NATIONAL ECOSYSTEM ASSESSMENT REPORT OF VIETNAM

Support to developing capacities to address science-policy-practice interface' project

Hanoi, May 2022

The report has been produced by the Center for Biodiversity Conservation under the Vietnam Union of Science and Technology Associations and the Institute of Strategy and Policy for Natural Resources and Environment of the Ministry of Natural Resources and Environment, as part of the initiative on Building capacity for national ecosystem assessments: linking science and policy and the Biodiversity and Ecosystem Services Network (BES-Net). Financial support was provided by the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of the Federal Republic of Germany.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ASEAN	Association of South East Asian Nations
CBD	Convention on Biological Diversity
CDM	Clean Development Mechanism
DARD	Department of Agriculture and Rural Development
DONRE	Department of Natural Resources and Environment
DOSTE	Department of Science, Technology and Environment
FPD	Forest Protection Department
FSIV	Forest Science Institute of Vietnam
GAP	Good Agricultural Practice
GDP	Gross Domestic Product
GEF	Global Emvironment Facility
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSO	General Statistics Office
IEBR	Institute of Ecology and Biological Resources
ISPONRE	Institute of Strategy and Policy for Natural Resources and Environment
IPBES	Intergovernmental Science-Policy Platform on Biodiversity & Ecosystem Services
IUCN	International Union for the Conservation of Nature
MARD	Ministry of Agriculture and Rural Development
MCD	Centre for Marine Life Conservation and Community Development
MOH	Ministry of Health
MONRE	Ministry of Natural Resources and Environment
MOST	Ministry of Science and Technology
MPA	Marine Protected Area
NEA	National Ecosystem Assessment
NP	National Park
NR	Nature Reserve
NTFP	Non-Timber Forest Product
PA	Protected Area
PFES	Payment for Forest Environmental Services
PPC	Provincial People Committee
RIMF	Research Institute of Marine Fisheries
VEA	Vietnam Environment Administration
TEV	Total Economic Value
USAID	United States Agency for International Development
VFD	Vietnam Forest and Delta Program Project
VNFOREST	Vietnam Administration of Forestry
VND	Vietnamese Dong (currency with exchange rate fluctuates from 20,000 VND to 23,000 VND = 1 USD during 2010-2021)
WWF	World Wide Fund for Nature

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EXECUTIVE SUMMARY

This report represents the first National Ecosystem Assessment (NEA) of Vietnam, one of the most biodiverse countries on the planet. A particular focus is on forest, wetland, and marine and coastal ecosystems that provide the highest level of ecosystem services for human well-being in the country and continue to be indispensable to the nation's economic growth. The NEA report has been developed on the basis of the following five policy questions:

1. What is the status of biodiversity and trends of key ecosystems (***forest, wetland, and marine and coastal ecosystems***) and the services they deliver in Vietnam?
2. How do forest, wetland, and marine and coastal ecosystems services contribute to the socio-economy?
3. What are the pressures driving changes in the status and trends of forest, wetland, and marine and coastal ecosystem services and their impacts on the socio-economy?
4. How might ecosystems and their services change in the future under various plausible scenarios?
5. What is the legal and institutional framework for biodiversity and ecosystem services and what are the impacts, gaps and recommendations to enhance ecosystems and their services?

The assessment reveals that these ecosystems, along with the vital social and economic services they provide, are under threat. The report highlights the main pressures driving the trends in degradation of the nation's ecosystems, the impacts of these changes on the economy and the society, and the current responses by the Government of Vietnam to raise the population's awareness of this degradation, and to design and implement suitable preventative and remedial actions such as payments for forest environmental services to communities to reverse this decline.

Following a comprehensive assessment of the current state of the nation's ecosystems and their services, four future scenarios were explored. These are the 'development as usual' scenario, the 'feasible baseline' scenario, the 'higher growth' scenario and the scenario of 'sustainable development associated with conservation'. For each of these scenarios, predicted changes in the importance of the drivers and pressures affecting ecosystems and their services, such as population growth, climate change, etc. were analysed. A range of proactive preventative management measures are also offered to counter ecosystem degradation and forestall ecosystem collapse.

Finally, the report examines the existing legal and institutional framework for protecting the nation's forest, wetland, and marine and coastal ecosystems and their services, along with conservation and sustainable use of biodiversity, genetic resources and the role of traditional knowledge. The assessment also identifies gaps in the current framework and proposes ways for it to be strengthened, including amending and supplementing the Biodiversity Law and the relevant policies.

The NEA report puts forward 21 key messages highlighting main problems facing ecosystems and their services as well as principal solutions, linked to the five policy questions, including:

1. Vietnam has high biodiversity with an abundance of natural ecosystems, species, and rich and endemic genetic resources.
2. Most of important ecosystems are located in a system of 176 protected areas.
3. Ecosystems which provide the most services and are high in biodiversity and biological productivity tend to be degraded.
4. Traditional and indigenous knowledge on conservation and sustainable use of biodiversity are extremely diverse and abundant.

5. Ecosystems which provide the most services and are high in biodiversity and biological productivity contribute significant benefits to the socio-economy.
6. Forest ecosystems in Vietnam contribute to the socio-economy in a range of ways, including to local livelihoods through payments for forest environmental services.
7. Evaluation studies of ecosystems in Vietnam show how significant these services are in the socio-economy.
8. The services provided by Vietnam's ecosystems are on a declining trend.
9. Societal awareness on the value of the benefits of ecosystem services is still low.
10. Seven factors as drivers of change in the status and trends of ecosystems affecting their services were identified by Vietnam's national ecosystem assessment.
11. Five factors as pressures to change in the status and trends of ecosystems affecting their services were identified by Vietnam's national ecosystem assessment.
12. The impact of changes in ecosystem services on the socio-economy shows a trade-off between increased production outputs and ecosystem degradation, leading to reduction in ecosystem services overall.
13. The first future plausible scenarios for ecosystems and their services were developed in Vietnam, examining the potential effects of changes in drivers and pressures.
14. The movement of drivers and pressures according to the scenarios developed under Vietnam's NEA shows that some factors (such as population growth) will become less important while others (such as population distribution) will be more important.
15. The scenarios developed by Vietnam's NEA predict changes in the quality of ecosystems and their services due to clear changes between the scenarios in provisioning and regulating services.
16. Seven sets of measures proposed in Vietnam's NEA show ways to improve proactive management of ecosystems and their services.
17. The legal framework on conservation and sustainable use of biodiversity and ecosystems is gradually being improved in Vietnam but it is still inconsistent or conflictive resulting in obstacles or difficulties in implementation.
18. The institutional framework on management of biodiversity and ecosystems in Vietnam has been reorganized, there are still overlaps in function and missions.
19. Policy documents have had significant impacts on biodiversity conservation and ecosystem services in the country.
20. Existing policy measures have made significant contributions to maintain and enhance ecosystems and their services.
21. Specific recommendations to maintain and enhance ecosystem services are proposed by the national ecosystems assessment.

The above 21 key messages summarise the most important findings and recommendations from the NEA to be conveyed to policy makers and stakeholders of relevant sectors at all levels, aiming for their integration into relevant policy development and societal processes.

INTRODUCTION

Vietnam is one of the world's richest centres of biodiversity with many natural and diverse ecosystems. According to the Ministry of Natural Resources and Environment (*MONRE, 2020*), terrestrial ecosystems, wetland ecosystems and marine ecosystems are identified as the country's three main ecosystem groups, featuring the typical ecology of the tropics. These three main ecosystem groups are habitat for many endemic wildlife species and provide a wide range of valued services for the stability and development of human well-being, the environment, and the national economy. However, currently, ecosystems in Vietnam are facing a decline in both quantity and quality due to various threats. Pressure from the increasing human population combined with an increasing level of consumption is resulting in overexploitation of biodiversity resources. Rapid socio-economic development has also changed the natural landscape. Land conversion and infrastructure construction has significantly reduced the area of natural habitats, increased ecosystem fragmentation, and degraded the habitats of many species of wild plants and animals. In addition, alien species, environmental pollution and climate change are all directly impacting on the biodiversity and ecosystems of Vietnam.

The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was established by Governments in 2012 with the specific aim of strengthening the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development. The identified functions of IPBES are to carry out and promote assessments and develop and promote the use of policy support tools; and to create the necessary enabling environment through facilitating capacity building and knowledge generation.

An ecosystem assessment plays an important role in synthesizing and communicating complex information and can both inform and influence decision-making processes, e.g. ecosystem assessments can: respond to decision makers' need for credible and robust information; highlight trade-offs between decision options; model future prospects to avoid unforeseen, long-term consequences; and provide critical judgement of options and uncertainty enabling decision makers to choose policies that sustain the appropriate mix of services, etc. Ecosystem assessments provide an opportunity to improve the required understanding based on scientific information and to significantly inform decision-making within global processes towards attaining the goals of the Strategic Plan for Biodiversity 2011-2020 and its Aichi Targets, the Sustainable Development Goals and other relevant processes. At national levels, ecosystem assessments equally provide an opportunity to inform decision-making processes towards attaining national development goals and national biodiversity related strategic plans; to meet the information needs for policy makers at different sectors; to strengthen capacity through the science-policy interface and to promote an integration of biodiversity and ecosystem services into action plans.

Since 2017, the National Ecosystem Assessment Initiative at UNEP WCMC has supported countries to conduct national ecosystem assessments. This support is delivered in collaboration with the United Nations Development Programme (UNDP) and the United Nations Educational, Scientific and Cultural Organisation (UNESCO) through the Biodiversity and Ecosystem Services Network (BES-Net). Financial support for the NEA Initiative is provided by the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection of the Federal Republic of Germany.

In Vietnam, the Center for Biodiversity Conservation (CBC) under the Vietnam Union of Science and Technology Associations (VUSTA) in collaboration with the Institute of Strategy and Policy for Natural Resources and Environment (ISPONRE) of the Ministry of Natural

Resources and Environment (MONRE) and relevant institutions are implementing the "Support to developing capacities to address science-policy-practice interface' project" from April 2017 to April 2022 to support and advise the Government on which policies should be revised and developed to maintain and enhance the benefits from ecosystem services in Vietnam. The specific objectives of the project are to (i) build national capacity on assessment of ecosystem services; (ii) provide a scientific base for the policy making process; and (iii) support to integrate biodiversity and ecosystem services into policy, planning development at all levels.

The national ecosystem assessment (NEA) report provides the assessment results on the selected three key ecosystems (forest ecosystem; wetland ecosystem; and marine and coastal ecosystems) in Vietnam for assisting the decision making process with the purpose of promoting an integration of biodiversity and ES into policy, planning development of relevant sectors.

