identity of the community.

The importance of Ecosystems in NbS

Understanding ecosystems and ecosystem services is fundamental to using NbS to address societal challenges.

According to the National Geographic Society (2024), an **ecosystem** is "*a geographic area where plants, animals, and other organisms, as well as weather and landscape, work together to form a bubble of life".* Ecosystems contain biotic or living parts, abiotic factors, and nonliving parts. There are various types of ecosystems. IUCN established a global ecosystem typology for ecosystems consisting of four core realms and six transitional realms (**see Box 1**).

How about urban areas? Urban areas or urban ecosystems are hybrid ecosystems where plants, animals, and humans inhabit the built-up urban environment (e.g., buildings, roads, sewage system). Urban ecosystems are affected by the natural environment and by culture, personal behavior, politics, economics, and social organization (Srinivas, 2015). Urban ecosystems rely on ecosystem services of other natural ecosystems, such as waste assimilation, water supply, and flood management (Srinivas, 2015; NatureScot, 2023).

Ecosystems function through what are called **Ecosystem Services**. Ecosystem Services are endowments of ecosystems that create an environment to support human well-being and quality of life (NatureScot, 2023). Ecosystem Services are generally categorized into four types (**Figure 2**).

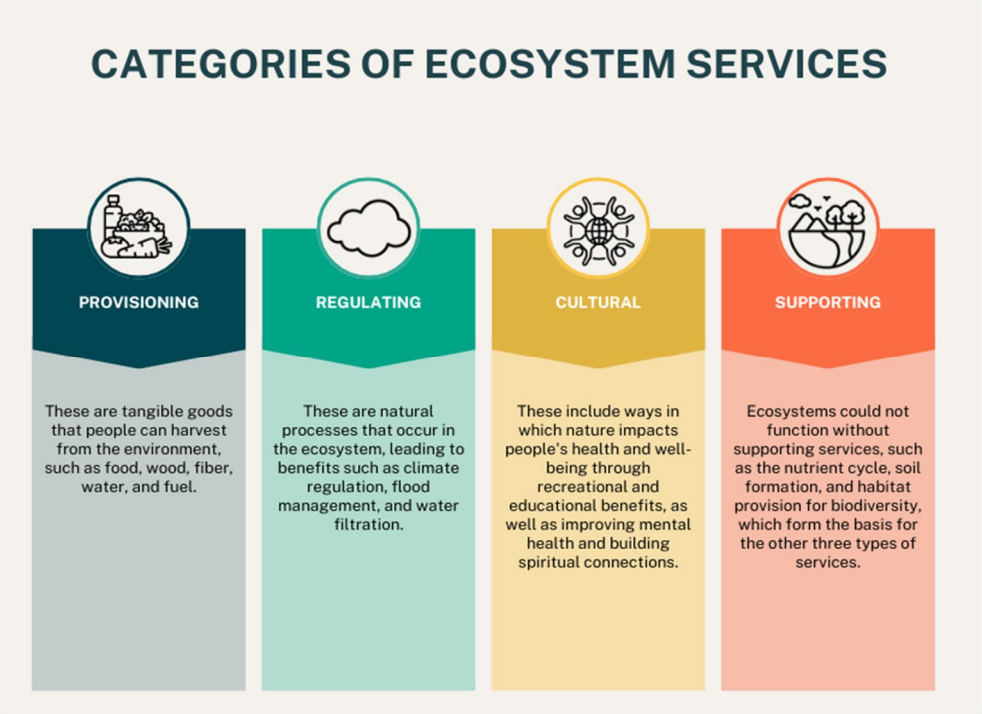


Figure 2. Categories of Ecosystem Services based on the Millennium Ecosystem Assessment (Source: NatureScot, 2023)

Categories of ecosystem services can be used in mapping, measuring, and valuing them. It will also be easier to conduct ecosystem assessments when the categories are applied (Czucz et al., 2018). By understanding these services, project implementers can design and implement NbS that are beneficial for both people and nature. For example, if the societal challenge identified is water security, chosen NbS must specifically restore or enhance the water supply ecosystem service. For flood management, NbS that specifically enhances flood risk mitigation service should be designed.

Box 1. IUCN's Global Ecosystem Typology.

IUCN defined a global ecosystem typology to provide a classification framework for the earth's ecosystems.

From their official website, the following terms were introduced to understand the global ecosystem typology:

- **Realm** -refers to the components of the biosphere or the living planet. Each component is a large ecosystem that differs fundamentally in ecosystem organization and function: terrestrial, freshwater, marine, subterranean, atmospheric, and combinations of these (transitional realms) which result from the variations that occur in nature. Transitional realms have their own unique organization and function.
- **Biome** – a component of a realm. There may be several biomes in one realm with encompassing features of ecosystem structure that unites them, and one or a few common major ecological drivers that regulate major ecological functions.
- **Ecosystem Functional Group** - a group of related ecosystems within a biome that share common ecological drivers, which in turn promote similar biotic traits that characterize the group.

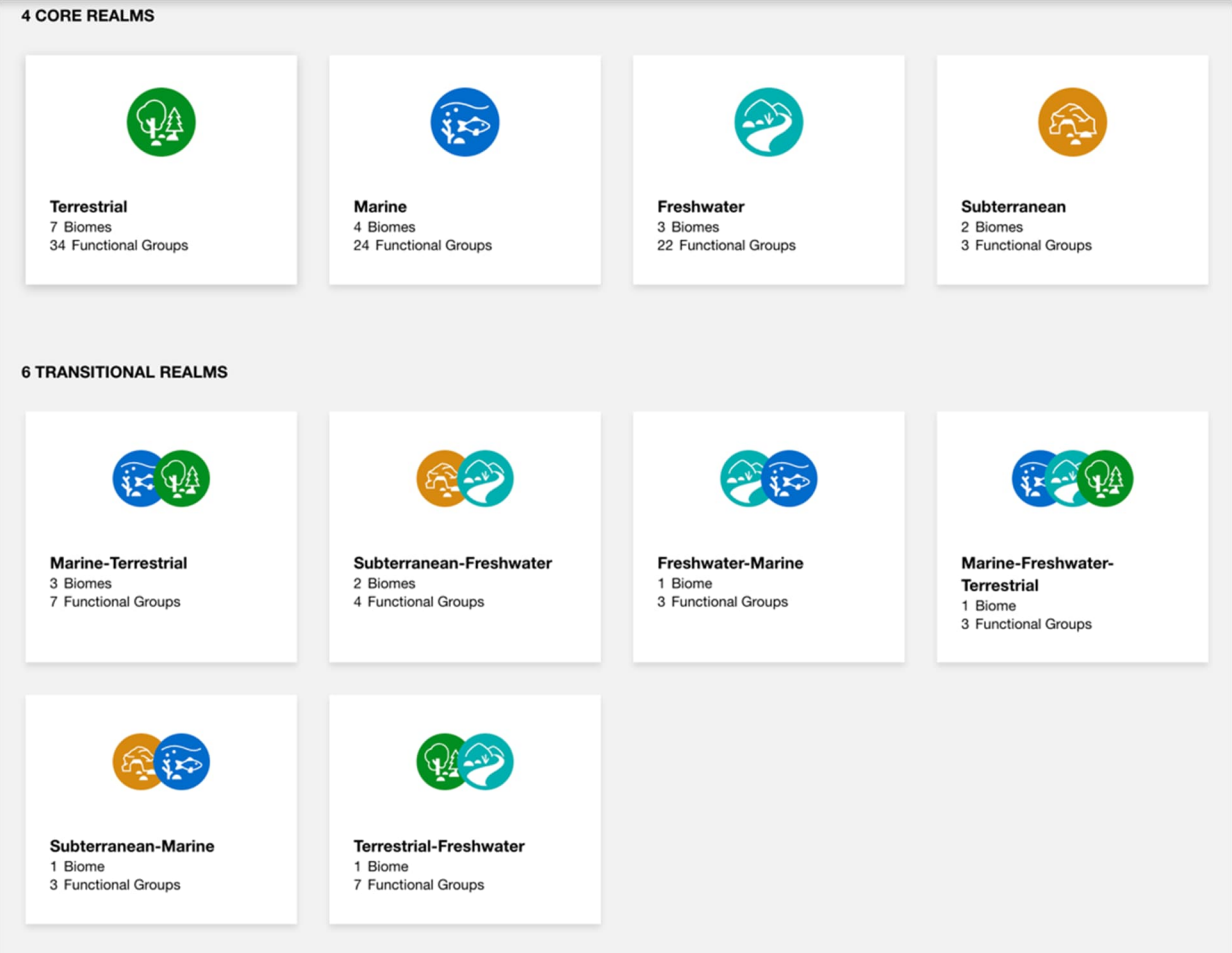
There are also four core realms in the ecosystem typology are:

- **Terrestrial Realm** - includes all dry land, its vegetation cover, proximate atmosphere and substrate (soils, rocks) to the rooting depth of plants, and associated animals and microbes. Example: forests, shrublands, grasslands.
- **Marine Realm** - includes all connected saline ocean waters characterized by waves, tides and currents. Example: seagrass, corals, submarine canyons, artificial marine structures.
- **Freshwater Realm** - includes all permanent and temporary freshwater bodies as well as saline water bodies that are not directly connected to the oceans, and are characterized by water regimes defined by frequency, duration, flow velocity, depth and extent of inundation. Example: streams, rivers, lakes.
- **Subterranean Realm** - includes the earth's crust and subsurface voids characterized by an absence or very low intensity of sunlight. Example: caves.

The typology included six transitional realms which are interfaces among these four realms. Each of the realms has a biome and a functional group.

For more information about the global ecosystem typology, visit: https://global-ecosystems.org/

Box 1. *Continuation…*



Source: https://global-ecosystems.org/

Knowing Your Ecosystems

Ecosystem Services help ensure health and well-being, hydrological/water cycle, food security, and even the beneficiary community's cultural, educational, and aesthetic values (Babi Almenar et al., 2020). Knowing existing ecosystems – or consciousness of ecosystems and its ecosystem services - is needed by project implementers to avoid or minimize its unintended effects. For example, not understanding the local ecosystem may lead to choosing alien/non-native species and cause ecological imbalance in the present ecosystem. On the other hand, distinguishing the upstream (opposite of water flow in rivers; from the source of water) and downstream (towards the water flow in rivers; to the outlet of water) processes in an area, together with involving the right key stakeholders who will champion and support the chosen NbS, critical to choosing the most appropriate intervention that will make infrastructure development sustainable and climate resilient.

One way of knowing your ecosystems and their ecosystem services is by identifying where they are located. Forests can be found within your vicinity, or may be larger such as those that are under the jurisdiction of two municipalities or provinces. It may also encompass a region. For example, the Agusan River, the third longest river in the Philippines, is a freshwater ecosystem whose head water is located in another region. A watershed may be shared by several barangays.

Towards a Contextualized NbS for Sustainable Infrastructures

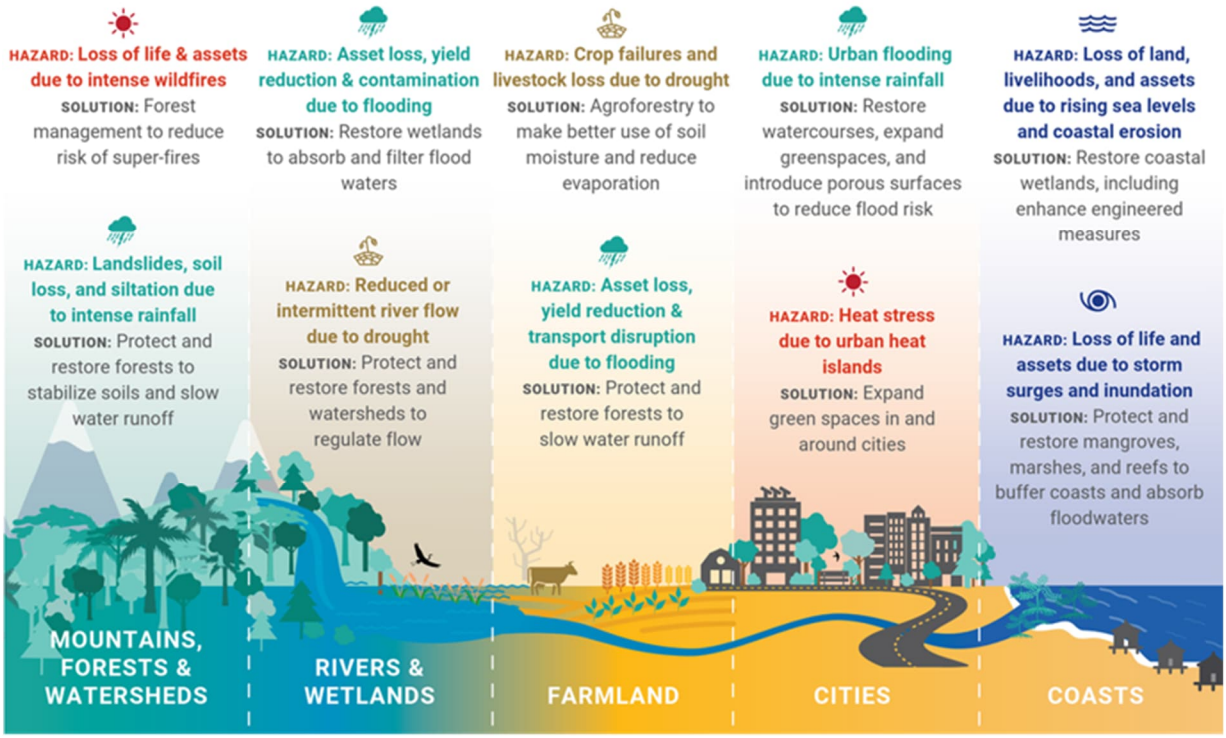
Nature provides many benefits. It will continue to do so if we conserve and protect it. With a proper knowledge on what NbS is, this training aims to help answer the following questions:

How can local policymakers and decision-makers amass the power of nature by working with it?