The NEA report comprises six parts including: (i) general information; (ii) the status of biodiversity and trends in ecosystems; (iii) contributions of the three key ecosystems to the socio-economy; (iv) drivers, pressures to changes in ecosystem services and its impacts on the socio-economy; (v) the four future plausible scenarios for ecosystems and their services; and (vi) legal and institutional framework on conservation and sustainable use of biodiversity and ecosystems including impacts, gaps and some recommendations to enhance ecosystems and their services.

The NEA report has been formulated on the basis of secondary information and data, and incorporates contributions from many experts in the field of environment and biodiversity from national and international organizations. The report has also been reviewed by different relevant stakeholders from central to provincial levels at many meetings, workshops and the national trialogue workshop in Vietnam. Therefore, we do hope that the report will be a valuable and useful reference document for policy makers as well as officials, experts, scientists in the field of biodiversity conservation and relevant areas.

PART I. GENERAL INFORMATION

I. CONTEXT, NECESSITY AND GLOSSARY OF TERMS

1.1. Context

In Vietnam, biodiversity is of great significance, and its ecosystems and varied biological resources have brought direct benefits to humans and have contributed significantly to the economy, especially in agriculture, forestry, and fisheries. Biodiversity and ecosystem services in Vietnam underpin national food security and maintain the genetic resources of farming animals and plants. They also have a substantial impact on quality of life and the economy, but are often not adequately assessed, especially in economic terms.

In Vietnam, about 25 million poor people are involved in forests and protected areas, where they are heavily dependent on forest ecosystem services for their livelihoods (*MARD, 2020*). The nature of these interactions in forests, as well as other ecosystems, might drive the degradation of biodiversity and ecosystem services if they are not refocused to harness nature's benefits to people more efficiently, while simultaneously ensuring the sustainability and resilience of biodiversity and ecosystems.

Recognizing the importance of biodiversity and ecosystems services, Vietnam has adopted relevant laws, strategies and plans for biodiversity conservation and sustainable development. Especially, forest ecosystems services have been the focus of the Government pilot policy for payment for forest environmental services (PFES) in 2008 and Government Decree on the policy for payment for forest ecosystems services issued in 2010. To date, PFES has been making a significant contribution to the national economy and human well-being.

In order to maintain and promote ecosystems services, there is a need of a national ecosystem assessment, which focuses on the links between ecosystem services and nature's benefits to people, paying particular attention to improving livelihoods within the context of demographic change (population growth, gender relations and urbanization), economic growth and poverty reduction. This is also to take into account the nature of interactions between economic development and ecosystems, which could drive the degradation of biodiversity and ecosystem services if the benefits of nature to people are not assessed comprehensively.

Vietnam became a member of the Convention on Biological diversity (CBD) in 1994 and the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) in 2015, and has a range of other biodiversity-related international commitments. IPBES was established by Governments in 2012 with the specific aim of strengthening the science-policy interface for biodiversity and ecosystem services for the conservation and sustainable use of biodiversity, long-term human well-being and sustainable development. The identified functions of IPBES are to carry out and promote assessments and develop and promote the use of policy support tools; and to create the necessary enabling environment through facilitating capacity building and knowledge generation. Accordingly, Vietnam shall put more effort into this national ecosystem assessment project to address the major challenges for biodiversity and ecosystems for sustainable development. Especially, integration of the priorities for biodiversity and ESs into national policies is essential to implement the CBD commitments and national strategies.

The "Support to developing capacities to address science-policy-practice interface' project" was funded to implement a pilot NEA in Vietnam and other partner countries, helping to achieve IPBES's objectives at national level.

1.2. Necessity

Ecosystem assessment is a tool to support decision-making on ecosystem management planning, investment in ecosystem protection and development or even ecosystem service prioritization (in case there needs to be a trade-off among ecosystem services). Healthy ecosystems provide a wide range of valuable goods and services to people. Therefore, sustainable management of ecosystems must take these values into account, and must examine the effects changing ecosystems have on human well-being. Specifically, ecosystem assessment analyses ecosystems and their provision of services at present and under future scenarios of change, such as climate change. Thereby, it gives decision makers the information they need to improve the conservation and sustainable use of ecosystems and to minimize negative impacts of development activities and other policy initiatives.

Ecosystem assessment is a social process which establishes a scientific connection between environmental issues and people (e.g. connecting the environmental and development sectors. It is a technical, interdisciplinary analysis of the ecosystem services produced and/or received within a defined study area, and how they may be affected by change (*Ash et al.,2010).*

A major challenge within national policy settings and decision-making processes on biodiversity and ecosystem services is a lack of real understanding of their value in many sectors of society, as well as a lack of tools to be able to integrate knowledge on ecosystem services into policy setting and into day-to-day decision-making based on scientific knowledge. Many different sectors are dependent on ecosystem services and they are often identified as critical for a country's development policy and related actions. Ecosystem assessments can provide a mechanism to develop an evidence base that meets the needs of different sectors and encourages the integration of biodiversity and ecosystem services within their actions (*The report of Global inception and capacity building meeting, NESDA-CA and UNEP-WCMC, 2017*).

This assessment will help decision makers and policy makers to develop relevant policy solutions, identify practical management options and tools and best practices for biodiversity and ecosystem services conservation in Vietnam. It will assist in mainstreaming biodiversity and ecosystem services into policy development. The NEA report will contribute to achieving the sustainability and conservation goals set out in the post-2020 Biodiversity Framework.

Though having numerous policies and regulations on biodiversity conservation, Vietnam still lacks regulations on ecosystem assessment, is especially lacking in methodologies and capacity for assessment and remains weak in the interrelation between science and policies. Up to now, there has been no NEA at a large scale at the national level. Therefore there is a need to conduct a NEA at the national level to provide all stakeholders an overview of the current status, threats, drivers, and pressures to key ecosystem services in Vietnam and based on that, high-level solutions can be discussed and agreed.

The "Support to developing capacities to address Science-Policy-Practice interface' project" is the first project on the NEA to be implemented in Vietnam. This project has provided a good opportunity for Vietnam to establish a partnership of different stakeholders for improving the science-policy-practice interface on biodiversity and ecosystem services, and through the NEA, addressing the above-mentioned shortages in Vietnam. Addressing this key concern constitutes a national priority for Vietnam and is aligned to the strategic approach defined by the CBD 2011-2020 Strategic Plan and its 2020 Aichi Targets. In addition, this project has also created an opportunity for the Vietnam assessment team to work in collaboration with colleagues from different countries for sharing information and experiences in NEA.

The NEA in Vietnam has closely coordinated with Government agencies on biodiversity management, and management of the three key ecosystems, in preparing the Vietnam Sixth

National Report to the CBD for mutual interaction and to support each other; and in consulting on the revision and amendment of some national policies. The NEA has also considered which policy and institutional drivers have been important vehicles for implementing the CBD 2011-2020 Strategic Plan and Aichi Biodiversity Targets. All these efforts require a strong knowledge base and strengthened interplay between scientists and policymakers, and between different knowledge systems and sectors, to which the NEA is well placed to contribute.

1.3. Glossary of terms

Some terms related to the content of the NEA report are explained as below.

Ecosystem

There are some different definitions of an ecosystem. Below are some specific ones:

- A flexible combination of plants, animals and microorganisms communities and the abiotic environment interacting with each other as a functional unit *(CBD).*
- Ecosystem is composed of communities and abiotic elements of a certain geographical area, interacting and exchanging matter with each other *(Vietnam's Biodiversity Law, 2008).*
- Ecosystem is any unit consisting of all organisms (that is, communities) of a given area interacting with the physical environment by means of energy flows that constitutes a definite nutrient structure, species diversity and the material cycle (i.e. metabolism between biotic and abiotic constituents) in the network (*Odum, 1971*).

To define it simply: ***An ecosystem is a system consisting of organisms and the environment interacting to create the cycle of matter and energy in the system***.

In Vietnam, ecosystems are divided into three groups: (i) **terrestrial ecosystems** including forest, rocky mountain (no forest cover), agricultural and urban ecosystems; (ii) **wetland ecosystems** including three sub-groups such as: *inland wetlands* (streams, rivers, lakes, reservoirs, underground lakes in karst caves and peat swamps, etc.); *coastal wetlands* (coral reefs and seagrass beds (at a depth of below 6m at low tide), tidal flats, estuaries, mangroves, etc.;); and *artificial wetlands* (aquaculture lagoons, water reservoirs, etc.); and (iii) **marine ecosystems** including coral reefs, and seagrass beds **(**at a depth of over 6m at low tide), lagoons, pools, bays, island salty ponds, etc. In addition, there are other groups of ecosystems, mainly artificial ecosystems on the mainland (*MONRE, 2020*).

According to the ecological point of view of Odum (1971), each ecosystem type has its own components, functions and properties. Most of ecosystems have similar ingredients, but their functions and properties have different features. In particular, when the ecosystem is artificially formed, its functions are oriented according to the human use purpose, but the ecosystem's properties develop randomly without the previous orientation.

Determination of the sustainability of the ecosystem

Ecological sustainable development according to IUCN & UNEP (1991) can be assessed by the following criteria/indicators:

- Economy: development investment must bring in profits and gross domestic product.
- Social status: social equity must be ensured, education, training and social welfare must be taken care of, and moral values must be protected and promoted.
- Natural resources: used within the renewable and rational scope, within the ecosystem's endurance.
- Environmental quality: pollution prevention and management must be ensured, community health and aesthetic requirements must be ensured.

In the ecosystem, the balance/or stability of the system results from the balance between opposing forces (growth factors and depleting factors) in adjusting population size (of species). In a sustainable ecosystem: (i) the total number of species does not seem to change from year to year. (ii) the same species occurs each year; and (iii) species population size is relatively equal over time. Sustainability does not mean that all parts of the ecosystem function fully. An ecosystem is a complex self-regulating system. The ability to recover some small changes in the system is called the elasticity of the ecosystem.

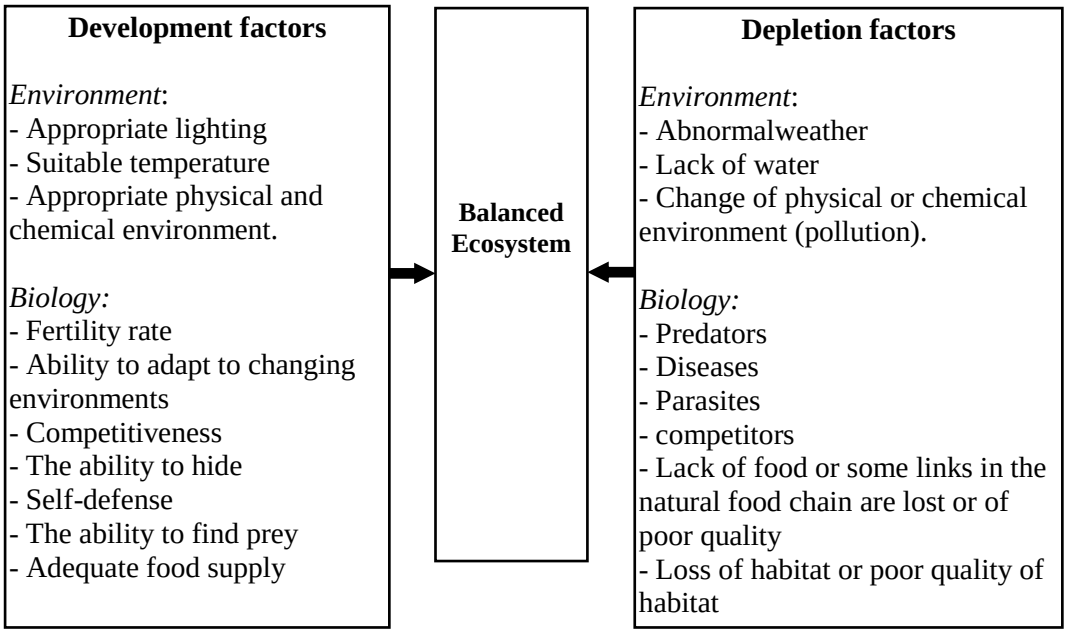


Figure 1. Balancing the ecosystem under the impact of environmental and biological factors

(*Source: Daniel D. Chiras, 1991*)

Ecosystem services

Ecosystem services are the benefits people obtain from ecosystems (*MA, 2005*).

The concept of ecosystem services provides a useful mean to identify the importance of the environment to the economy and human well-being. Ecosystem services are commonly understood around the world as the benefits that people obtain from ecosystems or more generally from nature. Diverse ecosystems from oceans to mountain tops yield valuable services. Humans are fundamentally dependent on the flow of ecosystem services for survival, well-being, and prosperity.

Ecosystem services can be classified in many ways. The Millennium Ecosystem Assessment (MA) (2005) classifies ecosystem services into four categories: (i) provisioning services (services related to tangible products such as fish and timber); (ii) regulating services (referring to the natural processes of ecosystems such as waste assimilation and carbon sequestration that contribute to social and ecological well-being); (iii) cultural services (that may be associated with both use and non-use values and relate to the non-material benefits obtained from ecosystems, for example, through tourism and educational use of the environment); and (iv) supporting services (any service that is necessary for the production of all other ecosystem services, including soil formation and nutrient cycling). Supporting services differ from the other services in that their impacts on people are either direct (via provisioning, regulating or cultural services) or occur over a long period time (indirect and difficult to see). Figure 2 below presents the typical services provided by different ecosystems.

Ecosystem assessment

Ecosystem assessment has been defined by some authors as below:

- An assessment process that "brings together diverse strands of knowledge in a way that is useful for decision making" (UNEP/GC.25/INF/12)
- An ecosystem assessment analyses existing data and information on ecosystems and their services.
- Ecosystem assessments can vary in geographical scale, from global to regional, to national and subnational (IPBES/1/INF/8).
- Ecosystem assessments provide the connection between environmental issues and people, considering both the ecosystems from which services are derived and the people who depend on and are affected by changes in the supply of services (*Ash et al., 2010*).
- A social process through which the findings of science concerning the causes of ecosystem change, their consequences for human well-being, and management and policy options are brought to bear on the needs of decision-makers (*MA, 2005*).

Figure 2. Ecosystem service categories

(Source: WWF, 2016)

In short, ecosystem assessment is a tool to support decision-making on ecosystem management planning, investment in ecosystem protection and development or even ecosystem service prioritization (in case there need to be a trade-off among ecosystem services).

Drivers

Drivers of change in ecosystem services are human-induced factors that directly or indirectly cause a change (about structure, function and process) in an ecosystem (*MA, 2005*).

The MA distinguished direct and direct drivers. Accordingly, indirect drivers include: demography; economic development; technology change; social, cultural and political factors; energy use and production; and an increasing consumption trend. Direct drivers include: greenhouse gas emissions; risk of acidification and excess nitrogen loading from air pollution; climate change; sea level rise; land use changes; use of nitrogen fertilizer and nitrogen loads to rivers and coastal marine systems; and disruption of landscape by mining and fossil fuel extraction.

Or, in a clearer way by Grant et al. (2008), drivers are exogenous factors including population, economy, society, and technology.

Pressures

According to Grant et al. (2008), pressures are endogenous factors such as physical, biological or chemical processes, consist of environmental pollution, climate change, changes in land / waters use, invasive alien species, etc.

Policy

According to Dr. Vu Cao Dam, 2011, a policy is a set of institutionalized measures that a powerful or managerial entity makes, which gives preference to one or several social groups,

stimulates their motivations, and directs their activities to achieve a certain priority in the development strategy of a social system. Thus, a policy is a set of measures taken by authorities or managers, institutionalized into legally valid regulations, in order to implement the development strategy of the system according to the target expected by the authorities.

II. SCOPE AND POLICY QUESTIONS FOR ASSESSMENT

2.1. Scope of assessment

At the workshop on scoping for the NEA held on 20th October 2017 in Hanoi, participants agreed that the scope of the NEA in Vietnam under the project should be focused on the three key ecosystems (forest, wetland, marine and coastal ecosystems) and their benefits at national level in the whole country of Vietnam, and that forest ecosystems are to be given higher priority.

The NEA report has been assessed, analyzed and synthesized on the basis of secondary information and data that have been taken from national policies, reports, projects, missions, etc. from different relevant agencies of the government, as well as national and international organizations.

The scoping of the assessment has only focused on the three key ecosystems (forest, wetland, marine and coastal ecosystems) and benefits of basic services of these three ecosystems, including (i) provisioning services; (ii) regulating services; (iii) cultural services; and (iv) supporting services.

2.2. Questions for assessment

Based on the Government's orientations and priorities on biodiversity conservation and sustainable development as well as satisfying the requirements and guidelines of the project, the NEA team has consulted with relevant stakeholders at national and international levels to develop five policy questions for assessment including:

1. What is the status of biodiversity and trends of key ecosystems (forest, wetland, and marine and coastal ecosystems) and the services they deliver in Vietnam?
2. How do forest, wetland, and marine and coastal ecosystems services contribute to the socio-economy?
3. What are the pressures driving changes in the status and trends of forest, wetland, and marine and coastal ecosystems services and their impacts on the socio-economy?
4. How might ecosystems and their services change in the future under various plausible scenarios? and
5. What is the legal and institutional framework on biodiversity and ecosystem services and what are the impacts, gaps and some recommendations to enhance ecosystems and their services?

These five policy questions were analyzed, assessed and presented in detail in the five parts of the NEA report.

III. APPROACH AND METHODOLOGY FOR ASSESSMENT

3.1. Approach

The NEA is based on the principle, process, approach and logical framework of IPBES. The DPSIR (Driver-Pressure-State-Impact-Response) framework has evolved into an interdisciplinary tool for environmental analysis (*EEA,1995*) and assumes a causal relationship between interactive components of social, economic and environmental systems. Ecosystem services under the DPSIR framework can be presented in the following model:

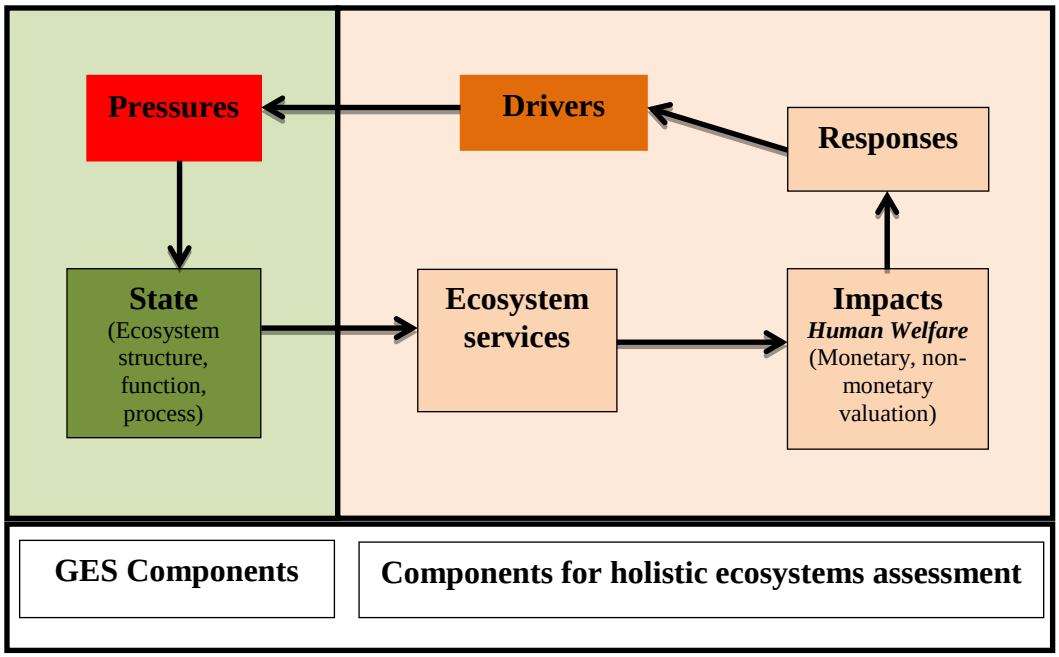


Figure 3. Ecosystem services in context of the DPSIR framework

(Source: Heiskanen et al., 2014)

3.2. Methodologies for assessment

Methodologies used for the NEA included:

- Identifying relevant stakeholders and engaging them in the NEA process.
- Collecting information, data, maps and approved documents (such as policies, national and international reports/publications and project/missions reports).
- Consulting different stakeholders by email, interviews, meetings, workshops and national trialogue.
- Research, analysis and synthesis of documents and maps.

3.3. Assessment process

The assessment process included the following steps:

- Scoping stage (identifying requirements, policy questions for assessment, and designing answers for the questions and consideration of potential obstacles.
- Design stage (developing report outline).
- Implementation stage (developing the report chapters including consultations with different relevant stakeholders).
- Peer review and approval.
- Communication and outreach.

PART II. STATUS OF BIODIVERSITY AND TRENDS OF ECOSYSTEMS

Key Findings

1. Vietnam has high biodiversity with an abundance of natural ecosystems, species, and rich and endemic genetic resources

The geographical location and topographical and climatic factors of Vietnam have created natural landscapes and diverse ecosystems in the mainland part of the territory as well as in the sea. In Vietnam, ecosystems are divided into three groups: (i) terrestrial ecosystems (including: forest, rocky mountain (no forest cover), agricultural and urban ecosystems); (ii) wetland ecosystems (including inland wetland, coastal wetland and artificial wetlands ecosystems); and (iii) marine ecosystems. In addition, there are other groups of ecosystems, mainly artificial ecosystems on the mainland (*MONRE, 2020*).