How can governments balance linear infrastructure development with environmental protection and conservation?

The rest of this training will help explain how national government agencies and local governments can work together and work with nature.

Box 2. Example of Nature-based Solutions based on hazard from the Global Commission on Adaptation.



Source: Global Commission on Adaptation. (2019). *Adapt Now: A Global Call for Leadership on Climate Resilience.* Rotterdam and Washington, DC: Global Commission on Adaptation

Box 3. Activity on Local Terminologies for Ecosystems and Nature-based Solutions.

Activity 1. Being familiar with the concepts of ecosystems, ecosystem services, and nature-based solutions, what areas in your city/municipality/province/region are you reminded of? What are their local names? Let's identify!

Ecosystem	Name and Location (City/Municipality/Province/Region)	Local Term
1. Terrestrial (ex. Forest)		
2. Marine (ex. Sea, Bay)		
3. Freshwater (ex. River)		
4. Subterranean (ex. Caves)		

Activity 2. Based on the local terms used for the ecosystems you have determined and the definition of NbS discussed in this module, what can we call nature-based solutions in your own dialect/language? How can we explain that they need to be related to the present ecosystem/s?

_____
_____
_____.

Activity 3. Based on IUCN's 7 Societal Challenges, which societal challenge/s can you observe in your area? Select among the seven the challenge/s you observed and provide reasons why you think the societal challenge/s is/are happening (support your answers with data, if available).

1. Climate change mitigation and adaptation _____
2. Disaster Risk Reduction _____
3. Economic and social development _____
4. Human health _____
5. Food security _____
6. Water security _____
7. Environmental degradation and biodiversity loss _____

MODULE 2: Appraising the National and Ground-Level Socio-Political Dimension

Purpose of the Module

The purpose of this module is to guide the project planners in designing NbS that is supported by legal frameworks. Likewise, this module aims to provide project implementers a guide on what is legally allowable under the Philippine setting.

Policies, at the national and local levels, facilitate the successful integration of NbS in infrastructure planning and development as these provide legal basis for implementation. Policies also identify the roles of each stakeholder that will be involved in an NbS project. For example, a memorandum or administrative order calling for the formation of a technical working committee (TWC) mandates its formation and delineates its duties and responsibilities. Additionally, policies can emphasize how necessary NbS are in addressing climate resilience and disaster risk reduction. Lastly, policies dictate government priorities for funding.

Recognizing a country's policy landscape—from the national to the local level—helps stakeholders, including government agencies, communities, and NGOs, communicate and collaborate more effectively. Understanding the policy context also enables stakeholders to justify the legitimacy of a project for investment planning and determine boundaries for each project. As such, it is important that project planners and implementers need to be knowledgeable on policies that support the implementation of Nature-based Solutions (NbS).

Learning Outcomes:

By the end of this module, participants are expected to understand the policy context in the NbS integration. Specifically, this module aims to help training participants to:

1. Identify the national and local policy frameworks relevant to the integration of NbS into infrastructure planning and development;
2. Demonstrate a comprehension of the relevant policy frameworks; and
3. Distinguish the role, power, and influence of identified stakeholders, including government agencies, communities, and NGOs, by leveraging policy.

Policy Landscape

Socio-political situations are important to be understood as they provide the backbone of effective project implementation. National and local policies are important guides in choosing

who to involve (technical working committee members and other stakeholders), what to involve (resources), and where to implement (land use).

The first step is to identify the different national and local policies and then assess them in relation to the NbS project implementation, especially on how they could be integrated into infrastructure development. Policies also identify the regulatory processes needed and the associated personnel who must be involved. Moreover, existing policy frameworks provide an avenue for the national government to delegate work to the local governments. They mandate administrative duties while considering natural resource management through conservation and preservation.

Legal bases for planning and implementing sustainable infrastructure need to be emphasized to encourage elected officials and bureaucratic administrators to incorporate NbS in infrastructure planning and development. In the case of the Philippines, the 1987 Constitution lays the foundation for the importance of infrastructure development in the context of providing social services in a self-reliant and independent national economy. **Article II** (see Box 4) further emphasizes the importance of comprehensive and integrated long-term plans to achieve these goals.

Box 4. Relevant provision in the Philippine Constitution (1987) related to infrastructure development

Article II (State Policies), Section 9. The State shall promote a just and dynamic social order that will ensure the prosperity and independence of the nation and free the people from poverty through policies that provide adequate social services, promote full employment, a rising standard of living, and an improved quality of life for all.

This constitutional basis provides subsequent policy frameworks and laws (see **Box 5** for a partial list of applicable national policy guidelines) related to infrastructure planning. Also, existing policy directives provide the impetus or driving force for national development plans related to infrastructure projects. A major policy convergence for infrastructure development can be aligned with the Philippine Development Plan (PDP) created through the National Economic Development Authority (NEDA) and implemented by an incumbent President of the Government of the Republic of the Philippines. An example of this alignment is the Build Better More Program, the infrastructure flagship program in the Philippines, that supports PDP's strategy to create an enabling environment through expansion and upgrading of infrastructures.

Box 5. Relevant national policies in the integration of NbS in infrastructure planning and development

- Philippine Highway Act of 1953 (RA 917) and related DPWH Department Orders
- An Act Authorizing the Financing, Construction, Operation and Maintenance of Infrastructure Projects by the Private Sector, and for Other Purposes (RA 6955)
- Build-Operate-Transfer (BOT) Law (provides for infrastructure projects through private sector partnerships) (RA 6957)

Box 5. Continuation…

- Local Government Unit Code of 1991 (RA 7160)
- National Integrated Protected Areas System Act of 1992 (RA 7586)
- Indigenous Peoples' Rights Act of 1997 (RA 8371)

- Right-of-Way Act (outlines the process for acquiring right-of-way for infrastructure projects) (RA 8974)
- Government Procurement Reform Act (covers the rules and regulations for government procurement, including for infrastructure projects) (RA 9184)
- Climate Change Act of 2009 (RA 9729)
- Philippine Disaster Risk Reduction and Management Act of 2010 (RA 10121)
- Expanded National Integrated Protected Areas System Act of 2018 (RA 11038)

Guiding the existing and upcoming PDPs of succeeding administrations is a 25-year strategic plan called "AmBisyon Natin 2040" crafted in 2015 and adopted in 2016 through Executive Order No. 5, series of 2016. Under this long-term plan, it envisions the Philippines by year 2040 to be "*a prosperous middle-class society where no one is poor*" (see **Box 6** for the complete AmBisyon Natin 2040 vision).

Box 6. AmBisyon Natin 2040 vision as an entry-point for NbS in Infrastructure Development (added emphasis)

By 2040, Filipinos will enjoy a strongly rooted, comfortable, and secure life. In 2040, we will all enjoy a *stable and comfortable lifestyl*e, secure in the knowledge that w*e have enough for our daily needs* and unexpected expenses, that we can *plan and prepare for our own and our children's future.* Our family lives together in a place of our own, and we have the *freedom to go where we desire*, protected and enabled by a clean, efficient, and fair government.

Complementing AmBisyon Natin 2040 is the Department of Science and Technology's (DOST) "Pagtanaw 2050" or the Philippine Science, Technology, and Innovation Foresight which was published in 2021 by the DOST National Academy of Science & Technology (NAST). Pagtanaw 2050 establishes 12 key operational areas, namely:

(1) Blue Economy;
(2) Governance;
(3) Business and Trade;
(4) Digital Transformation and Information and Communications Technology;
(5) Science Education and Talent Retention;
(6) Food Security and Nutrition;
(7) Health Systems;
(8) Energy;
(9) Water;
(10) Environment and Climate Change;
(11) Shelter, Transportation, and Other Infrastructure; and
(12) Space Exploration.

Policies, such as those in Box 5, establish the legal bases for implementing infrastructure projects at the national level and the possible ways these can be applied to incorporate NbS in improving the sustainability and resilience of implemented projects. The legal bases also provide convergence points for international guidelines for sustainable development. In other words, it supports the Sustainable Development Goals (SDGs). Apart from the SDGs, various multilateral environmental agreement platforms are present for strengthening the integration of NbS in national infrastructure programs, including the United Nations Framework Convention on Climate Change (UNFCCC), Convention on Biological Diversity (CBD), Sendai Framework for Disaster Risk Reduction (Sendai Framework), and other

internationally recognized platforms. A clear example of this is the Nationally Determined Contributions of the Philippines submitted to the UNFCCC highlights together with the NAP, highlights how critical safeguarding biodiversity and restoring natural assets are in addressing climate change. These are entry points for NbS to be integrated.

Regional Administrative Mechanisms

Decentralizing growth at the national level is made possible through regional administrative regions. Regions in the Philippines are composed of geographically adjacent government units that are grouped as units for coordinating economic development policies from the national government. There are currently 18 administrative regions, which includes the newly created autonomous region, Bangsamoro Autonomous Region in Muslim Mindanao (BARMM) in January 2019 and the re-established Negros Island Region in June 2024. An autonomous region has legislative powers related to (a) administrative organization, (b) creation of sources of revenues,(c) ancestral domain and natural resources,(d) personal, family, and property relations, (e) regional urban and rural planning development, (f) economic, social, and tourism development, (g) educational policies, (h) preservation and development of cultural heritage; and other matters deemed constitutionally lawful and appropriate for the socio-cultural characteristics of the region. Otherwise, an administrative region will rely on the national government for overall matters, although a degree of decentralization is achieved through a Regional Development Council or RDC.

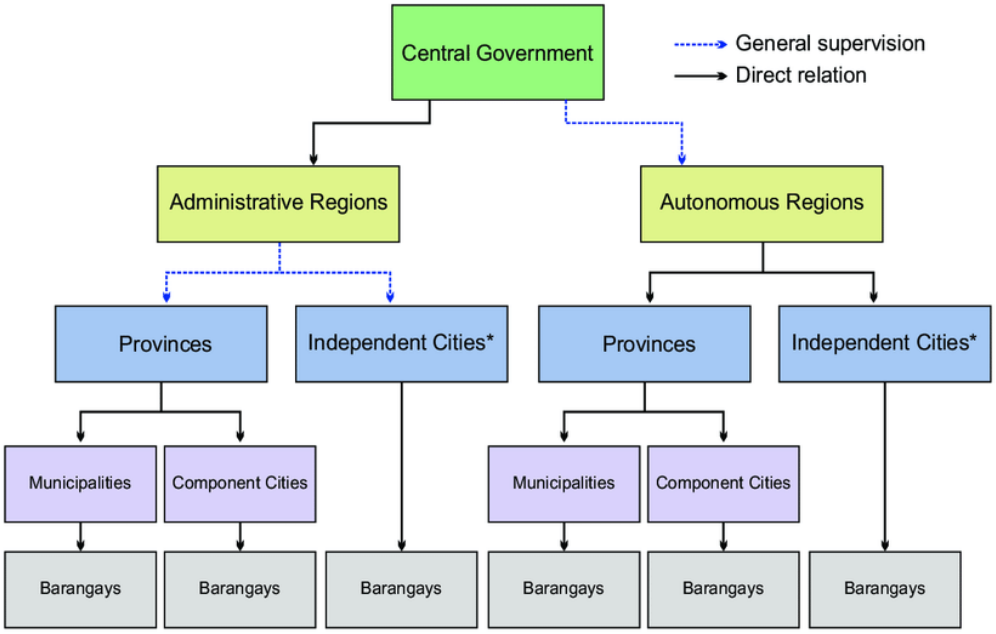


Figure 3. Philippine local government structure. Source: Gera, 2018.
*Independent Cities include highly urbanized cities and independent component cities. According to Gera (2018), there are no cities independent from a province Bangsamoro Autonomous Region of Muslim Mindanao.