In Vietnam to date, approximately 61,700 natural species of organisms have been identified, including: some 7,500 species/varieties of microorganisms; 2,200 species of fungi, 16,977 species of terrestrial and aquatic plants; 1,932 species of terrestrial vertebrates; 20,000 species of insects; 1,500 species of terrestrial invertebrates; and nearly 2,000 species of freshwater invertebrates and fish. In the ocean, there are over 11,000 marine species including microalgae, seaweed, sea grass, zooplankton, crustacean, molluscs, echinoderms, coelenterates, sponges, marine fish, marine reptiles, and marine mammals, etc. (*MONRE, 2021*).

Vietnam is one of the world's most diverse centers of cultivated plant and animal genetic resources, including about 800 plant species, more than 6,000 rice varieties, and 887 livestock varieties of which 30 varieties are widely used (*MONRE, 2021*).

2. Most of important ecosystems are located in a system of 176 protected areas

In Vietnam, important ecosystems have the highest levels of biodiversity and biological productivity, making great contributions to the economy and social welfare. Most of the important ecosystems in Vietnam are located in a system of 176 protected areas (PA) of Vietnam, covering a total area of about 2,512,530 ha (7.6% of the national area) (*MONRE, 2021*).

Forest ecosystem

Wetland ecosystem

Marine ecosystem

3. Ecosystems which provide the most services and are high in biodiversity and biological productivity tend to be degraded

Erythrorchis ochobiensis

Vietnam's forest cover area is tending to increase mainly by new plantations; the ecosystems of rivers, streams, lakes, reservoirs and estuarine areas are degraded and biodiversity has been reduced; the peat swamp is reduced in area and in the thickness of the peat layer; natural tidal flats are affected; lagoons are degraded in varying degrees; seagrass beds are decreasing in area; coral reefs in the sea of Vietnam are declining in area and coverage of live coral; the number of threatened species increases; and the number of individuals of endangered species has been reduced or has not appeared for a long time.

In the period 2014-2017, the scientists have proposed to be

included in the Vietnam Red Book for the next period 1,211 species, including: 600 species of plants and fungi; 611 animal species. Thus, compared with the 2007 Vietnam Red Book (the total number of threatened species is listed as 882 species, consisting of 418 animal species and 464 plant species), the number of species proposed to the Red Book of Vietnam in this new period will be markedly increased (*MONRE, 2019*).

The results of multi-year monitoring of some important bird areas show that the number of individuals of rare and precious species, especially globally endangered migratory birds in the protected areas has decreased, such as the Spoonbill (*Platalea minor*) in Xuan Thuy National Park (NP) and crested cranes (*Grus antigone*) in Dong Thap NP and Phu My Wetlands Nature Reserve (Kien Giang province), even some species have not been seen for many years such as sea dugong (*Dugong dugon*) in Phu Quoc) (*MONRE, 2019*).

Platalea minor

4. Traditional and indigenous knowledge on conservation and sustainable use of biodiversity are extremely diverse and abundant

Due to the diversity of ethnic minority communities and languages, along with indigenous cultures and customs, traditional and indigenous knowledge on the conservation and sustainable use of natural resources in general, and biological resources in particular in Vietnam are extremely diverse and rich. The people of ethnic communities in the mountainous regions of Vietnam for a long time have accumulated many traditional remedies from hundreds of medicinal plants in the forest. The Institute of Medicinal Materials has collected 1,296 folk remedies of ethnic communities that have served for screening research, and research and development to create disease prevention products (*MONRE, 2019*).

Knowledge of using materials from forest trees for community housing, daily tools, weaving and other purposes. Knowledge and experience in cultivation and breeding: many generations have drawn upon indigenous knowledge in agricultural and forestry production of ethnic communities is building experience through production practice. That experience has been gathered by word of mouth from generation to generation, in every family and in each community. It is knowledge of trees, wildlife in the forest, experiences with farming and livestock, weather cycles and other features of nature. Regarding the issue of management, protection and development of forest resources, indigenous knowledge of the people is really effective, such as knowledge of land use in cultivation, identification of forest trees, forest animals, and knowledge about exploitation and use of forest products. This is a favorable factor for community participation in local forest management, protection and development activities. Forests are of great importance to the life of the communities (*Pham Quoc Hung and Hoang Ngoc Y, 2009*).

I. STATUS OF BIODIVERSITY

1.1. Status of ecosystems

1.1.1. The ecosystems in Vietnam are very diverse

In Vietnam, ecosystems are divided into three groups such as terrestrial ecosystems; wetland ecosystems; and marine ecosystems. In addition, there is another group of ecosystems that are mainly man-made ecosystems on the mainland (Annex 1), *(MONRE, 2020).*

The topographical and climatic conditions of Vietnam have created the diversity of the natural ecosystems on the mainland part, in which the natural forest ecosystems include: (i) evergreen closed tropical humid forest with a dense vegetation and rich biodiversity; (ii) semi-deciduous closed tropical humid forest; (iii) evergreen broad leaved forests on limestone; (iv) natural needle leaved forests; (v) dry dipterocarp forest; (vi) natural dry forest (thorny trees); (vii)

freshwater swamp *Melaleuca cajuputi* forest; (viii) Bamboo forests; and (ix) mangrove forests (*Nguyen Ngoc Lung et al., 2010).* In addition to the forest ecosystem types, forestry scientists have also classified into 14 forest vegetation types according to ecological factors (*Thai Van Trung, 1999).*

In six marine ecoregions of Vietnam, 20 marine ecosystems have been distinguished. Typical marine ecosystems in coastal areas such as coral reefs, seagrass beds (at a depth of over 6m at low tide), lagoons, pools, bays, conifers, ponds, etc. In addition, there are aquatic ecosystems around coastal islands, coast, offshore islands, continental slopes, and open seas around the Hoang Sa and Truong Sa archipelagoes.

1.1.1.1. Terrestrial ecosystems

Forest ecosystems

Forests in Vietnam with diverse and rich vegetation types are considered as habitats for tens of thousands of wildlife species, forming the most important biological species on the mainland, including all plant groups, lower to higher animals, invertebrates, reptiles, amphibians, birds and mammals. The evolution of forest ecosystems in Vietnam has changed according to a number of key timelines: In 1943, the first data on Vietnam's forest area was announced as 14.3 million ha, the coverage rate was up to 43%. At that time, the entire forest area was natural forest and most of it was primary forest. The most widely distributed forest types are the tropical evergreen monsoon forests. Only a small area of the mid-central region actually has a tropical rain-loving forest in low terrain with broadleaf trees, while semi-deciduous, broad-leaved tropical forests are distributed in many southern regions such as in Central Highlands and the Southwest region and less in the Northwest.

Due to many reasons about the war as well as the management of exploitation and use of forests, in the period 1990-1995, the forest area of Vietnam has been seriously reduced to only 9.1-9.2 million ha the coverage rate was only 27-28%. After that, thanks to the continuous implementation of afforestation projects, up to now, the forest area and forest cover rate have increased back to almost the same level as the peak period in 1943.

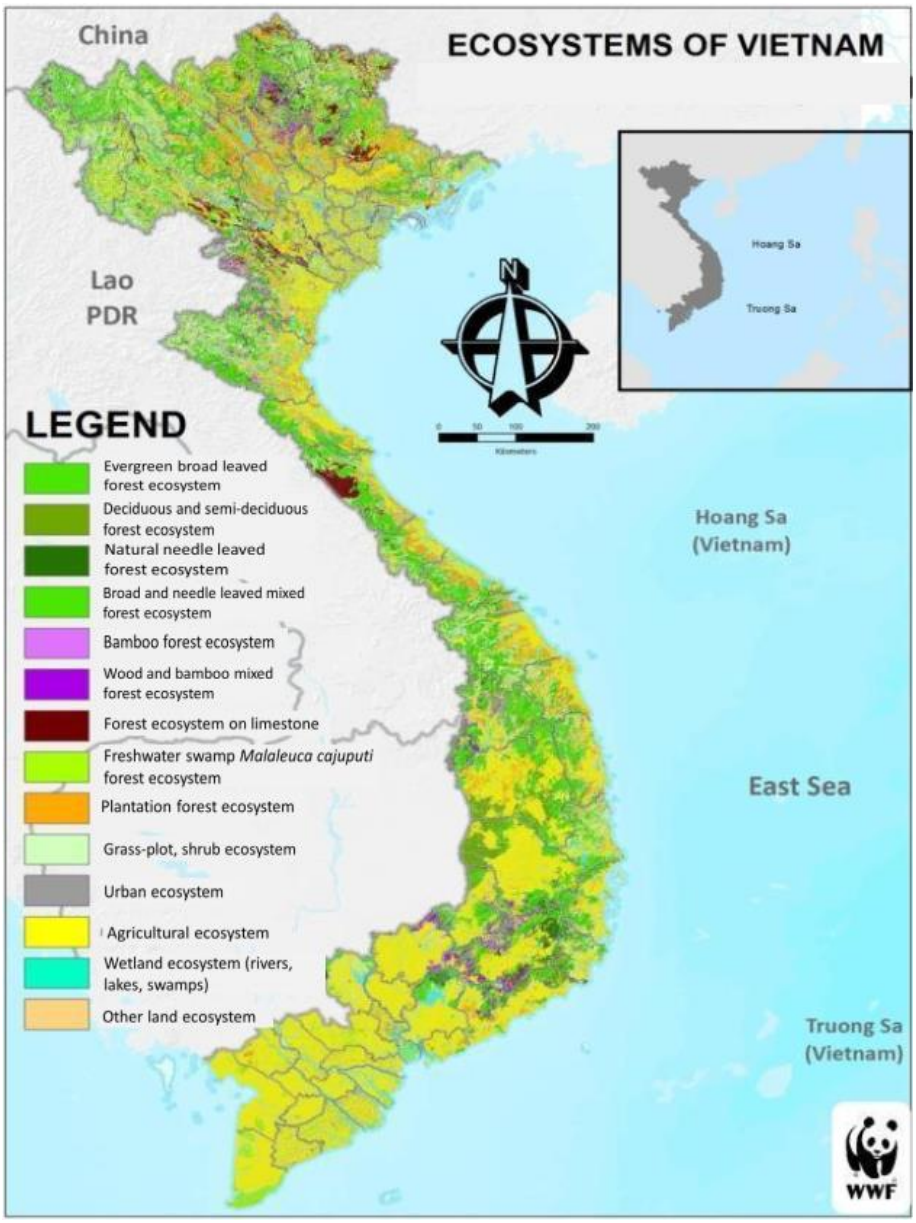


Figure 4. Map of ecosystems on the mainland in Vietnam

(*Source: MONRE & WWF, 2013*)

According to the MARD (2021) in 2020, Vietnam had 14,677,215 ha of forest land. Of which, 10,279,185 ha was natural forest and 4,398,030 ha was planted forest. The area of forested land eligible for calculation of the national coverage rate was 13,919,557 ha, the coverage rate was 42.01%.

Table 1. Forest area by ecological region in 2020

Region	Natural forest area (ha)	Planted area (ha)	Total area of forested land (ha)	Coverage rate (%)
Northwest	1,574,797	207,414	1,782,210	46.41
Northeast	2,364,934	1,584,315	3,949,249	56.30
Red River Delta	46,269	37,059	83,328	6.18
North Central	2,205,433	921,271	3,126,704	57.35
Central Coast	1,570,943	872,242	2,443,185	50.43
Central Highland	2,179,794	382,411	2,562,205	45.94

Southeast	257,122	222,985	480,107	19.42
Southwest	79,893	170,334	250,227	5.45
Whole country	**10,279,185**	**4,398,030**	**14,677,215**	**42.01**

(*Source: MARD, 2021)*

Vietnam forests are divided into three types as special use, protection and production forests by use purposes.

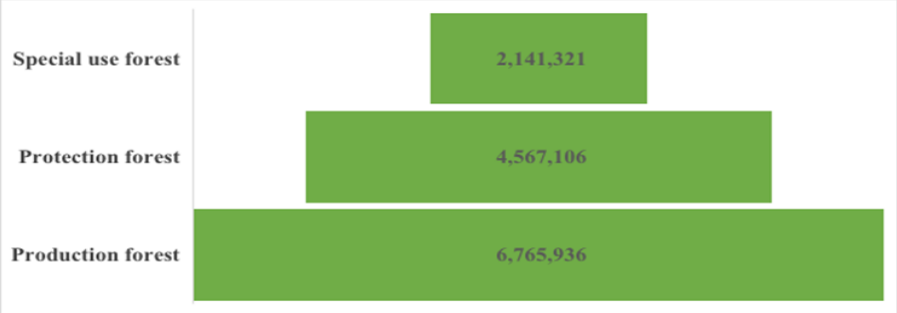


Figure 5. Forest area (ha) by use purpose

(Source: MARD, 2018)

Rocky mountain ecosystem (no forest cover)

The limestone mountains on the mainland in Vietnam have a fairly large area, up to 50,000 - 60,000 km^2, accounting for nearly 15% of the land area, concentrated mainly in 4 sub-regions of Viet Bac (Ha Giang, Cao Bang and Lang Son provinces); the Northeast (Quang Ninh province); the North West (Lai Chau, Lao Cai, Son La, Hoa Binh and Ninh Binh provinces); and the North Central (Quang Binh province). Up to now, the official area of rocky mountains (without forest) in Vietnam has not been determined. However, it is possible to imagine the rocky mountain ecosystem, including limestone mountains, which has not yet formed a forest cover, but has quite rich and diverse shrubs. Research on rocky mountain ecosystems has not been much, however, during the investigation of the flora of limestone mountains in Ha Long Bay, botanists of the Institute of Natural Resources and Environment in collaboration with Singapore botanists discovered a new variety (*Zeuxinella*) and nine new plant species for science: *Zeuxinella vietnamica* (Orchidaceae), *Livistona halongensis* (Arecaceae), *Chirita hiepii, Chirita modesta, Chirita halongensis, Paraboea halongensis* (Gesneriaceae), *Impatiens halongensis* (Balsaminaceae), *Alpinia calcicola* (Zingiberaceae) and *Cycas tropophylla* (Cycadaceae). Some other studies show that groups of animals with typical habitats in limestone mountains such as terrestrial snails are very diverse and abundant, up to 51 species are endemic to limestone mountains in Ha Long Bay.

Agricultural ecosystems

In relation to agricultural area, according to MONRE's Decision no.2311/QD-BTNMT, dated 28 September 2017, on approval and announcement of land statistic results in 2016, by the end of 2016, Vietnam has 11.5 million ha of land used for agriculture, accounting for one third of Vietnam's total land, in which, approximately 20% of agricultural land had been cultivated annually, 11% for perennial crops and 2-6% for livestock (*MONRE, 2017*). The Mekong River Delta and the Red River Delta are the two largest and most productive agricultural regions of Vietnam.

Urban ecosystems

With an area of 340,000 km^2, urban areas now account for 10.7% of Vietnam's total land area. Compared to other terrestrial ecosystems, urban ecosystems are much less diverse, with

green space (tree cover) less than $2m^2$/person (i.e. lower than the national standard of urban tree cover and equal to 1/10 standard of urban tree cover in cities of developed countries in the world) (*MONRE, 2016*).

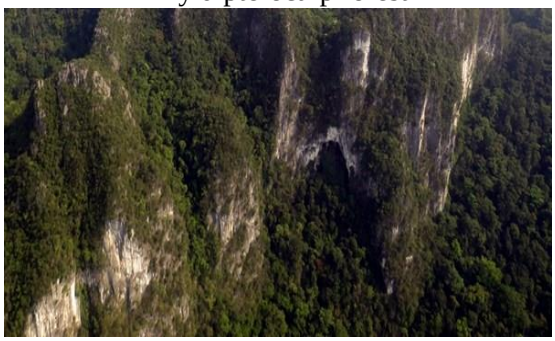
1.1.1.2. Wetland ecosystems

In Vietnam, wetland ecosystems are diverse. The Cicular no.7/2020/TT-BTNMT dated August 31, 2020 on technical guidance on wetland classification has identified 26 types of wetlands in Vietnam according to 3 groups: (i) coastal wetlands such as coral reefs and seagrass beds (at a depth of below 6m at low tide), tidal flats, estuaries, mangroves, etc.; (ii) inland wetlands (including streams, rivers, lakes, reservoirs, underground lakes in karst caves and swamps, etc.); and (iii) artificial wetlands (such as aquaculture lagoons, water reservoirs, etc.). The total area of wetlands in Vietnam was 11,847,975 ha (excluding the area of seasonally flooded rivers and streams, thermal springs, and mineral waters), accounting for 37% of the total natural land area of Vietnam. In which, the Mekong River Delta accounts for nearly 51% of Vietnam's wetland area, the Red River Delta accounts for 13%. In addition, there are 74 important wetland areas at international and national level (*Nguyen Thi Thu Ha et al., 2016*). This can be considered as an updated and systematic statistical data on wetland area, distribution characteristics in different territories of Vietnam. Below are pictures of some topical mainland ecosystems in Vietnam:

Evergreen closed tropical humid forest

Dry dipterocarp forest

Natural needle leaved forests



Forests on limestone

Mangrove forest

Freshwater swamp *Melaleuca cajuputi* forest

Bamboo forest

Cave ecosystem (Son Doong cave)

River ecosystem (Con river, Binh Dinh province)

Lake ecosystem (West lake in Hanoi)

Agricultural ecosystem

Urban ecosystem

Figure 6. Some typical mainland ecosystems in Vietnam

1.1.1.3. Marine ecosystems

Vietnam has a coastline of more than 3,260 km (excluding islands) with more than 3,000 large and small islands along the coast and two archipelagos of Hoang Sa and Truong Sa. Vietnam's exclusive economic zone is over one million km^2. On the basis of natural conditions, marine environment and marine life, especially with the biodiversity of coral reefs, Nguyen Huy Yet (2000) has divided Vietnam's sea into the six ecological regions with specific biodiversity characteristics:

- Gulf of Tonkin (to the South of Con Co island, Quang Tri province);
- Central coastal waters (from Con Co island to Mui Dinh in Phan Rang-Varellacape);
- Central coastal waters (from Dinh Cape to Vung Tau province);
- Southeast coastal waters (from Vung Tau to Ca Mau province);
- South West Coast Sea (from Ca Mau to Phu Quoc Island in the Gulf of Thailand);
- Offshore-sea (waters of the Spratly archipelagos and Paracel archipelagos).

Among the six marine ecoregions in Vietnam mentioned above, 20 types of marine ecosystems have been distinguished. They include typical marine ecosystems in the coastal zone (also types of coastal and marine wetlands) include coral reefs and seagrass beds (at a depth of over 6 m at low tide), lagoons, pools, bays, island salty ponds. In addition, there are

aquatic ecosystems around coastal islands and offshore waters (including the Hoang Sa and Truong Sa archipelagos) (*MONRE, 2019).*

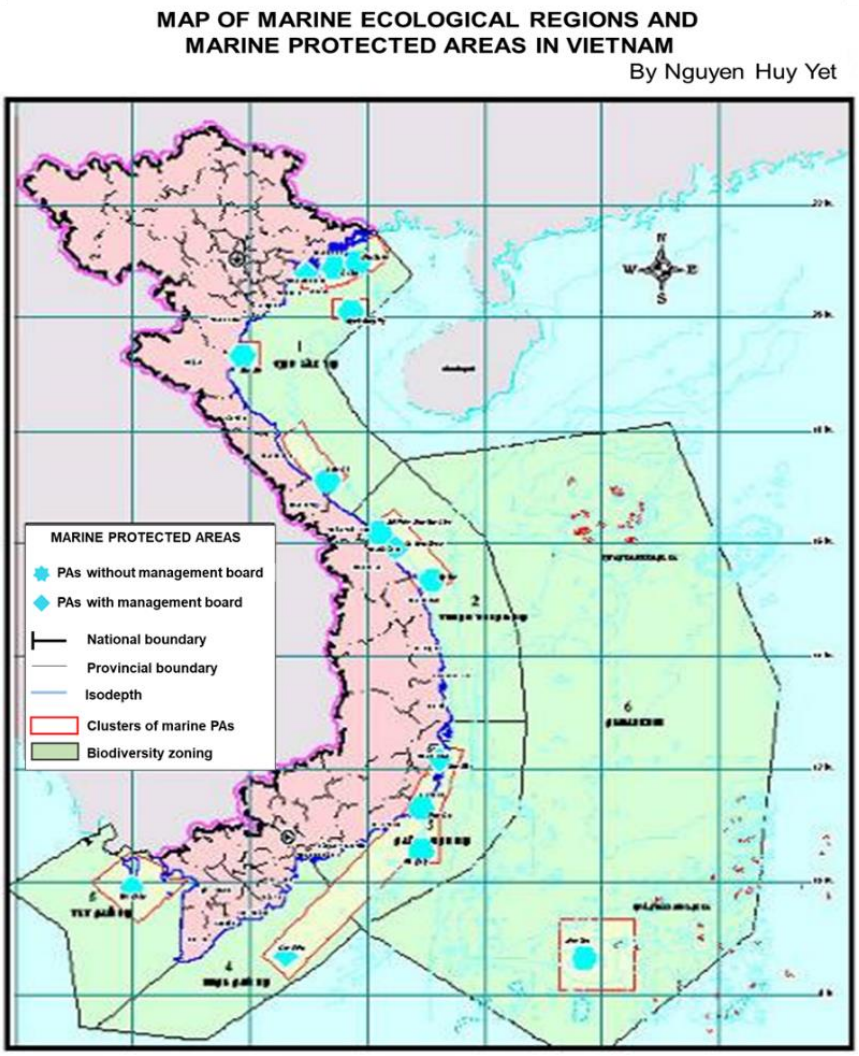


Figure 7. Map of marine ecological regions and marine protected areas in Vietnam

(*Source: Nguyen Huy Yet, 2000)*

Coral reef ecosystem

Seagrass bed ecosystem

Tam Giang Lagoon

Chau Truc/Tra O lagoon (Binh Dinh province)

Bay ecosystem (Ha Long Bay)

Salt-lake on Cong Do island, Ha Long Bay (*Source: Waltham Tony*)

Figure 8. Some typical coastal ecosystems in Vietnam

1.1.2. Key important ecosystems in Vietnam

Pygathrix nemaeus

Based on the level of contribution to the economy and social welfare, the following ecosystems are considered as the most important ecosystems of Vietnam, having the highest biodiversity and biological productivity:

Important forest ecosystems: evergreen closed tropical humid forest; semi-deciduous closed tropical humid forest; evergreen broad leaved forests on limestone and; natural needle leaved forests.