The RDC coordinates and sets the direction of a region's economic and social development efforts. It acts as the regional counterpart of the NEDA Board Executive Committee. It is, therefore, the highest planning and policy-making body for integrating national and local government development activities. In this regard, integrating NbS in infrastructure projects that may or may not involve a number of political administrative boundaries is better coursed through an RDC. As an entity that initiates and coordinates regional and special

development projects' development, funding, and implementation, NbS-related infrastructure planning and implementation is better mainstreamed through a region's RDC.

Box 7. Composition of the Regional Development Council in Caraga Region

According to the NEDA Caraga Region website, the Regional Development Council is composed of three major sectors: the Local Government Units (18), Regional Line Agencies (22), and the Private Sector (14).

Local Government Units:

- Provincial Governors (5)
- City Mayors (6)
- Presidents of the Leagues of Municipalities (5)
- Mayors of Capital Towns (2)

Regional Line Agencies represented in the NEDA Board:

- National Economic and Development Authority (NEDA)
- Bangko Sentral ng Pilipinas (BSP)
- Bureau of Local Government Finance (BLGF-DOF)
- Commission on Higher Education (CHED)
- Department of Agrarian Reform (DAR)
- Department of Agriculture (DA)
- Department of Budget and Management (DBM)
- Department of Education (DepEd)
- Department of Human Settlement and Urban Development (DHSUD)
- Department of Energy (DOE)
- Department of Environment and Natural Resources (DENR)
- Department of Foreign Affairs (DFA)
- Department of Health (DOH)
- Department of the Interior and Local Government (DILG)
- Department of Labor and Employment (DOLE)
- Department of Public Works and Highways (DPWH)
- Department of Science and Technology (DOST)
- Department of Social Welfare and Development (DSWD)
- Department of Trade and Industry (DTI)
- Department of Transportation (DOTr)
- Department of Tourism (DOT)
- Technical Education and Skills Development Authority (TESDA)

Private Sector Representatives (14)

Source: https://nro13.neda.gov.ph/regional-development-council/composition-2/

Local Government Units

A local government unit (LGU), as categorized in the Constitution and through the Local Government Code of 1991 (RA 7160), may be a province, a city, a municipality, or a barangay. All LGUs have local legislatures (termed *Sanggunian*), and a locally elected chief executive in the person of a governor for a province, mayor for a city or municipality, and a barangay captain for a Barangay, all of which are elected by popular vote. Additionally, a barangay may have an appointed purok or sitio leader. A purok or sitio is an arbitrarily identified area by the barangay officials that can be classified according to densely populated areas characterized by various landmarks and boundary-identifying characteristics.

The chief executives and their legislatures are key individuals for a local government's development agenda and should be coordinated within various development programs and projects. In identifying appropriate sites for infrastructure development integrated with NbS, for example, chief executives provide local scenarios and contexts for sustaining and maximizing implemented projects. With their legislatures and political agendas, local chief executives may also give impetus or directives for mainstreaming NbS in infrastructure planning and development through the passage of related resolutions and ordinances.

In navigating the various local ordinances and resolutions appropriate for mainstreaming NbS strategies, the first step is to list all potential plans, policies, and projects and categorize them into their administrative scope. This is followed by enumerating all the key provisions of these policies. It is important to identify the provisions of these policies relevant to the integration of NbS in infrastructure planning and development at different administrative levels. The last crucial step is identifying potential gaps and opportunities presented by these policies. Table 3 offers a sample matrix for the assessment of policies in the context of Butuan City.

Table 3. Relevant policies for integrating NbS in Butuan City's Infrastructure planning and development.

LGU POLICY	LGU LEVEL AND DESCRIPTION	KEY PROVISIONS	POTENTIAL CHALLENGES FOR INTEGRATING NbS	OPPORTUNITIES FOR INTEGRATING NbS

To better facilitate the organization of a local institutional landscape, a worksheet is provided to allow the participants to list all stakeholders deemed relevant for integrating NbS in infrastructure planning and development. A **stakeholder**, as used in this manual, refers to a government or non-government organization that fulfills a specific role related to the implementation of policies for infrastructure planning and development in a specific local government unit or units. A sample of a worksheet is provided in Table 4. This table may be used at the city/municipality, provincial, and regional planning levels. This worksheet could

also be used as the basis for the design of stakeholder mapping workshop(s) and can be crafted per LGU level.

Once stakeholders are identified, their level of power and influence over infrastructure planning and development decisions can be mapped via a stakeholder mapping exercise. **Power** is defined in this manual as *the inherent capacity of the stakeholder to influence or cause an effect on decisions related to infrastructure planning and development*, while **interest** describes *a stakeholder's level of participation throughout the processes of infrastructure planning and development*. In mapping a stakeholder's level of interest and power, a grid can be created to help determine which stakeholder must be considered to address problems or issues related to integrating NbS in infrastructure projects (see also Bryson, 2004). A stakeholder grid for Butuan City is provided as an example (Figure 4).

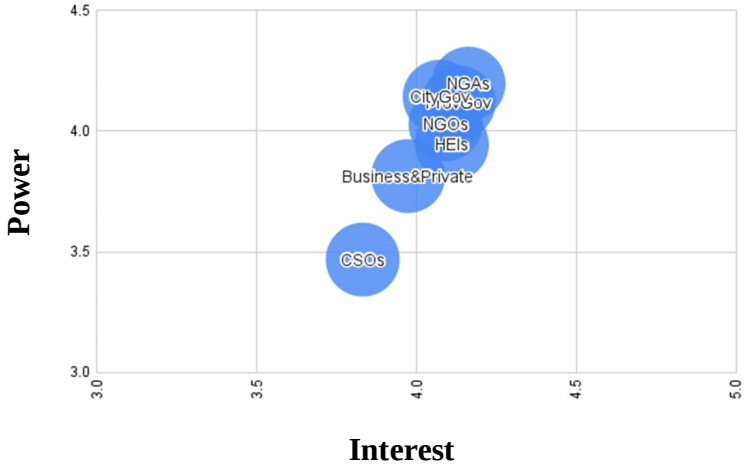


Figure 4. Upper Right Quadrant of Stakeholder Sentiments for Integrating NbS in Infrastructure Planning in Butuan City in relation to Agusan del Norte and Caraga Region

The identification of stakeholders and their level of interest and power is important in prioritizing ecosystem services, which will be discussed in the module 4. Once key stakeholders are determined, they can be consulted when identifying the observed ecosystem services based on their firsthand knowledge of their local environment and its services. s. It should also be noted that learning about the level of power and interest of stakeholders will be helpful in creating a technical working committee and in tapping the right partners. Those with low power but high interest generally have a sense of ownership over implemented projects and strengthen support for chosen priorities and actions. Mapping this kind of stakeholder would lead to the successful implementation and long-term sustainability of an NbS-integrated infrastructure project.

Table 4. Sample worksheet in crafting the local institutional landscape of Butuan City.

STAKEHOLDER	CATEGORY (NGA, LGU, Private, CSO)	PRIMARY ROLE	EXISTING RELEVANT INITIATIVES	POTENTIAL ROLE IN INTEGRATING NBS IN INFRASTRUCTURE PLANNING	POWER	INFLUENCE

MODULE 3: *Forming the local technical working committee*

Purpose of the Module:

Integrating NbS into infrastructure planning and development represents a pivotal framework for fostering sustainability within the planning process. This module emphasizes the establishment of a local Technical Working Committee (NbS TWC) as the initial step to facilitate this integration effectively.

The NbS TWC serves as the focal group that facilitates the integration of NbS in infrastructure planning and development. It offers technical and institutional guidance in the planning process to ensure that the design and implementation of policies and programs are context-specific (i.e., based on the needs and challenges of the local stakeholders). Implementing development initiatives that are context-specific could strengthen their effectiveness and sustainability.

Learning Outcomes:

By the end of this module, participants are expected to understand the importance of establishing NbS TWC, such as to:

1. Learn how to establish and organize a local Technical Working Committee (NbS TWC) that will facilitate the effective integration of NbS into infrastructure projects; and

2. Acquire skills in steering the integration process of NbS into infrastructure planning while ensuring alignment with sustainability objectives and community needs.

Definition and key elements of a technical working committee

The NbS TWC serves as an advisory group, which is ideally established by a government entity. In the Philippines, a TWC can be established by the **local government unit** – either provincial or city/municipal- government, or a **national government agency**, particularly at the regional or national level to provide policy recommendations relevant to the integration of NbS into infrastructure planning and development. This advisory group should be composed of members of various stakeholder groups including technical experts on various key aspects of NbS and infrastructure development.

It has the following key elements:

S tructure: this pertains to the formal rules that guide the operations of the NbS TWC. These include leadership, membership composition, and communication mechanisms within the group.

T echnical expertise: this refers to the knowledge, competencies, and skillsets required from the members of the NbS TWC.

R oles: these are the responsibilities assigned to each member of the NbS TWC. It highlights the accountability of each member in achieving the group's collective goals.

I nteraction: this emphasizes the required working dynamics within the NbS TWC. In achieving the different goals of the group, collaboration among members is important.

V alue: this highlights the positive contribution of the NbS TWC to the community through the integration of the NbS to infrastructure planning and development.

E ngagement: this refers to the active participation of each member of the NbS TWC in the different activities of the group. It also highlights the commitment of the members to achieving the collective goals.

In the Philippines, a TWC, or sometimes referred to as a technical working group (TWG), is formed to pool technical experts from various offices to draft a local development plan, address technical aspects of procurement of equipment and supplies, or coordinate work between and among agencies. For sustainable infrastructure projects and NbS, a TWC is recommended to be formed since the integration of NbS will require experts not only on engineering but also on botany, marine biology, and environmental science.

Responsibilities of the NbS TWC

The NbS TWC is expected to undertake a diverse range of responsibilities aimed at ensuring the successful integration of NbS, such as the following:

- **Steering the Integration Process:** The NbS TWC guides the integration process, ensuring alignment with sustainability objectives.
- **Data Acquisition, Processing, and Analysis:** Members guide the acquisition, processing, and analysis of relevant data to inform decision-making regarding NbS implementation.
- **Strategic Planning and Formulation:** The NbS TWC develops strategic plans and formulates NbS strategies tailored to local contexts and challenges.
- **Monitoring and Evaluation:** Continuous monitoring and evaluation of NbS implementation and effectiveness enable the NbS TWC to make informed adjustments and improvements in the integration process.

Through these functions, the NbS TWC assumes a critical role in seamlessly weaving NbS into infrastructure projects, thereby advancing sustainability and resilience in the built environment. As this might be an additional workload to the members of the NbS TWC, local governments may consider allocating funds for honoraria of members to compensate for the extra work they need to deliver on top of their regular workloads. Other incentives may also be explored and stipulated in administrative orders that will support the creation of an NbS TWC.

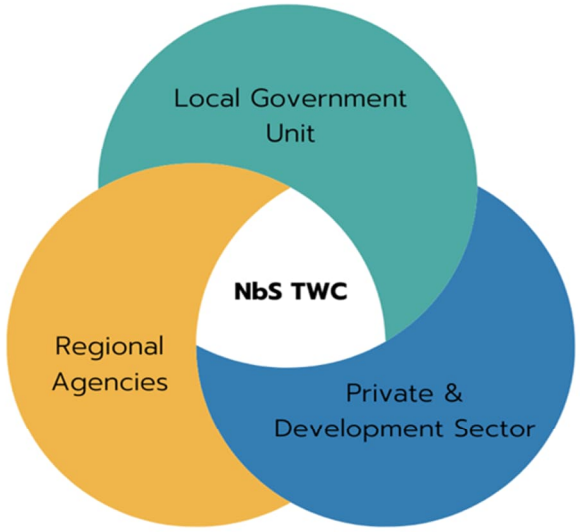
Forming the Local Technical Working Committee

Starting mainstream work in planning and development needs a leader at the helm. Someone to steer the ship to make things work. In many of the policies of the Philippines, the LGU takes the leadership in planning for several challenges that need to be addressed. For example, the city/municipal or provincial local government units must come up with a periodic Local Climate Change Action Plan, Local Disaster Risk Reduction and Management Plan, and Comprehensive Land Use Plan, to name a few. Those who are usually involved in planning are also determined and officially given assignments via an administrative order signed by the local chief executive (mayor or governor). Meanwhile, national government agencies such as the Department of Interior and Local Government and the National Economic Development Authority provide supervision and guidance for LGUs in planning.

In the integration of NbS in Infrastructure Planning and Development, ***the lead LGU shall play an important role in facilitating the selection of the members of the NbS TWC***. The LGU also needs to ensure that it has the necessary institutional support. This institutional support could be through the enactment of a city/municipal ordinance, especially if the infrastructure planning will be facilitated at the local level. Depending on the scope of the development initiative, partnerships between several LGUs might be necessary. For example, if the NbS requires a watershed approach, the local governments that hold jurisdiction in the upstream and downstream might need to be involved.

The leadership must identify all potential members from various relevant organizations when forming the NbS TWC. Creating a multi-sectoral TWC is necessary to effectively integrate NbS in infrastructure planning, where key stakeholders and experts are involved. Doing so offers an opportunity to have a wider perspective on the planning process. **Box 4** identifies the prescribed members of the NbS TWC.

Box 4. Prescribed members of the NbS TWC:



LGU Level:

- Municipal/ City Planning and Development Officer
- Municipal/ City Agriculturist
- Municipal/ City Environment and Natural Resources Officer
- Municipal/ City Disaster Risk Reduction and Management Officer
- Provincial Planning and Development Officer
- Provincial Agriculturist
- Provincial Environment and Natural Resources Officer
- Barangay LGU representatives
- Municipal/City Council Members holding the infrastructure and environment committees
- Indigenous Peoples Mandatory Representative (if applicable)

Regional level:

- DA Regional Office Representative
- DENR Regional Office Representative
- DPWH Regional Office Representative
- Protected area superintendent (if applicable)
- NCIP Regional Office/ Service Center Representative (if applicable)

Private and development sector:

- Electric Cooperative/ Company
- Environmental NGO
- Academe
- Civil society organizations
- Water service provider

Table 1 provides a sample filled-in worksheet with the information needed to form the NbS TWC. A blank worksheet is available in the guidebook's appendix.

Table 1. Example of filled-in worksheet reflecting information about NbS TWC

MEMBER	**AFFILIATION**	**MAIN TASK/S**
City Planning and Development Officer	Butuan City LGU	• Prepare plans • Monitor and evaluate implemented projects
City Agriculturist	Butuan City LGU	• Identify areas with FMR and proposed FMRs • Propose NbS that will be purposeful for agricultural areas
DPWH Regional Office Representative	DPWH Regional Office	· Provide information on road networks
DENR Regional Office Representative	DENR Regional Office	· Recommend/Help identify Ecosystem-based NbS

Crafting the work plan and process flow

Once the NbS TWC is formed, the next step is to craft the work plan or process. The work plan serves as a comprehensive and strategic framework that sets directions for the lead organization and the NbS TWC to effectively integrate the concept of NbS in infrastructure planning and development. The work plan will also be a guide in prioritizing projects for implementation and institutionalization of strategies. The work plan should also include a monitoring and evaluation mechanism to ensure that the different strategies deliver their intended results (outputs, outcomes, and impacts).

In crafting the work plan, the lead agency and the NbS TWC could consider the following information:

- **ACTIVITIES:** The NbS TWC should identify a set of specific activities. These activities include the initial activities, such as collecting primary and secondary data and monitoring and evaluation activities. The set of activities should be manageable for the TWC and its members; hence, breaking the activities down into smaller tasks is important.

- **DURATION:** The NbS TWC should estimate a realistic timeframe for each activity. Some considerations in estimating the duration of each activity include (1) its complexity and (2) the availability of resources.

- **FOCAL PERSON:** A lead individual or group should be identified for each activity. The lead or focal person is responsible for ensuring the completion of these activities and reports to the NbS TWC about any progress or even challenges. Identifying a focal person or group allows accountability for the members of the NbS TWC.

- **TARGET OUTPUTS:** The NbS TWC should also identify or specify expected outputs or deliverables. These outputs could take different forms, such as reports, processed data, policy briefs, and even policies. The expected outputs should be based on the nature of the activities and the realistic timeframe allotted by the NbS TWC.

Table 2 serves as an example of a worksheet for the integration of NbS in infrastructure planning and development. The NbS TWC could use the blank worksheet available in the appendix section or may opt to add more relevant information as needed.

Table 2. Example of worksheet reflecting the work plan

ACTIVITIES	DURATION (months)	FOCAL PERSON	TARGET OUTPUTS

MODULE 4: Climate Risk Assessment and Impact Chain Analysis

Purpose of the Module:

The main goal of climate risk assessment is to provide a thorough evaluation of the current climate conditions, their dynamics and structures. This process also involves conducting an impact chain analysis to systematically identify, evaluate, and quantify potential climate-risks and their cascading impacts on ecosystems, infrastructure, and communities. As such, this module is designed to equip participants with the skills to perform climate risk assessments using data from various sources, carry out risk assessments and impact chain analyses, and apply mapping techniques to make informed decisions about the most appropriate NbS for addressing societal challenges in their area. By the end, participants will have practical knowledge and tools to assess ecological conditions, make data-driven decisions, and implement effective mitigation strategies for sustainable ecosystem management.

Climate risk assessment and impact chain analysis are essential tools for systematically identifying and evaluating potential climate-related threats, allowing users to understand the full scope of risks, predict their cascading effects on ecosystems and infrastructure, and implement effective mitigation strategies to enhance resilience and ensure sustainable management.

Learning Outcomes:

By the end of this module, participants are expected to learn how to perform climate risk assessment and impact chain analysis using data from various sources. Specifically, participants are expected to:

1. Identify and evaluate potential climate-related risks, including those arising from ecological changes and human activities, through climate risk assessments;
2. Analyze potential impacts of these risks using impact chain analysis to understand their cascading impacts on ecosystems, infrastructure, and communities; and
3. Create visual representations of data through mapping to aid in decision-making processes.

The **Climate Risk Assessment** is an important tool for identifying and characterizing environmental risks, as well as understanding the underlying causes of existing or potential climate-related issues. Its main goal is to provide a comprehensive evaluation of communities or municipalities, including their climate dynamics and structural vulnerabilities. Conducting this assessment equips planners and stakeholders with critical insights into the condition and functionality of ecosystems, helping to identify key ecological processes that are most vulnerable to the impacts of climate change and human activities. Alongside the social and political assessments conducted in Modules 2 and 3, the climate risk assessment establishes baseline information about essential ecosystem characteristics in a given area.

In this module, climate risk assessment will be introduced using maps, through spatial and attribute analysis applications.

Tools for Spatial Analysis and Attribute Data Collection (Mapping)

According to the QGIS Documentation (n.d) Website, **Spatial Analysis** is the process of manipulating spatial information to extract new information and meaning from the original data. Usually, spatial analysis is carried out with a Geographic Information System (GIS), a computer system that allows users to record base maps using geospatial referencing and add additional layers suited to the user's objective (Bantayan, 2006). Meanwhile, **Attribute Data** consists of non-spatial information related to geographic features and is linked to the corresponding spatial data, which describe the features themselves. To put simply, attribute data enables mappers to grasp the features of an area.

The initial step for ecological assessment is the spatial analysis and attribute data collection consists of the following:

QGIS Software. This training manual encourages users to use QGIS, an open-source Geographic Information System (GIS) software, to process spatial data obtained from various sources. This software can be downloaded online using this link (Download QGIS).

Spatial Projection. After that, all thematic layers will be projected into the WGS 1984 Universal Transverse Mercator (UTM) Zone 51N coordinate system for consistency.

Geoprocessing. Some techniques, like clipping for vector data and extracting by mask for raster data, will help create new features specific to the study area from larger datasets.

Basemap. A base map representing the study's geographic reference will help users orient themselves to the landscape features.

Digitization is necessary when linear infrastructure data is unavailable. It involves converting images into geographic digital format, which can be represented as polygons, polylines, and points. This process enables the visualization of generated data in GIS and the creation of thematic layers.

Attribute databasing. Following digitization, the next step involves generating attribute data, which provides essential characteristics of the spatial data. While the spatial data represent the geometry and location of the features, attribute data provide additional descriptive information associated with the features.

Resource Characterization using GIS

The term characterization is widely used in resource management. This approach aims to assess the physical features of an area of interest as a basis for sustainable resource management. The integration of advent technologies like GIS is vital for sustainable resource management, offering detailed spatial insights and enhancing the efficiency, effectiveness, and sustainability of various resource-related activities. The utilization of GIS has made resource characterization easier and more accurate.

Overall, the resource characterization enables local government and decision-makers to act as the basis for development, environmental protection, and long-term stewardship of natural resources.

Physical Characterization

In the training manual on Watershed Characterization and Vulnerability Assessment using GIS and Remote Sensing (RS), produced by Forest Management Bureau (FMB) of the DENR, the resource characterization covers the physical, biological, social and economic component of the watershed.

For this module, the characterization focuses on the physical features of the area of interest using GIS. Physical characterization follows the DENR issued Memorandum Circular 2008-005, known as the guidelines in the preparation of Integrated Watershed Management Plans in identifying components that should be described under physical environment for resource characterization. These are as follows:

1. *Geophysical location* – This refers to the area (in ha or sq km) of the area of interest and its administrative jurisdiction. and its relative geographical location. Coordinates are supported by basemaps and other map features to provide a comprehensive overview.

2. *Topography* – This describes the topographic features of the area of interest, including slope, elevation, and landforms. For areas with watersheds, it includes a discussion on the geomorphological features of the watershed, their influence on the amount and velocity of water moving on the land surface, effects on soil erosion potential, and suitability for various land uses.

3. *Geology* - This component focuses on the geological composition, formation, age, and lithology of the area relative to maps of geo-hazard areas and seismicity, especially near fault lines. It also covers geological features (textural and structural) in relation to soil and water.

4. *Soil* – This component refers to the major soil types, conditions, and characteristics, and erosion susceptibility within the interest area. It includes a discussion on the influence of soil characteristics on infiltration capacity, surface runoff, groundwater recharge, and related processes. It also assesses soil characteristics relative to the suitability of the area for crop production.

5. *Land Classification* – This component discusses the extent of Alienable and Disposable Lands (A&D) and forestlands in terms of area coverage within the area of interest.

6. *Land Use/Land Cover* - This examines the current land use and land cover within the area of interest. It includes classifications of various land uses such as agricultural, residential, commercial, industrial, forested, and water bodies. Analysis helps in understanding the spatial distribution and changes over time, which are critical for planning and management.

7. *Climate* – It covers the climatic conditions of the area of interest, including temperature, precipitation, humidity, and seasonal variations. It also discusses climate-related risks such as extreme weather events, droughts, and floods. Understanding the climate is essential for assessing its impact on land use, agriculture, water resources, and overall environmental sustainability.

8. *Linear Infrastructure* - This component details the linear infrastructure within the area of interest, including transportation networks (roads, railways), utility lines (electricity, water, gas), and communication networks (telephone, internet cables). The analysis covers the spatial distribution, connectivity, and impact of these infrastructures on land use, accessibility, and environmental factors.

These components are also available from various agencies and can be accessed from websites or geoportals.

Risk Assessment

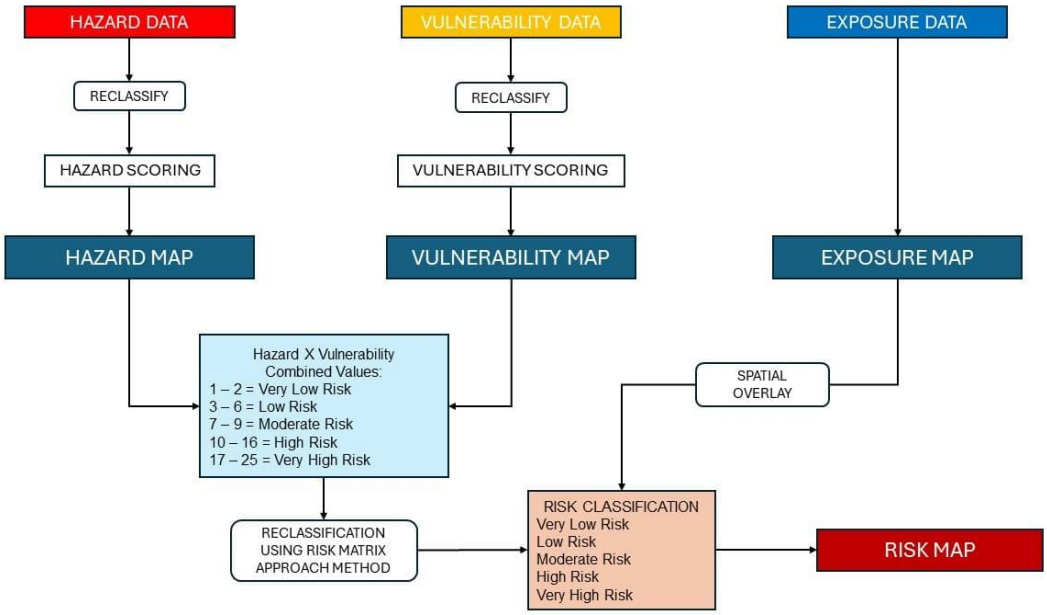
The Philippine Disaster Risk Reduction and Management Act of 2010 defines **Risk Assessment** as a methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihood and the environment on which they depend.