Important wetland ecosystems: coral reefs, seagrass beds (at a depth of below 6m during low tide), rivers, streams, natural lakes, reservoirs, peat swamps, estuaries, tidal flat, mangroves.

Important marine and coastal ecosystems: coral reefs, sea grass beds (at a depth of over 6m during low tide), lagoons, bays, coastal islands and offshore waters (including archipelagos of Hoang Sa and Truong Sa).

By 2014, the Prime Minister signed and issued Decision no.45/QD-TTg approving the National Master Plan for Biodiversity Conservation to 2020, with a vision to 2030. In this Master Plan, the system of existing conservation areas has been arranged and research proposals have been gradually established and put into operation 46 new PAs, bringing the total existing and newly established PAs nationwide by 2030 reaching 219 PAs with a total area of 3,067,000 ha, evenly distributed throughout the country according to 8 geographical/ecological regions on the mainland and 6 marine ecoregions.

Trachypithecus poliocephalus

Wetland ecosystem

Marine ecosystem

Some nature reserves (NR) and other territories with high biodiversity value are recognized by international or regional organizations as of international importance with the following titles:

- 06 global priority ecological zones recognized by WWF: Wet forests in the Truong Son range; Indochina dry forest; Lower Mekong region; North Indochina subtropical humid forest; Southeastern China humid forest-Hainan; and Tay Giang Rivers and Streams (Bang River-Ky Cung).
- 09 Ramsar sites: Xuan Thuy NP in Nam Dinh province (1989); Bau Sau belongs to Cat Tien NP in Dong Nai province (2005); Ba Be Lake in Bac Kan province (2011); Tram Chim in Dong Thap province (2012); Mui Ca Mau NP in Ca Mau province (2013); Con Dao NP in Ba Ria-Vung Tau province (2014); Lang Sen Wetland Reserve in Long An province (2015); U Minh Thuong NP in Kien Giang province (2016); and Van Long NR in Ninh Binh (2019) with a total area of 120,549 ha.
- 11 World Biosphere Reserves recognized by UNESCO: Can Gio in Ho Chi Minh city (2000); Dong Nai (2001); Cat Ba in Hai Phong city (2004); Inter-provincial coastal areas of the Red River Delta in Thai Binh, Nam Dinh and Ninh Binh provinces (2004); Kien Giang in Kien Giang province (2006); Western Nghe An in Nghe An province (2007), Ca Mau Cape in Ca Mau province (2009); Cu Lao Cham in Quang Nam province (2009); Langbiang in Lam Dong province (2014); Nui Chua in Ninh Thuan province (2021); and Con Ha Nung Highland in Gia Lai province (2021) with a total area of 4,900,872 ha.
- 06 World Natural Heritage sites with a total area of 1,537,952 ha recognized by UNESCO, including: Ha Long Bay in Quang Ninh province (1994); Phong Nha-Ke Bang NP in Quang Binh province (2003, 2015); Dong Van Stone Plateau in Ha Giang province (2010); Trang An Scenic Landscape Complex in Ninh Binh province (Cultural-Nature Mixed Heritage, 2014); Non Nuoc Cao Bang Geopark in Cao Bang province (2018); and Dak Nong Global Geopark in Dak Nong province (2020).
- 10 ASEAN Heritage Parks: Ba Be NP in Bac Kan province (2003); Kon Ka Kinh NP in Gia Lai province (2003); Chu Mom Ray NP in Kon Tum province (2003); Hoang Lien NP in Lai Chau and Lao Cai provinces (2003), U Minh Thuong NP in Kien Giang province (2012); Bai Tu Long NP in Quang Ninh province (2016), Vu Quang NP in Ha Tinh province (2019); Ngoc Linh NR in Kon Tum province (2019; Bidoop-Nui Ba NP in Lam Dong province (2019); Lo Go-Sa Mat NP in Tay Ninh province (2019), with a total area of 355,710 ha.
- 63 important bird areas (IBA), accounting for about 5% of the total land area of the country, confirmed by Birdlife International, with a total area 1,689,900 ha.
- 104 key biodiversity areas (KBA) covering an area of 3.35 million ha, accounting for 10% of the land area on the mainland of Vietnam, are listed by Birdlife International and World Conservation Organization confirmed in 2013.

According to the Law on Forestry (2017), forests are classified into five categories: (i) NP; (ii) nature reserves; (iii) species - habitat reserves; (iv) landscape protection forest; and (v) scientific research or experiment forest, while the Biodiversity Law classified PA system into four categories: (i) NP; (ii) nature reserve; (iii) species/habitat PA); and (iv) landscape PA.

There are three main PA systems as forest PA system; marine PA system, and wetland PA system in Vietnam (*MARD, 2017*). Most of the key ecosystems are located in the three systems 176 PAs, covering a total area of about 2,512,530.78 ha (7.6% of the national area) (*MONRE, 2021*).

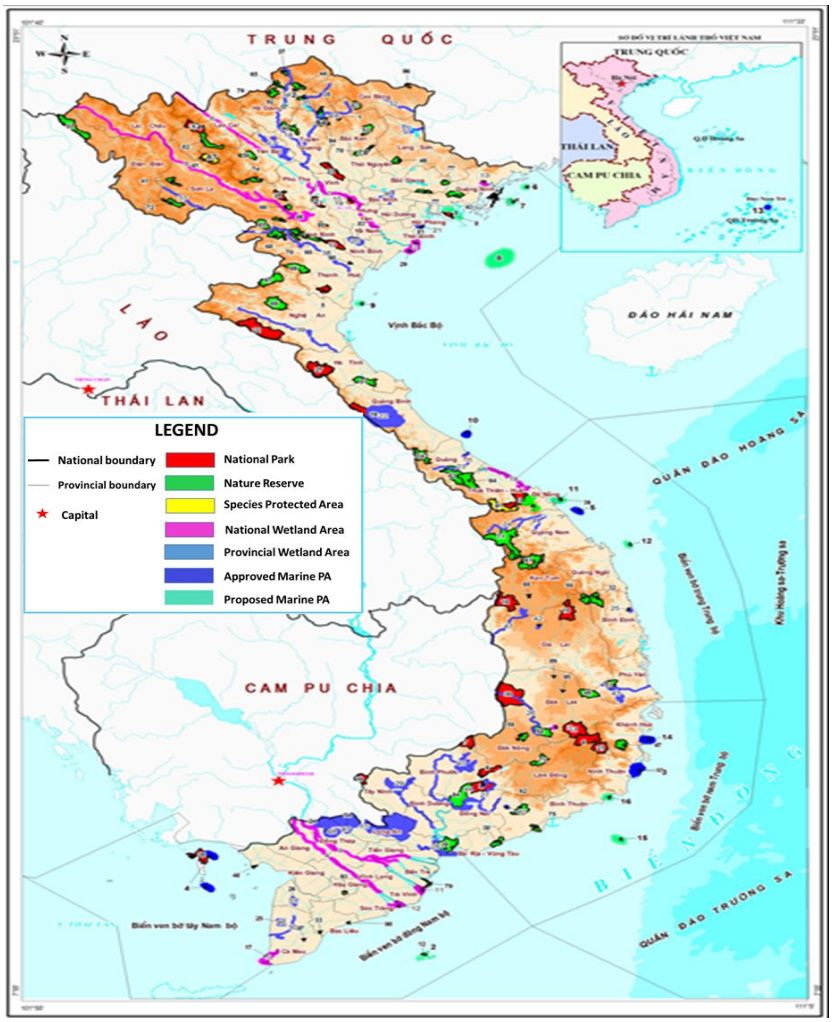


Figure 9. Map of protected areas systems in Vietnam

(*Source: MARD, 2017*)

According to the Biodiversity Law 2008, a biodiversity corridor is an area that connects natural ecological areas to allow living species in these ecological areas to easily move back and forth. Biodiversity corridors play an important role in biodiversity conservation strategy on a large scale with a long-term vision. Corridors create space to connect PAs, allowing animals and plants to spread and move, to adapt to climate change and varying habitat conditions. In Vietnam, since 2004, thanks to the financial and technical supports of the Asian Development Bank (ADB), there have been some projects that have piloted the establishment of biodiversity corridors in Vietnam. Within the scope of the National Master Plan on Biodiversity Conservation to 2020, a vision to 2030, 21 biodiversity corridors have been reviewed and proposed to develop. Currently, 07 biodiversity corridors have been established in Vietnam include (i) Phong Dien PA connected to Bach Ma NP; (ii) Chu Duong Sin NP connected to Ta Dung PA; (iii) Kon Ka Kinh NP connected to Kon Chu Rang PA; (iv) Sao La PA connected to Thanh River NR and Elephant NR in Quang Nam Province; (v) Sao La PA connected to Phong Dien PA; (vi) Dak Rong PA connected to Bac Huong Hoa PA; and (vii) transboundary corridor is Trung Khanh PA in Cao Bang (Vietnam) connected to Jingxi Nature Reserve in Guangxi (China) (*MONRE, 2021*).