The climate risk assessment outlined in this training manual follows the framework established by the United Nations Office for Disaster Risk Reduction (UNDRR) in 2015. This framework evaluates climate risks based on hazards, exposure, and vulnerability.

Climate risk assessment can be done by overlaying the hazard, exposure, and vulnerability maps for various hazards, such as flooding, liquefaction, rainfall-induced landslides, storm surge, rainfall and temperature changes. As these maps are readily available from government agencies as part of their mandated initiatives, the training will utilize this existing data pool.

The resulting risk maps will serve as crucial tools for pinpointing areas of heightened risk within the context of infrastructure planning, supporting efforts to promote resilience and sustainability.

Box 6. The sample flow chart of GIS-based Climate Risk Assessment



Evidence-based Formulation: Impact Chain Analysis

After risk mapping, evidence-based formulation will be done to establish clear linkages between the natural hazards and their impacts on linear infrastructure and determine the problems that need to be addressed. Being evidence-based means using scientific data and information to show how natural hazards, in various ways, contribute to the infrastructure planning process and implementation.

Hence, this section of the training manual discusses the overall process of the impact chain analysis, a tool that will guide the users to outline and formulate a logical plot of the overall story using the four elements, as adopted and modified from the Asian Institute of Technology manual. Aside from that, identification of the stakeholders or sectors that are direct receptors of the identified hazards within the area will be employed.

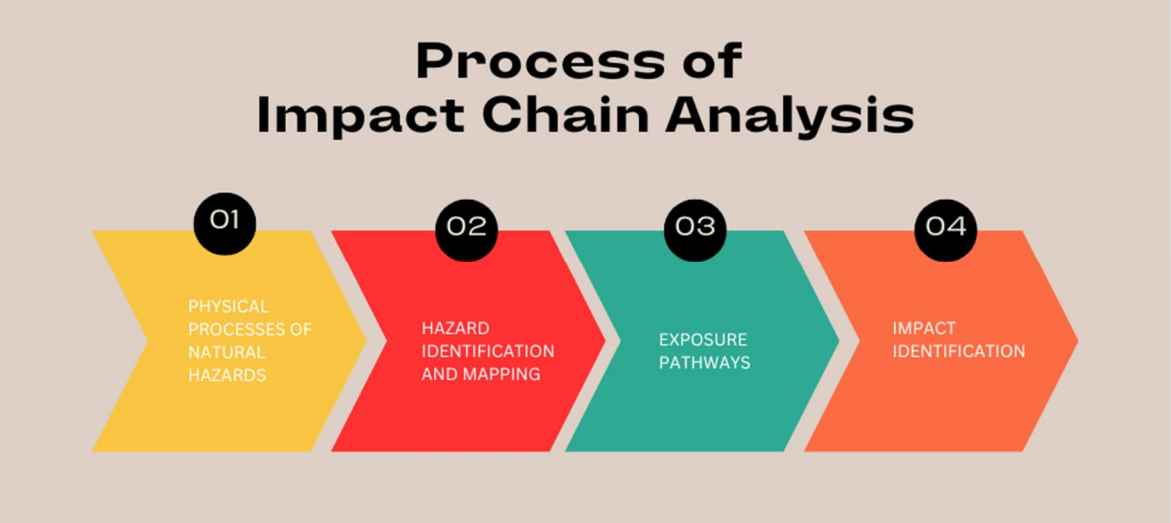


Figure 3. The sample flow chart of Impact Chain Analysis

Step 1: Physical Processes of Natural Hazards

This is the initial step of the impact chain analysis, aiming to understand the physical process of the identified climate-related hazards and earthquake-related hazards for the area.

Step 2. Hazard Identification

This step aims to identify the hazards that tend to be shaped by the interaction of the local topographic features of the area and the physical processes. This may also involve taking into consideration the weather patterns, geologic conditions, human activities, or other relevant factors. Estimation of the likelihood of the hazard scenario to occur will also be done.

Step 3. Exposure Pathways

After hazard identification, the next step is to describe the exposure pathways of how these hazards can cause harm to it. The people, assets, infrastructure, and environmental components that are potentially exposed to the hazard scenario will be determined. The routes of mechanism through which the hazard can affect the vulnerable elements will be traced. This may involve considering direct physical impacts, indirect effects, or cascading consequences.

Step 4. Impact Identification

The last step refers to identification of impacts of hazards to linear infrastructure. To have an in-depth understanding about the impacts of the hazards associated with exposure, variables like linear infrastructures, various tools like problem-tree analysis, and fish-bone technique (see Annex __) are highly recommended which can be used to determine both direct and indirect impacts of the hazards.

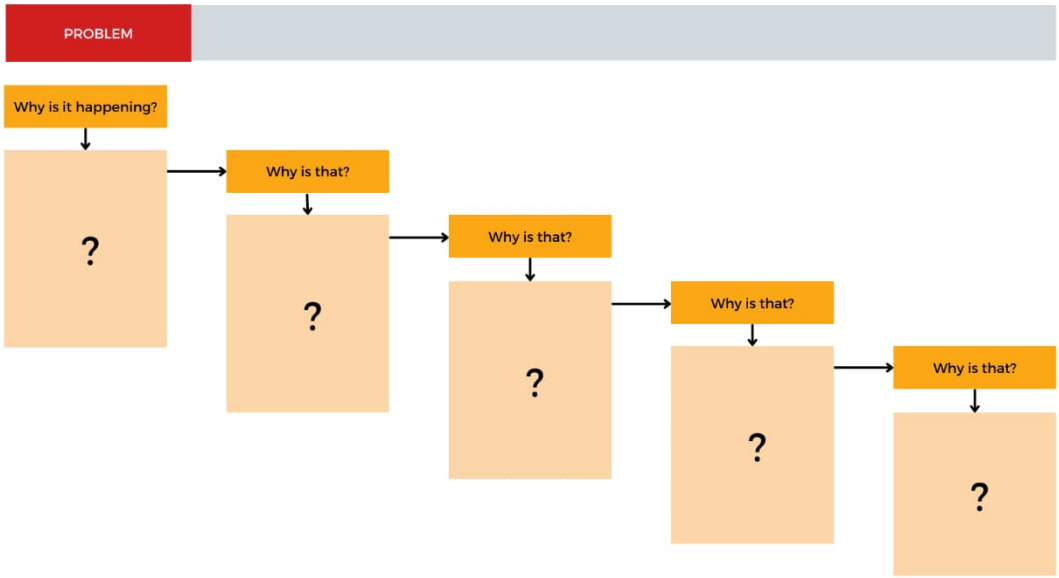
There will be an evaluation of potential consequences of the hazard scenario on the vulnerable elements. For more comprehensive impact identification, the magnitude and severity of the potential impacts are also estimated in the form of number of fatalities, economic costs, displacement of people, loss of ecosystem services, or other relevant indicators. Based on their severity, likelihood, and potential for cascading effects, the most significant impacts will be identified. This can serve as a guide in the mitigation and adaptation efforts in the most critical areas.

Box 7. Activity on Impact Chain Analysis

This activity will use the “5 Whys” technique to diagnose and understand the root cause of key problems affecting your community, local economy, and livelihood. The sample flow diagram will be used for diagnostic analytics.

INSTRUCTIONS

1. **Identify Hazards**:
    a. List the potential hazards associated with your city or town.
    b. Select a key problem that significantly impacts your community.
2. **Define the Problem**:
    a. Clearly state the problem that needs to be addressed.
3. **Apply the 5 Whys Technique**:
    a. **Step 1**: Ask "Why?" the problem is happening.
    b. **Step 2**: Write down the answer.
    c. **Step 3**: Use the answer from Step 2 as the basis for the next question. Ask "Why?" again.
    d. **Step 4**: Repeat this process until you have asked "Why?" five times.
4. **Analyze**:
    a. Review your answers to uncover the root cause of the problem.



Sample diagram for 5 why's techniques

EXAMPLE:

Problem: Frequent flooding in the community.

- **Why?:** It is located next to a river that often floods.
- **Why?:** The forests upstream are no longer able to hold the excess water.
- **Why?:** Many forests have been lost due to land use/land cover changes
- **Why?:** There has been increased infrastructure development upstream
- **Why?: The roads were routed through the forests instead of around them.**

MODULE 5: Identification, Prioritization, Mapping and Quantification of Ecosystem Services (ES)

Purpose of the Module:

This module provides key concepts and methods in evaluating ES. It is structured into four essential phases: (1) ES identification, (2) ES prioritization, (3) ES mapping, and (4) ES quantification. The objective of the module is to guide users through a systematic process of identification, prioritization, mapping and quantifying ecosystem services, providing a clear understanding of how natural ecosystems benefit humans.

Throughout this module, the participants will learn how to identify and evaluate the four categories of ecosystem services: provisioning, supporting, regulating, and cultural. By exploring the spatial distribution and economic value of these services, users—such as local stakeholders—will gain the knowledge needed to make informed decisions. These decisions can support sustainable development, enhance conservation efforts, and optimize the allocation of resources for maximum ecological and economic benefit.

The information generated from this module is crucial for raising awareness about the importance of ecosystems and integrating ecological considerations into planning, management practices, and decision-making processes for sustainable development and resource optimization.

Learning Outcomes:

By the end of this module, participants are expected to gain comprehensive skills in the identification, prioritization, mapping, and quantification of ES, specifically the following:

1. Identify and prioritize key ecosystem services based on their significance to human well-being and ecological health.
2. Utilize mapping techniques and tools for spatial analysis and data integration.
3. Develop skills to measure, quantify, and economically value different ES.
4. Analyze spatial distribution to pinpoint critical areas for conservation and management.
5. Apply knowledge to support informed decision-making, promoting sustainable development and resource optimization.
6. Communicate findings effectively to diverse audiences

Key Concepts of ES

As discussed in Module 1, ecosystem services are endowments of ecosystems that create an environment to support human wellbeing and quality of life (NatureScot, 2023). There are four ecosystem services categories: (1) provisioning, (2) regulating, (3) cultural, and (4) supporting services.

Even though ecosystem services (ES) are not a new idea, this concept still needs additional studies to address inconsistencies in order to precisely understand it (Danley & Widmark, 2016; Saarikoski et al., 2015). To make it simple, the Millennium Ecosystem Assessment (MA) (2005) defined ES as the benefits that humans derive from ecosystems. ES are essential to enhancing and protecting the well-being of humans (Remme et al., 2024).

There have also been quite a few efforts to classify ES. The most influential attempt to create an ecosystem service typology is the MA (Danley & Widmark, 2016). MA has divided ES into four main groups:

1. provisioning (i.e., goods directly used)
2. regulating (i.e., nutrient retention, micro-climate regulation)
3. cultural (i.e., education, spiritual), and
4. supporting (i.e., pollination).

Based on this classification system, the European Environment Agency (EEA) developed a simplified classification named Common International Classification of Ecosystem Services (CICES). While this classification maintains the four categories, it acknowledges that the supporting services are underlying functions that characterize the ecosystems (Grima et al., 2023). This classification has been adopted in the United Nations System of Environmental-Economic Accounting, a framework aiming to consider the state of ecosystems and their services in the economic decision-making process, thus facilitating a more comprehensive understanding of the interplay between the environment and the economy (Sylla et al., 2021).

Identification and Prioritization of ES

Decision makers also need information about ES present in an area. Identifying ES is considered a fundamental step in understanding the benefits that a natural environment can provide to people. This can be achieved by mapping out the ecosystems present within the area of interest using current land cover data. To identify and prioritize ES, an activity in Box 8 shall be accomplished by the training participants during the training.

After identifying and ranking the present ES, the next step is discerning and characterizing ES based on how ecosystems contribute to human well-being, such as by providing clean air and water, regulating climate, supporting pollination, offering recreational opportunities, and maintaining soil fertility (please refer to Module 1 for more information). A comprehensive ES checklist will be prepared to guide training participants in easily identifying the ES present in the area of interest. Data from the activity will be used in mapping the present ES.

In prioritizing ES, it usually begins with identifying key stakeholders who have an interest in or are affected by the local ecosystem. The stakeholders identified in Module 3 are important in determining whose choices matter in prioritizing ES. This may include representatives from local government, national and regional government agencies, community

organizations, environmental groups, indigenous communities, farmers, fisherfolk, businesses, and other relevant entities.

Depending on the familiarity of local stakeholders with ecosystems and ecosystem services, providing a brief educational session may be beneficial. This serves to refresh participants' understanding of the subject matter and ensure that everyone starts from a common foundation, promoting participation and discussion.

After establishing expectations and ensuring a shared understanding of ecosystems and ecosystem services, participants will collaboratively rank the priority ecosystem services. They will identify those vital for daily community activities, those requiring urgent attention, and those deemed more significant than others.