The following is a description of some important ecosystems in Vietnam:

1.1.2.1. Forest ecosystems

According to Nguyen Ngoc Lung, Do Xuan Quat, Nguyen Dinh Sam et al. (2010), general features of some important terrestrial forest ecosystems may be described as follows:

Evergreen closed tropical humid forest

Forest ecosystems with this type of flora are very rich and diverse, and are distributed in the provinces such as Quang Ninh, Cao Bang, Lang Son, Phu Tho, Yen Bai, Tuyen Quang, Lao Cai, Ninh Binh (Cuc Phuong), Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien-Hue, Quang Nam and the Central Highlands. Tropical humid evergreen forest ecosystems are distributed at altitudes below 700 m above sea level in the North and under 1,000 m in the South. Forest ecosystems of this type often have a 5-story structure: (i) upper story, (ii) ecological dominant story, (iii) lower story, (iv) bushes story; and (v) climber story. In this forest ecosystem types, the plant species composition belongs to the flora of South Vietnam-Malaysia-Indonesia in the South, and the flora of North Vietnam-South China in the North.

Semi-deciduous closed tropical humid forest

This variety of forest ecosystems are distributed in areas including Quang Ninh, Bac Giang, Bac Kan, Tuyen Quang, Phu Tho, Yen Bai, Son La, Lai Chau, Thanh Hoa and Nghe An provinces in the Central Highlands and Southeast. Semi-deciduous closed tropical humid forest is distributed at altitudes below 700 m above sea level in the North, and under 1,000 m in the South. The forest structure consists of wooden layers, typically deciduous species: *Lagerstroemia tomentosa* and *Liquidambar formosana*. The composition of the plant species belongs to the floras of Malaysia - Indonesia system and the India - Myanmar.

Evergreen broad leaved forests on limestone

Limestone mountains are distributed in 24 provinces and cities, but are mainly concentrated in the northern and north central provinces. The provinces with limestone mountains are: Dien Bien, Lai Chau, Son La, Hoa Binh, Ha Giang, Cao Bang, Lang Son, Quang Ninh, Hai Phong, Ninh Binh, Thanh Hoa, Thai Nguyen, Nghe An, Ha Tinh, Quang Binh. Limestone mountains can be divided into five regions as follows: Cao Bang-Lang Son; Tuyen Quang-Ha Giang region; the Northwest-Western Hoa Binh-Thanh Hoa; the North Truong Son region and the archipelago. Forest ecosystems of this type are distributed from a few tens of meters to 1,200 meters above sea level. Evergreen broadleaf forest ecosystems in limestone mountains have majority of these precious wood species.

Natural needle leaved forests

Coniferous forest ecosystems include two types: lowland sub-tropical needle leaved forest ecosystems distributed mainly in mountainous areas such as Yen Chau, Moc Chau (Son La), Nghe An, Ha Giang, Da Lat (Lam Dong), etc., and ecosystems of temperate needle leaved forests on medium mountain are mainly found in Sa Pa (Lao Cai), Tuan Giao (Lai Chau), Ha Giang, Tay Con Linh (Cao Bang), and Chu Yang Sinh (South Central Coast), Lam Dong, amongst others.

1.1.2.2. Wetland ecosystems

Rivers and streams

River and stream are general term for the type of water body that flows from the inland. Streams are common types of flowing water bodies in mountainous areas. Streams can be considered as level 1 rivers, some large ones are class 2 rivers. The stream is characterized by a narrow and shallow bed, low water level, and has a bottom that is rocky, with boulders or pebbles. Rivers are the confluence of many streams, a typical flowing water body with the following characteristics: the water mass always flows in a certain direction, from upstream to

downstream due to the difference in height compared to sea level of the river bed. Rivers in the lowlands flow more slowly than rivers in the mountains (*Dang Ngoc Thanh, Ho Thanh Hai, 2007*).

Rivers and streams are inland wetland ecosystems with high biodiversity levels, which disperse aquatic populations to other inland freshwater waters in the basin. The river and stream aquatic fauna is diverse in species composition. Rivers are very important habitats of fish populations. According to the evaluation of many authors (*Kottelat, 1996*), the aquatic ecosystem of the stream ecosystem has a high rate of endemic species and in this type of ecosystem, many species await discovery. In the flood season, the benthos in the stream is destroyed very quickly, but then recovers quickly, right after the flood ends.

Vietnam currently has about 3,450 rivers and streams with a length of more than 10 km, distributed in 108 river basins, of which 15 basins have an area of more than 2,500 km^2 and 10 river basins with a width of more than 10,000 km^2 (*MONRE, 2015*). These rivers and streams account for 80% of the total inland water area of Vietnam. There are a number of international rivers flowing through Vietnam with a total annual flow volume of 835 billion m^3. Among international rivers, the Mekong River and the Red River are the two most important. The Mekong River is the longest river in Southeast Asia, originating in China, flowing to and branching with the downstream areas at the Myanmar and Laos borders. The downstream area of the Mekong River covers an area of about 600,000 km^2, located in the territory of four countries, Laos, Cambodia, Thailand and Vietnam. The Red River is the largest river basin in Vietnam. The river originates in Yunnan province in China and flows through the North of Vietnam into the Gulf of Tonkin forming a large plain.

Table 2. Major river systems in Vietnam

River system	River basin in Vietnam (km^2)	Total flow rate (billion m^3)	Main estuaries
Ky Cung - Bang Giang	11,220	7.3	Flowing into Xijiang river in China
Hong river-Thai Binh river	82,340	80.3	Nam Trieu, Cam, Van Uc, Thai Binh, Tra Ly, Ba Lat, Lach Giang
Ma - Chu	17,729	16.5	Lach Truong, Lach Tao (Hoi)
Ca	17,730	24.5	Hoi
Vu Gia - Thu Bon	10,350	17.9	Dai
Ba	13,900	13.8	Tuy Hoa
Dong Nai	33,300	32.6	Can Gio, Soai Rap, Dong Tranh
Cuu Long (Mekong)	39,000	55	Tieu, Dai, Ba Lai, Ham Luong, Co Chien, Cung Hau, Dinh An, Tran De, Bat Sac

(Source: MONRE, 2015)

Lakes, reservoirs

Most experts on lakes and reservoirs agree on the concept of a natural lake as a type of water body that takes the form of a large deep depression on the water-bearing ground, with either standing or slow flowing water. Natural lakes are formed from many origins. In Vietnam, Ba Be Lake in Bac Kan province is derived from tectonics surrounded by limestone mountains with many caves and underground streams, and belonging to Ba Be National Park. Ba Be Lake was formed more than 200 million years ago. Late Cambrian tectonic evolution in Southeast Asia brought a giant body of water with a surface area of approximately 5 million $m^3$and a thickness of more than 30 m halfway up the shale and limestone mountains, creating Ba Be Lake. One of the group of volcanic lakes in Vietnam is Bien Ho (locally called T'Nung lake, meaning mountain sea) near Pleiku city, Gia Lai province. According to scientists, the

T'Nung lake is a crater that has been inactive for hundreds of millions of years. The lake is oval in shape, 20-30 m deep, with an area of 230 ha. The lake shore is a crater rim rising so high so you can still see it from a distance. In the group of lakes originating from rivers in Vietnam West Lake, Hanoi is typical. West Lake in the inner city of Hanoi is the largest natural lake in the Northern Delta. According to the latest data in 2011, the lake has an area of about 520 ha, the maximum depth is only 2.8 m, an average of about 1.5 m, capacity about 8 million m^3 of water. West Lake has a relationship with the Red River.

Vietnam currently has over 100 natural lakes with an area of over 10 ha each. In general, natural lakes in Vietnam are formed long ago, dating back hundreds of years or more. Due to the topographic feature of the Red River Delta with alluvial deposits, the flow changes during the formation of the Red River Delta, Hanoi is the locality with the most lakes in our country today. The Da Lat plateau had a number of lakes with an area of approximately 1,000 ha such as Tuyen Lam Lake with an area of about 240 ha and many other small lakes.

Table 3. List of natural lakes with area over 100 ha in Vietnam

Lake' name	Area (ha)	Lake' name	Area (ha)	Lake' name	Area (ha)
Thuan Ninh	430.24	Xa Vinh Son	223.52	Hoa Trung	120.11
Thuong Tuy	232.56	Da Cat	101.07	Kim Son	171
Tau Voi	133.02	Cu Lay	207.09	Trai Tieu	146.07
Suoi Trau	197.47	Suoi Hanh	108.96	Ta Ruc	136.97
Nghi Cong	108.45	An Ma	559.08	Cam Ly	260.19
Thai Xuan	169.59	Suoi Ngang	197.81	Suoi Dau	314.27
Buon Dong	177.74	Ea Cuor Kap	122.64	Ea R'bin	143.8
Ea Tyn	118.42	Ho Lak	607.17	Dak Minh	123.96
Bien Ho	460.55	Loc Thang	122.58	Bao Thuan	266.58
Bao Lam	155.61	Tuyen Lam	238.05	Da Den	355.05
Da My	592.38	Bien Lac	772.2	Ca Day	389.07
Song Quao	468.81	Da Ton	278.28	Thua Duc	252.36
Khuan Than	188.28	Hong Linh	114.84	Suoi Nua	113.38
Lang Thung	127.79	Ba Be	366.66	Pa Khoang	151.65
Ho Tay	523.71	Dong Quan	121.68	Xuan Khanh	120.87
Tuy Lai	122.58	Yen So	132.5	Quan Son	368.81
Dong Xuong	135.22	Dong Thai	325.8	Khe Che	206.46
Ben Chau	154,71	Bac Son	104.76	Song Vat Cai	622.71
Lang Van	117.88	Van Truc	174.06	Hien Luong	475.38

(Source: Research Center for Sea and Island, 2016)

The aquatic species composition of the lake is more homogeneous than the river aquatic species, depending on the geographical location of the lake, the origin of the lake, and the water source. The species composition of natural lake is mainly intrinsic to areas where there is a lot of light and dissolved oxygen (*Dang Ngoc Thanh, Ho Thanh Hai, 2007*).

Reservoirs are usually formed by building dams to block the flow of rivers to store water. Reservoir dams can be constructed of concrete, soil, stone or mixed materials. According to the statistics of the Central Management Board of Irrigation Projects (CPO), MARD and the Ministry of Industry and Trade (2018), there are about 7,000 reservoirs for irrigation and hydropower, including hydroelectric reservoirs with a total capacity of about 56 billion m^3,

accounting for about 86% of the total capacity of the reservoirs in the country. While reservoirs are distributed quite evenly in the North-Central-South regions of Vietnam, large reservoirs are usually distributed in the big rivers of the Northwest (Da River) and Northeast (Chay River, Lo River-Gam River), North Central region (Ca River, Ma River), South Central region (Vu Gia-Thu Bon River system), Central Highlands (Ba River, Se San River, Sre Pok River) and in the Southeast (Dong Nai-La Nga rivers, Be River and Saigon River).

Aquatic species composition of reservoirs is intermediate between lake and river organisms. In the species composition, far from the dam there are forms that adapt to flowing water, such as in rivers, while near the dam slow-flowing water has a species composition and developmental rules like lake aquatic organisms. The composition of this species is distinctly local, with the species of plankton and benthic found in reservoirs in mountainous areas, being similar to that of natural lakes in the mountains.