Box 8. Activity on Ecosystem Services Identification and Prioritization

Imagine the ecosystems in the city or town where you live. Imagine being assigned as an advocate for the sustainability of your natural environment. You wanted to implement various strategies to protect the environment. However, you are faced with many limitations – limited financial resources, limited energy to work, limited time. What will you do?

Similar to implementing NbS, a local government is faced with various limitations. This is where prioritization is important – with the limited resources you have, what ecosystem service do you think is the priority to be conserved, enhanced, or protected? This exercise will teach you how.

In your group, discuss the answer to the following questions:

1. In your city/municipality and barangay from where you live, what ecosystems can you identify?
2. What are the ecosystem services present in your area?
3. Which of the ecosystem services is the most important to your group?

   Imagine each member of your group as a stakeholder whose decision carries a significant weight, not only for their personal well-being but also for the entire community. Your collective choices will directly influence what is the most critical ecosystem service that requires focused attention and mitigation efforts. You may rank these based on your personal experiences and perceptions.

   Agree in your group which services are:
   a. most essential to your daily lives
   b. most vulnerable to disruption, and
   c. requires the most urgent attention to ensure their continued provision for the benefit of the entire community.

   Rank each ecosystem service you identified, with 1 being the topmost priority.

   Report the results of your ranking in the plenary after the activity.

   **This activity is a simulation of a participatory approach in ecosystems services ranking. By doing so, it ensures that prioritization reflects the values, needs, and lived experiences of the stakeholders, fostering a sense of ownership and shared responsibility for the sustainable management of their ecosystem.*

   Given that regulating services are often overlooked due to their "invisible" nature, it is crucial for the planner to exercise their discretion and include additional regulating services that may not have been initially prioritized. This is also where the role of Environmental Planners may assist. These services, while less tangible, play a critical role in maintaining ecosystem balance and supporting other essential services. Recognizing their importance and incorporating them into the management plan can enhance the overall resilience and sustainability of the ecosystem.

Mapping of Ecosystem Services

In recent times, technological advancements in remote sensing, geographic information systems, and online platforms like Google Earth Engine and ArcGIS Online have been

gaining popularity in quantitative methodologies in ecological and environmental research (Bagyaraj et al., 2023).

These advancements have greatly enhanced the spatial analysis of land use and land cover in landscape management, particularly concerning the consideration of ecosystem services. Mapping and quantifying ecosystem services have become crucial in integrating nature-based solutions into infrastructure planning. This process offers decision-makers a basis for the spatial distribution of ecosystem services, enabling informed evaluations of potential benefits and trade-offs associated with different infrastructure development options. By mapping ecosystem services, decision-makers can access evidence-based information to prioritize areas for nature-based solutions, ultimately enhancing the resilience and sustainability of infrastructure systems.

Various tools are employed to quantify and map these services, including the Integrated Tool to Value Ecosystem Services and their Trade-offs (InVEST), Artificial Intelligence for Environment and Sustainability (ARIES), Multiscale Integrated Model for Ecosystem Services (MIMES), and Social Values for Ecosystem Services (SolVES). End-users must exercise due diligence in selecting tools, acknowledging their limitations, and disclosing these limitations to set appropriate expectations, especially for those relying on the information.

In this module, InVEST will primarily be utilized due to its accessibility, user-friendly interface facilitating capacity building, and simplified data requirements. While the numerical results of models may not be absolute, the focus lies in understanding the relationships and dynamics of ecosystem services relative to the land use and land cover of the study site.

InVEST Software. This training manual encourages the users to utilize InVEST software in mapping ES. InVEST is an open-source software model used to map and value natural goods and services essential for human life. It helps various entities, such as governments and non-profits, manage natural resources by evaluating trade-offs between environmental and economic goals and identifying areas for investment in natural capital. The toolset includes models for various ecosystems and helper tools for data processing and output visualization, enabling decision-makers to make informed choices that benefit both human development and conservation (https://naturalcapitalproject.stanford.edu/software/invest)

Figure 4. The InVEST software

The software can be downloaded from this link: https://naturalcapitalproject.stanford.edu/software/invest/invest-downloads-data. The overall process of mapping the pre-determined ecosystems services was also provided in the software (see figure__).

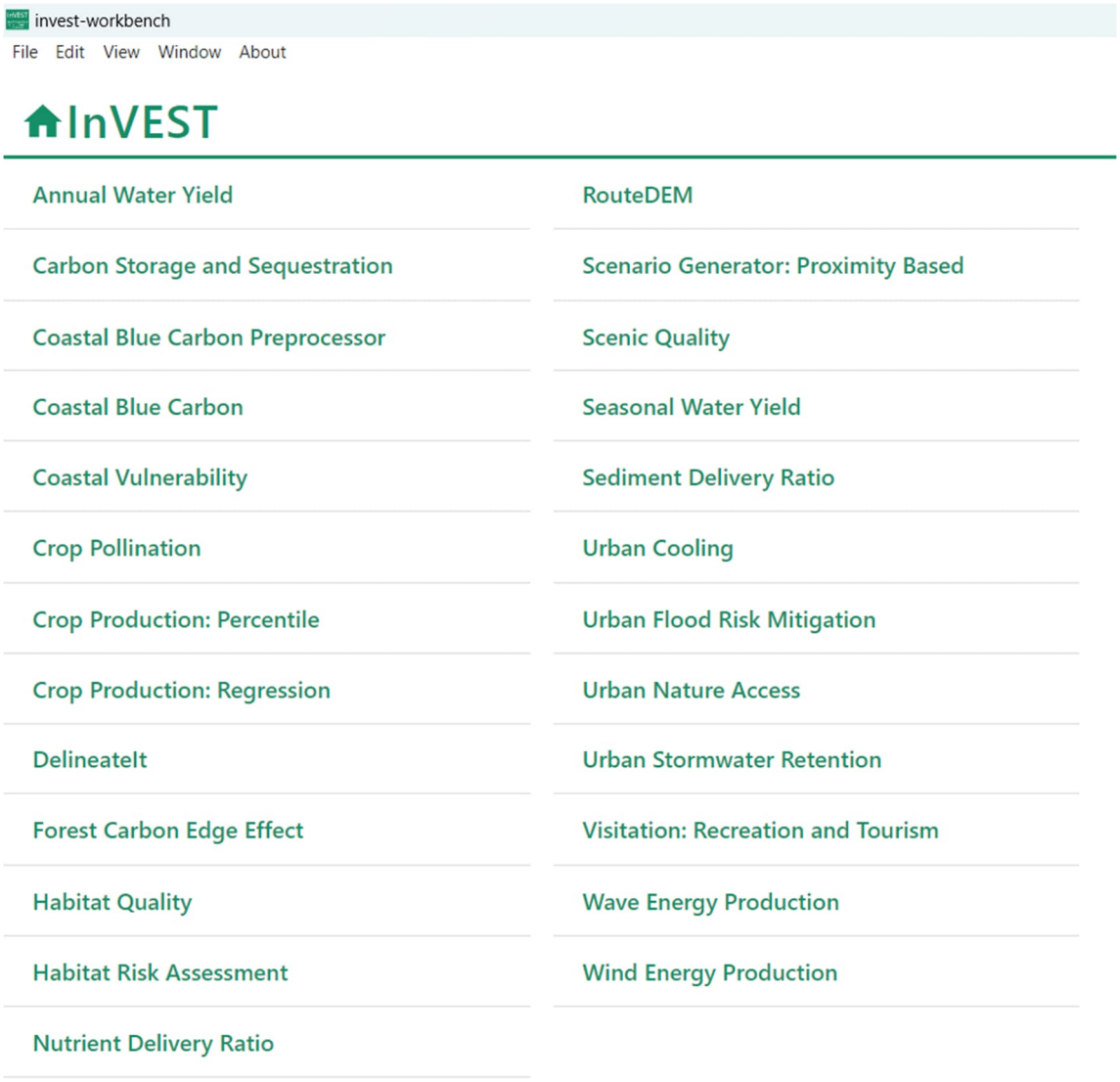


Figure 5. The list of pre-determined ES that can be mapped using InVEST software

Quantification of Ecosystem Services

Quantifying ecosystem services, particularly when aided by spatial data, plays an important role in implementing location-specific approaches to landscape management within policy-making frameworks. By identifying and targeting impaired ecosystem services that are deemed most important among the stakeholders, decision-makers can effectively select NbS tailored to the needs of the area. Priority ecosystem services can be informed by discussion with stakeholders and the community who will potentially benefit from it. Identifying the ecosystem services on which to focus or prioritize will ensure that the efforts and limited resources of a local government and the community are directed towards the most critical services that require immediate attention and are those that are most vital for the well-being of the ecosystem and local communities.

It should be emphasized that engaging local stakeholders in the prioritization of ecosystem services is essential because they hold valuable, firsthand knowledge about their local environment and its services. Please refer to Module 3 on how to identify stakeholders to be involved in the NbS Project.

Process of Combining all ES

Step 1: Uniform Projection

The geospatial layer generated from InVEST software, showing ecosystem services (ES) identified by stakeholders, will be mapped using QGIS software. All ES layers will be projected into WGS 1984 UTM Zone 51N to ensure uniform projection before normalization.

Step 2: Raster Data Normalization

Normalization scales raster data to a common range, typically between 0.00 and 1.00. This process allows users to easily compare datasets from various sources with differing scales and units. It improves the interpretation of values and the visual consistency of maps, highlights patterns and trends, and ensures that when integrating multiple raster layers in models, each layer contributes equally to the final output.

In this module, the raster calculator will be used to normalize all the generated geospatial ES data using the formula used on the study of Fan, et al. (2019):

$$ES_{std} = \frac{ES_{obs} - ES_{min}}{ES_{max} - ES_{min}}$$

where ES_{std} is the standardized value of an ecosystem service, ES_{obs} is an observed value, ES_{min} and ES_{max} are the minimum and maximum observed data, respectively.

Step 3. Creating a New Raster

To combine all the normalized geospatial layers of ES, the creation of a new raster database is required. By doing that, it helps in organizing and managing spatial data efficiently. When you create a raster dataset in a geodatabase, you establish an empty container to hold your raster data. This allows you to add multiple raster datasets through copying or mosaicking, facilitating the integration of various data sources.

Additionally, having a dedicated raster database enables you to leverage geoprocessing tools and other geospatial operations, enhancing your ability to perform complex spatial analyses and obtain accurate results. By structuring your raster data in a geodatabase, you ensure better data management, accessibility, and analytical capabilities.

Mapping ES hotspots and cold spots

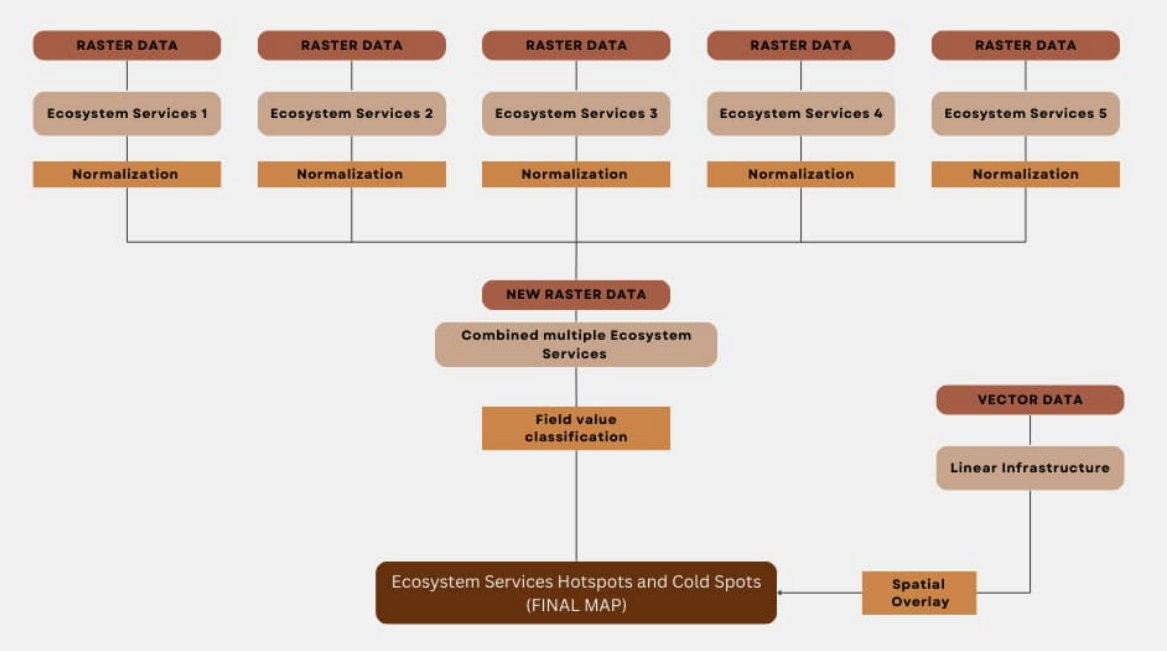
After combining the multiple quantified ES maps into a new raster, the normalized field values will be classified into 5 classes using symbology to visually represent the map. It's crucial for users to easily interpret what the map shows. By doing that, it will identify areas with ES

concentrations. This geospatial approach enables the identification of spatial clusters of ES, which will be valuable for the decision-makers (Lyu et al., 2021).

The spatial analysis will identify hotspots and cold spots in terms of ecosystem services distribution, highlighting areas of abundance and scarcity. It will also illustrate where future linear infrastructure projects are planned to be developed. The process will also identify areas where NbS should be implemented to enhance sustainability and resilience.

By conducting this, stakeholders better understand the spatial dynamics between ES and planned linear infrastructure development. This information is necessary for informed decision-making in infrastructure planning and management. This will also allow decision-makers to identify priority areas for infrastructure development, anticipate potential impacts on ES, and integrate NbS where necessary to mitigate risks and enhance sustainability.

Box 9. The flow diagram shows the methodological process of generating geospatial layer that shows the ES hotspots and cold spots



MODULE 6: NbS Strategies for Sustainable Infrastructure

Purpose of the Module:

Culminating the learnings from this module is enabling planners, decision-makers, and stakeholders to select the most appropriate NbS to support the sustainable development and climate resilience of infrastructures in a given administrative area, may it be a city or municipality, provincial, or region-wide. As such, the purpose of this module is to capacitate the training participants to select the most appropriate NbS strategy/ies that shall help solve the societal challenges they are experiencing vis a vis the necessary infrastructure needed for socio-economic development.

NbS, as discussed in Module #1, has its advantages. However, when poorly selected, an NbS project may become maladaptive. Worse, it can introduce plant species that can negatively affect biodiversity in the area. It is necessary that the NbS project that will be selected does not only pique the interest the community through its provisioning services (i.e., livelihood, food), but it also solves the need to *conserve*, *protect*, and *enhance* the regulatory and support services of the present ecosystem, It must complement the built and proposed infrastructures in the area.

Learning Outcomes:

By the end of this module, participants are expected to:

1. Utilize the knowledge gained in the previous modules in selecting the appropriate NbS for the target ecosystem;
2. Develop an NbS Action Plan that will address the current societal challenge/s; and
3. Present the NbS Action Plan at the end of the training

Developing a NbS Action Plan

Determining the right NbS project entails the application of the knowledge gained in the previous modules in selecting the appropriate NbS for the target ecosystem as well as understanding the global standards. Now that the right foundations needed have been laid, from the technical concepts to the standards, an action plan may now be created. At the end of this module, a template for action planning is included where training participants will choose the most appropriate NbS project needed for the local communities. This will be a group activity where the participants, emulating a Technical Working Committee (TWC) will work together in selecting at least three NbS projects that are suitable for their chosen municipality/city/community.

In crafting the NbS Action Plan, the following are strategies may be considered by NbS Planners:

- ***Choose NbS Projects in connection with the risk assessment and ecosystem priorities.*** NbS projects are meant to solve any or all of the seven societal challenges. This means it is necessary that the TWC is knowledgeable of the current problems within the community, and what are the ecosystem services present to be able to tailor-fit the chosen project to the needs of the community. This places an importance to Modules 1 and 4 of this training-workshop.

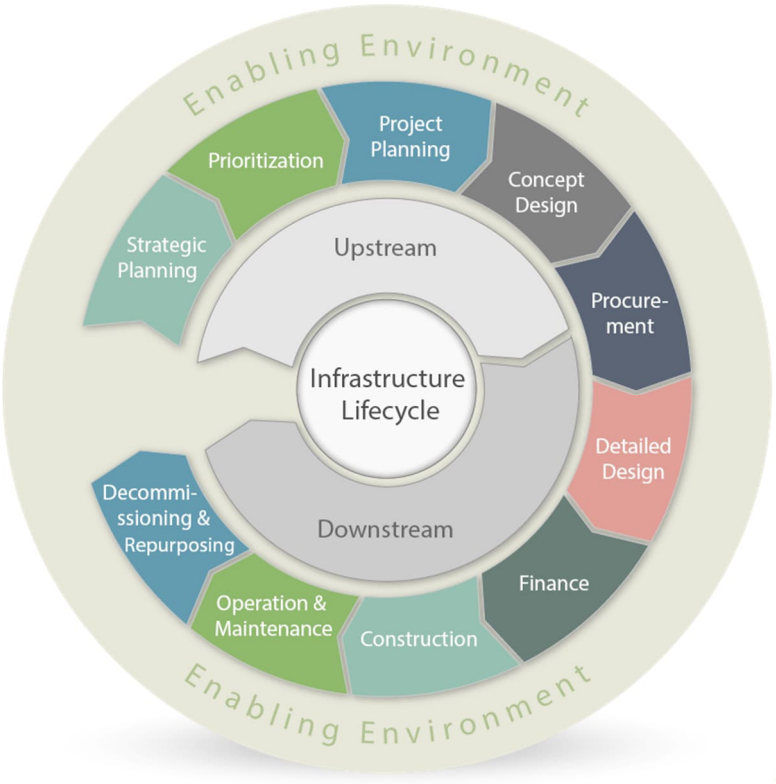
  For example, if flooding is a risk determined in module 4 and the cause is determined, the training participants may determine possible solutions to increase flood risk mitigation. NbS that may be chosen may include designating floodable parks and use of strategies incorporating permeable pavements. If flooding is due to river swelling, an NbS that may be considered is the Kasumi-tei of Japan which helps lessen the kinetic energy or speed of river flow and divert water into floodable areas such as rice paddy fields.

- ***Review plans from various levels of the government and choose projects that align with the development priorities***. For a quick overview of how infrastructure planning and development occurs, the Sustainable Infrastructure Tool Navigator developed the Infrastructure Life Cycle Diagram. Experts' opinion is critical first and foremost during strategic planning where most plans are developed (Figure 6). This is why review of plans is also essential as NbS may have already been determined during strategic planning. Otherwise, NbS may be integrated during project planning, concept design, and detail design.

  The national government, regional development councils, and LGUs have periodic development plans. At the LGU level, they are mandated by national policies to produce several plans including the following:

  - Comprehensive Land Use Plan (CLUP)
  - Comprehensive Development Plan (CDP)
  - Local Climate Change Action Plan (LCCAP), and
  - Local Disaster Risk Reduction and Management Plan (LDRRMP)

  Some cities and municipalities also have their:
  - Masterplan for Sustainable Urban Infrastructure Development Plan (MPSUID)
  - Flood Master Plan (as with the case of Butuan City)
  - River Basin Plan
  - And other types of planning documents



[3]

Figure 6. The Infrastructure Lifecycle Diagram.
Source: https://sustainable-infrastructure-tools.org

At the national and regional levels, the following are also being published:

- The Philippine Development Plan
- National Adaptation Plan
- Regional Development Plan

Other significant plans to consider:

- Protected Area Management Plan
- Ancestral Domain Sustainable Development Plan

These plans already identify the Priority Areas, Programs, Projects, and Activities, and may have a budget allotment already. At the local level, the CLUP details what kinds of projects will be allowed and in what zone or area it should be placed. While tedious, reviewing the available plans may help the local planners to tag priority projects as NbS or enhance the proposed projects by incorporating NbS. In the revision of these plans, NbS projects may also be mainstreamed by incorporating stand-alone NbS projects or by proposing for hybrid green-grey solutions in the plans instead of just engineering-based projects.

- ***Utilization of DRRM Funds for NbS Projects***. In line with RA 10121, the local and national governments are allocating a percentage of their budget to the DRRM fund. Stakeholders may suggest NbS projects to be part of the DRRM funding plan. With this, the expertise of the members of the NbS TWC comes into play where those who are already part of the planning exercise in their LGUs may provide advice on the utilization of DRRM Funds. Additionally, the expertise of those from the academe and

[3]

national agencies such as the DENR, may provide technical advice on NbS projects that may address disaster risk reduction and climate change mitigation and adaptation.

- ***Improvement of social coherence towards a Whole-of-Society Approach***. NbS Projects need the participation of the stakeholders and are a way of enhancing social coherence by allowing people to participate in the implementation and management of NbS. Actions that enable social mobilization and community organizing should be seen as opportunities to improve social coherence towards better disaster resilience by accomplishing the whole-of-society approach in NbS implementation and thus be included in action plans. This can be done through intentional stakeholder consultations to be led by the local government unit (city/municipality/province) and the regional development council through NEDA.

- ***Crafting Information and Education Campaigns (IECs)***. Since NbS requires technical know-how and societal appreciation, the dissemination of vital information on natural resource conservation activities is among the most important steps in ensuring the effective implementation of the NbS projects. Local stakeholders need capacitation on the significance of the natural environment in cushioning the effects of risks to communities. In addition, project implementors can likewise conduct a KAP survey to better design and implement IECs. A very important tool for IEC in the internet age is the use of social media platforms. Conventional strategies such as print formats of brochures or pamphlets are still useful. The national as well as local governments may also partner with the Department of Education to develop school materials that increase awareness of students about the importance of nature, the benefits derived, and the importance of NbS.

- ***Use of engineering mechanisms (hybrid actions).*** While NbS is a promising solution to societal challenges, green solutions will always have a time lag before it grows and realizes its full potential. Project implementors should consider hybrid actions or the combination of engineered and nature-based strategies. An example of a hybrid solution is Japan's Minami-Gamo ecotone where seawalls are built 40 meters away from the coastline to enable the coastal ecosystem to be restored and help in slowing down waves.

- ***Selection of appropriate floral species.*** The selection of floral species in various NbS recommendations, such as mangrove reforestation and floodable and waterfront parks, should be grounded on different considerations. These considerations include the local climatic characteristics, soil and water conditions, and genetic matching of the planting materials. Project implementors should note that poor genetic matching of planting material to the target site may result in reduced viability of the restoration projects. In this case, the expertise of the academe and the Department of Environment and Natural Resources may be tapped.

- ***For areas whose sources of risk comes from an upstream location, consider transboundary collaborations and creation of a NbS TWC with a larger area of jurisdiction.*** Depending on the climate risk assessment conducted in module 4 (for this training), or the results of the climate and disaster risk assessment (CDRA) of each local government, proposed Nature-based Solutions (NbS) can adopt a transboundary approach to address root cause of risks and strengthen its impact. With this, interventions must be planned and implemented across boundaries, whether they be across cities, municipalities, provinces, or regions, especially for

areas with interconnected ecosystems, such as watersheds, river basins, and coastal areas, where environmental challenges and benefits extend beyond a single administrative area.

For instance, problems related to the Agusan River Basin, NbS TWC may adopt the organizational structure of the committees involved in the Agusan River Basin Masterplan, a good example of transboundary approach in river basin management that extends up to the Compostela Valley in Davao De Oro. Through this approach, problems of deforestation, mining, and land conversion in upstream areas that can lead to increased sedimentation, flooding, and reduced water availability downstream may be holistically addressed. To start such work, NGAs such as NEDA, DPWH, and DENR may start the coordination among various local government units.

By working together, administrative jurisdictions may collaboratively explore and implement NbS such as, but not limited to, the following:

1. Forest and watershed restoration for water retention, reduction of erosion, and improved water yield to supply clean water to downstream communities;
2. Sustainable agriculture, agroforestry, and agri-tourism programs to minimize land degradation and improve soil conditions, while providing livelihoods for local communities;
3. Coastal and riverbank protection through mangrove restoration and establishing riparian buffer zones to reduce the impact of floods and enhance biodiversity; and
4. Early warning systems and climate adaptation measures, integrating nature-based flood control strategies with disaster risk reduction.

By coordinating efforts, all local government units within these transboundary areas can maximize resources, enhance climate resilience, and ensure long-term sustainability of NbS projects. Transboundary collaborations provides an enabling environment for policy alignment, shared funding opportunities, and strengthened community engagement, elements that can make NbS effective in addressing societal challenges at a wider scale.

How do we make this module work?

The knowledge gained from this module, along with the learnings from modules 1 to 5, are foundational in designing and implementing the NbS Action Plan that is contextualized, grounded in science, collaborative, and sustainable. Each module contributes essential elements to the planning process:

- **Module 1** lays the important foundation on the purpose of NbS and the concepts related to it that shall participants the ecosystems surrounding them. Appreciating nature's capabilities is a key in addressing key societal challenges such as climate change, water security, and biodiversity loss.
- **Module 2** provides the policy frameworks necessary to justify the legitimacy of NbS for inclusion in investment planning

- **Module 3** relates the relevance of forming a Technical Working Committee (NbS TWC) to facilitate NbS integration in planning effectively as it will serve to offer technical and institutional guidance in the planning process.
- **Module 4** tackles climate risk and impact chain analysis which is the first step in identifying and tailor-fitting NbS based on community's need to improve climate resilience and determine the type of NbS that will complement infrastructure plans and the ecosystems present in the area.
- **Module 5** provides key concepts and methods in identifying, prioritizing, mapping, and quantifying ecosystem services. This encourages planners to work with remote-sensing specialists who could provide maps for decision-making.

By integrating these elements into an NbS action plan, it becomes **a strategic, evidence-based, and collaborative solution for sustainable development and climate resilience**. Additionally, incorporating a **transboundary, ecosystem-based approach**, not only does a singular LGU can work with nature but LGUs across provinces and regions can work together with nature through well-informed NbS.

Now it's time to work on your NbS Action Plan! Let us make practical use of your learnings in this training. In the next page you will find a template for the NbS Action Plan you can fill in groups.

Activity: Template for NbS Action Planning

Now that you have understood what NbS is, identified the risks, and the priority ecosystem services, your final activity is to create an action plan. Please fill out the following action planning table by selecting NbS Projects that are appropriate for your barangay, city/municipality/region/watershed/river basin scale.

Nature-based Solution	**Societal Challenge to be Addressed[a,b]**	**Complementary Grey Infrastructure (if applicable)**	**Performance Indicator and Description of Indicator[c]**	**Target (e.g., area, year, type, number of seedlings planted)**	**Possible Funding Source**	**Responsible Government Office**	**Stakeholder/s to be involved**	**Remarks (M&E, etc.)**
Barangay-Level NbS								
1.								
City/Municipal-Level NbS								
2.								
Regional/Watershed/River Basin Scale NbS								
3.								

[a]Societal challenges: (1) Climate change mitigation and adaptation, (2) Disaster Risk Reduction, (3) Economic and social development, (4) Human health, (5) Food security, (6) Water security, (7) Environmental degradation and biodiversity loss

[b]Refer to your answers in Module 1 - Activity 3 on Societal Challenges.

[c] Performance indicators are indicators that may be used to monitor the performance of the project whether it succeeded or failed. For example, in reforestation efforts, the performance indicator that may be used is the mortality rate of seedlings planted after a period of time. Lower mortality rates may be interpreted as a well-performing project.

References

Albert, C., Schröter, B., Haase, D., Brillinger, M., Henze, J., Herrmann, S., Gottwald, S., Guerrero, P., Nicolas, C., & Matzdorf, B. (2018). Addressing societal challenges through nature-based solutions: How can landscape planning and governance research contribute? Landscape and Urban Planning, 182, 12–21. https://doi.org/10.1016/j.landurbplan.2018.10.003

Babí Almenar, J., Elliot, T., Rugani, B., Philippe, B., Navarrete Gutierrez, T., Sonnemann, G., & Geneletti, D. (2021). Nexus between nature-based solutions, Ecosystem Services and urban challenges. *Land Use Policy*, *100*, 104898. https://doi.org/10.1016/j.landusepol.2020.104898

Bagyaraj, M., Senapathi, V., Karthikeyan, S., Chung, S.Y., Khatibi, R., Nadiri, A.A., & Lajayer. (2023). A study of urban heat island effects using remote sensing and GIS techniques in Kancheepuram, Tamil Nadu, India. *Urban Climate, 51,* 101597. https://doi.org/10.1016/j.uclim.2023.101597

Beck, M. W., Narayan, S., Trespalacios, D., Pfliegner, K., Losada, I. J., Menéndez, P. Espejo, A., Torres, S., Díaz-Simal, P., Fernandez, F., Abad, S., Mucke, P., Kirch. L. (2018). The global value of mangroves for risk reduction. Summary Report. The Nature Conservancy, Berlin. https://www.conservationgateway.org/ConservationPractices/Marine/crr/library/Documents/GlobalMangrovesRiskReductionSummaryReport10.7291/V9930RBC.pdf

Bryson, J. M. (2004). What to do when Stakeholders matter: Stakeholder Identification and Analysis Techniques . *Public Management Review*, *6*(1), 21–53. https://doi.org/10.1080/14719030410001675722

Bush, J., & Doyon, A. (2019). Building urban resilience with nature-based solutions: How can urban planning contribute? Cities, 95, 102483. https://doi.org/10.1016/j.cities.2019.102483

Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). Nature-based solutions to address global societal challenges. IUCN: Gland, Switzerland, 97, 2016-2036

Czucz, B., Arany, A., Potschin-Young, M., Bereczki, K., Kertesz, M., Kiss, M., Aszalos, R., & Haines-Young, R. (2018). Where concepts meet the real world: A systematic review of ecosystem service indicators and their classification using CICES. Ecosystem Services, 29, Part A, 145-157. https://doi.org/10.1016/j.ecoser.2017.11.018

Danley, B., & Widmark, C. (2016). Evaluating conceptual definitions of ecosystem services and their implications. *Ecological Economics, 126,* 132-138. https://doi.org/10.1016/j.ecolecon.2016.04003

Department of Environment and Natural Resources. (2008). DENR Memorandum Circular NO. 05-08 – Guidelines in the Preparation of Integrated Watershed Management Plans

European Commission: Directorate-General for Research and Innovation. (2015). Towards an EU research and innovation policy agenda for nature-based solutions & re-naturing cities : final report of the Horizon 2020 expert group on 'Nature-based solutions and re-naturing cities' : (full version). Publications Office. https://data.europa.eu/doi/10.2777/479582.

European Commission (2024, October 17). Nature-based solutions. https://research-and-innovation.ec.europa.eu/research-area/environment/nature-based-solutions_en

Fan, F., Liang, C., Tang, Y., Harker-Schuch, I., & Porter, J. R. (2019). Effects and relationships of grazing intensity on multiple ecosystem services in the Inner Mongolian steppe. Science of the Total Environment, 675, 642–650. https://doi.org/10.1016/j.scitotenv.2019.04.279

Global Commission on Adaptation. (2019). *Adapt Now: A Global Call for Leadership on Climate Resilience.* Rotterdam and Washington, DC: Global Commission on Adaptation

Grimma, N., Jutras-Perreault, M.C., Gobakken, T., Ørka, H.O., & Vacik, H. (2023). Systematic review for a set of indicators supporting the Common International Classification of Ecosystem Services. *Ecological Indicators, 147,* 109978. https://doi.org/10.1016/j.ecolind.2023.109978

International Union for the Conservation of Nature (IUCN). (2020). IUCN Global Standard for Nature-based Solutions. https://portals.iucn.org/library/sites/library/files/documents/2020-020-En.pdf

IUCN. (2020, July). Ensuring effective nature-based solutions. *IUCN Issues Brief.* https://www.iucn.org/sites/default/files/2022-02/iucn_issues_brief_-_nbs_standard_eng.pdf

IUCN (2017, November). Ecosystem-based Adaptation. *IUCN Issues Brief*. https://www.iucn.org/sites/default/files/2022-07/ecosystem-based_adaptation_issues_brief_final.pdf

Keith, D. A., Ferrer-Paris, J. R., Nicholson, E., Bishop, M., Polidoro, B. A., Ramirez-Llodra E., Tozer, M. G., Nel, J. L., Mac Nally, R., Gregr, E. J., Watermeyer, K. E., Essl, F., Faber-Langendoen, D., Franklin, J., Lehmann, C. E. R., Etter, A., Roux, D. J., Stark, J. S., Rowland, J. A., … R. T. Kingsford. (2022). A function-based typology for Earth's ecosystems Nature 610, 513–518. https://global-ecosystems.org/

Lyu, R., Clarke, K. C., Zhang, J., Feng, J., Jia, X., & Li, J. (2021). Dynamics of spatial relationships among ecosystem services and their determinants: Implications for land use system reform in Northwestern China. *Land Use Policy*, *102*(January), 105231. https://doi.org/10.1016/j.landusepol.2020.105231

Maes, J., & Jacobs, S. (2017). Nature-based solutions for Europe's sustainable development. Conservation letters, 10(1), 121-124.

National Geographic Society. (2024, March 6). Ecosystem. https://education.nationalgeographic.org/resource/ecosystem/

NatureScot. (2023). Ecosystem services - nature's benefits. https://www.nature.scot/scotlands-biodiversity/scottish-biodiversity-strategy-and-cop15/ecosystem-approach/ecosystem-services-natures-benefits

Penn Wharton Budget Model. (2018, February 9). Options for infrastructure investment: dynamic modeling. Retrieved from: https://budgetmodel.wharton.upenn.edu/issues/2018/2/9/infrastructure-investment-dynamic-modeling?Rq=complement

Remme, R.P., Meacham, M., Pellowe, K.E., Andersson, E., Guery, A.D., Janke, B., Liu, L., Lonsdorf, E., Li, M., Mao, Y., Nootenboom, C., Wu, T., & van Odenhoven, A. (2024). Aligning nature-based solutions with ecosystem services in the urban century. *Ecosystem*

Services, 66, 101610. https://doi.org/10.1016/j.ecoser.2024.101610

Saarikoski, H., Jax, K., Harrison, P.A., Primmer, E., Barton, D.N., Moninen, L., Vihervaara, & Furman, E. (2015). Exploring operational ecosystem service definitions: The case of boreal forests. *Ecosystem Services, 14,* 144-157. https://doi.org/j.ecoser.2015.03.006

Saito, O., Subramanian, S. M., Hashimoto, S. & Takeuchi K. (2020). Introduction: Socio-ecological Production Landscapes and Seascapes. In O. Saito , S. M. Subramanian, S. Hashimoto & K. Takeuchi (Eds.), Managing Socio-ecological Production Landscapes and Seascapes for Sustainable Communities in Asia, Science for Sustainable Societies. Springer. https://doi.org/10.1007/978-981-15-1133-2_1

Seddon, N., Chausson, A., Berry P., Girardin C. A. J., Smith A., & Turner B. (2020). Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Philosophical Transactions B*, *375,* 1-12. http://dx.doi.org/10.1098/rstb.2019.0120

Srinivas, Hari, "Sustainable Development: Concepts". GDRC Research Output E-008. Kobe, Japan: Global Development Research Center. Retrieved from https://www.gdrc.org/sustdev/concepts.html

Sylla, Harmáčková, Z.V., Grammatikopoulou, I., Whitham, C., Pártl, & Vačkářová, D. (2021). Methodological and empirical challenges of SEEA EEA in developing contexts: Towards ecosystem service accounts in the Kyrgyz Republic. *Ecosystem Services, 50,* 101333. https://doi.org/10.1016/j.ecoser.2021.101333

Thacker S., Adshead D., Fantini C., Palmer R., Ghosal R., Adeoti T., Morgan G., & Stratton-Short S. (2021). Infrastructure for climate action. Retrieved from: https://content.unops.org/publications/Infrastructure-for-climate-action_EN.pdf?mtime=20211008124956&focal=none

1

Yan, Y., Liu, W., Wang, J., Yu, W., Luo, H., & Liu, W. (2021). A dynamic monetary valuation perspective for carbon sequestration: Effect on biomass utilization strategy of Caragana plantation as an illustration. *Ecological Indicators*, *128*, 107854. https://doi.org/10.1016/j.ecolind.2021.107854

Appendix 1. Worksheet for members of the NbS TWC

MEMBER	**AFFILIATION**	**MAIN TASK/S**

Appendix 2. Worksheet for the workplan

ACTIVITIES	**DURATION**	**FOCAL PERSON**	**TARGET OUTPUTS**

Valuable Resources on Nature-based Solutions

1. WWF Powering Nature: Creating the Conditions to Enable Nature-based Solutions. https://lp.panda.org/powering-nature-report

2. IUCN Nature-based Solutions Website. https://www.iucn.org/our-work/nature-based-solutions

3. InVEST Models. https://naturalcapitalproject.stanford.edu/software/invest

4. Examples of Nature-based Solutions for Risk Management from the Federal Emergency Management Agency of the US Department of Homeland Security. https://www.fema.gov/emergency-managers/risk-management/climate-resilience/nature-based-solutions

5. Adaptation Literacy E-Learning: Nature-based solutions for the local communities from the Asia-Pacific Climate Change Adaptation Information Platform. https://ap-plat.nies.go.jp/adaptation_literacy/resources/e_learning/index.html

6. Public Infrastructure for Effective Climate Mitigation and Adaptation: A Workshop from the National Academies of Sciences, Engineering, and Medicine. https://www.nationalacademies.org/our-work/public-infrastructure-for-effective-climate-mitigation-and-adaptation-a-workshop?utm_source=All+DBASSE+Newsletters&utm_campaign=83ce5528b4-becs-public-infrastructure-pib&utm_medium=email&utm_term=0_-83ce5528b4-%5BLIST_EMAIL_ID%5D

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