Table 4. Some large and medium reservoirs in Vietnam

Reservoir' name	Catchment (km^2)	Area of surface water (ha)	Capacity (billion m^3)
Son La	43,760	22,400	9,260
Hoa Binh	51,700	20,800	9,450
Thac Ba	6,100	23,000	2,940
Tri An	14,600	32,400	2,760
Dau Tieng	2,700	32,000	1,580
Thac Mo	2,200	10,300	1,370
Yaly	7,455	6,450	1,037
Phu Ninh	235	3,200	414
Song Hinh	772	-	357
Ke Go	223	2,500	345

(Source: MONRE, 2015)

Peat swamps: the peat swamp is a typical water body of Southeast Asia, formed by decomposed perennial aquatic plants. According to the Ramsar Convention, and MONRE's Circular no. 1093/2016/QD-TCMT, on technical guidelines for wetland classification in Vietnam, the peatland with forest, shrubs or without vegetation cover (Tb) is the peat layer formed from buried vegetation amassing for many years, accumulating in flooding conditions, with existing timber trees and shrubs growing above or not covered by plants.

Table 5. Distribution of peatlands in Vietnam

Locations		Area (ha)
Provinces	**Districts**	
Lang Son	Binh Gia, Na No	7
Bac Ninh	Yen Phong	5
Ha Nam	Ba Sao, Kim Bang, Tam Chuc	31
Ninh Binh	Gia Son, Son Ha	13
Quang Tri	Gio Linh	6
Thua Thien Hue	Phong Dien	31

Binh Dinh	My Thang	9
Dak Lak	Cu M'Gar	7
Lam Dong	Bao Loc, Di Linh	12
Dong Nai	Long Thanh	30
Tay Ninh	Trang Bang	25
Long An	Duc Hue, Thanh Hoa, Tan Thanh	72
Tien Giang	Tan Phuoc	21
Ben Tre	Binh Dai	17
An Giang	Tri Ton	62
Kien Giang	An Minh	2,900
Ca Mau	Tran Van Thoi	7,531

(Source: APFP, 2018)

U Minh Thuong (Kien Giang province) and U Minh Ha (Ca Mau province) are two places with large areas of remnant *Melaleuca cajuputi* forest on peatland in Vietnam. U Minh Thuong NP is located in a freshwater wetland area, including forests on peatlands, seasonally inundated grasslands and open swamps. It is home to a substantial amount of forest on the remaining peat swamp of Vietnam and is one of the three priority wetland conservation areas of the Mekong River Delta. It is also one of the big and important bird sanctuaries in the Mekong River Delta.

U Minh Ha NP is located in Ca Mau province. The administrative boundary is located on two districts of U Minh and Tran Van Thoi. The total area of the National Park is 8,527.8 ha, with a buffer zone around 25,000 ha. The outstanding feature of U Minh Thuong NP is the ecosystem of *Melaleuca cajuputi* (*Myrtaceae*), formed in flooded alum conditions on peatland, typical of the Mekong River Delta. In addition, this is also the habitat of many rare and distinctive species of birds and animals recorded in the Vietnam Red Book, IUCN Red List.

Estuaries

An estuarine water area is an area subject to the interaction of two water bodies: fresh water from inland rivers and surface water from the sea. Therefore, the prominent features in estuarine waters are changing salinity, tidal activity, and interaction between freshwater and salt water. The estuary area is usually shallow with great turbidity. An estuarine water area is complex with very high biological productivity. Studies in Vietnam show that in the delta estuaries of the Red River and Mekong River, the river hydrological process is the dominant force. The absolute dominance of the river in the rainy season is manifested in the proportion of river water blocks accounting for 80-90% of the water mass in the Red River tidal area, and 70-80% of the Mekong River Delta estuary. Meanwhile, in estuarine areas such as Bach Dang, Tien Yen-Ha Coi (Quang Ninh-Hai Phong province) and Dong Nai (Ba Ria-Vung Tau province), the role of the river is weak and the dominant dynamic is tidal, with the sea prevailing. In addition, there is also a form of the liman estuary, which is an uncompensated submerged area, in a region with no tides or small tides with significant wave dynamics and often with sand bars blocking the estuary. The liman estuary is located only in Central Vietnam. In the rainy season, river water is only 20-40%, dry season only 5-10%, low suspended sediments are mainly redistributed (*Vu Trung Tang, 1994*).

Vietnam has 114 different large and small estuaries, evenly distributed (with one estuary for approximately every 25 km of coastline) across the territory of 24 coastal provinces and cities, creating diverse and rich estuarine biomes, including freshwater, brackish and saltwater

ecological adaptive groups of organisms. The two largest delta estuaries of Vietnam are the Red River Delta and the Mekong River Delta estuaries, feature developing alluvial flats towards the sea. Ba Lat is the main estuary of the Red River that provides a habitat for many species of fauna and flora and is a stopover for many internationally important waterfowl on their migration path. Dinh An, the largest estuary among the Mekong estuaries, is also an important habitat and breeding ground for many aquatic species migrating from the upper Mekong (*Le Duc An et al., 2011*).

Table 6. Estuaries distributed by region in Vietnam

No	Region	Number of river mouth	Percent (%)	Length of coastline (km)
1	North	32	28,1	515
2	North Central Coast	24	21,1	642
3	South Central Coast	31	27,2	1290
4	South	27	23,6	828
	Total	**114**	**100**	**3260**

(Source: Le Duc An et al., 2011)

In estuaries, natural factors (marsh, mud, tidal canals, and coastal) and biological (phytoplankton, zooplankton, benthic, fish and mangrove vegetation) interact together and form a very complex food web. The rich estuarine flora in the intertidal zone includes mangrove plants, algae, phytoplankton and microalgae. Most mangroves are perennial (up to 50 years). Mangrove forest (mangrove) is a typical ecosystem type of tropical estuaries. There are some dominant mangrove populations such as *Rhizophora* spp. and *Avicennia* spp.

Large groups of seaweed commonly live in estuaries on muddy tidal flats or stone reefs. Some species of seaweed only live in sub-tidal areas and are only found during low tide. The size and growth rate of plants are an important basis for the local nutrient content of the estuary.

Phytoplankton in estuarine waters also have blooming periods such as those in inland shallow lakes. However, the patterns of phytoplankton or benthic microalgae in estuarine waters still have different features compared to inland freshwater bodies. The number of individuals of zooplankton in estuarine waters is quite abundant. Some of the typical forms are the widespread *Acartia* spp. Estuarine benthic zones play a huge role, as estuarine bio-dynamics depend on polychaete populations, groups of bivalve molluscs, and shrimp and crabs living in the bottom sediments.

Coastal tidal flats

Tidal flats are distributed throughout the coastal areas of Vietnam. The western coastal areas of the Gulf of Tonkin and the Southeast coast have a diurnal regime with the largest tidal range in Vietnam (with a maximum of more than 4 m), so the tidal flats here are often large. These two areas are considered to be typical for intertidal ecosystems. The tidal flats in the Red River's mouth are several kilometers wide. In some main estuaries, there are sandbanks outside the river mouths. The tidal flats are distinguished by muddy tidal flats in estuaries (with mangroves or without mangroves); sand tidal flats, rock tidal flats, and dead coral tidal flats in areas far from estuaries. The tidal flats are divided into three zones: high tidal zone, medium tidal zone and low tidal zone, in which each tidal zone has its own ecosystem.

The estuarine intertidal communities mainly include: mangrove plants (*Sonneretia*, *Acanthus*, *Avicennia*), Cyperacea (*Cyperus*), polychaetes (*Sabellidae, Chaetopterus*), Sipunculida; mud crab Grapsidae (*Sesarma, Metagrapsus*), Ocypodidae (*Uca*), mud crab Portunidae (*Scylla*); small snails Littorinidae, Neritidae, Cerithidae; and clams (*Cyclina*).

The composition of the intertidal rock species in the northern part of Vietnam is found in the Quang Ninh-Hai Phong region, include molluscs (*Ostrea, Patella, Acmaca, Nerita* snails, *Littorina*), large snail species Veneridae, Trochidae, Haliotidae as well as clinging crustaceans (*Balanus, Mitella*), crab Grapsidae (Sesarma, Nanosesarma, Metopograpsus), *Nereis filamentous* worms, and notably, echinoderms (*Cucumaria, Temnopleurus, Diadema*). The sand tidal flats are generally slightly steep, small and narrow, strongly influenced by waves. The bottom substance is clean sand with abrasive skeletal remains. The species composition is quite poor (*Dang Ngoc Thanh, Ho Thanh Hai, 2007*).

Mangroves

Mangrove ecosystems are formed in estuaries along the coast in the tropics. The main feature of the habitat is the mangrove carpet. Muddy tidal flats with developed mangroves create the typical mangrove ecosystem of tropical tidal zones. This type of habitat is usually in mid- and high-tide areas, where flooding occurs during daily high tides.

In Vietnam, mangroves develop in estuarine areas along the coast, in major estuaries in the North (Red River, Thai Binh River), and in the South (Mekong River, Dong Nai River). According to the research data of Phan Nguyen Hong (2001, in the East Sea Monograph), up to now, there are about 94 species of mangrove plants, with species belonging to the families: Acanthaceae (*Acanthus*), Avicenniaceae (*Avicennia*), Myrsinaceae (*Aegiieras*), Palmae (*Nypa*), Phizophoraceae (*Bruguiera, Ceropus, Kandelia, Rhizophora*), Sonenratiaceae (*Sonneratia*), including the following groups:

- Group I includes major mangrove species, including 35 species of 20 genera, and 16 families.
- Group II includes salt-tolerant plants that migrate into mangroves, often found in secondary forests, planted forests, alluvial soil, and along canals that are only inundated at height or rarely in tidal flooding. This group includes 40 species of 35 genera and 27 families. There are also a few random species that have moved from the inland.

In terms of distribution, there is a difference between the composition of mangrove plants in the North and the South of Vietnam. From North to South, the distribution can be classified into four regions with 11 sub-mangrove forests (*Phan Nguyen Hong, 2001*).

Mangroves are the habitat and breeding grounds of very rich mangrove communities, with great importance for coastal marine resources and coastal protection. Mangroves play an important role in the lives of people living in coastal tropical countries in general, and Vietnam in particular. Management of mangroves for sustainable harvest has increased in recent years, with the importance of mangroves in socioeconomics, environment and ecology being recognized by many international organizations, government, local authorities, and NGOs local communities and interested scientists.

Coral reefs (at a depth of below 6m during low tide)

The coral group consists of thousands of polyps made up of coral. Coral polyps are characterized by their ability to eat zooplankton and other small particles floating in the water. It is a coral reef, but in reality, only a few groups of organisms participate in creating the reef.

Nguyen Huy Yet and Vo Si Tuan have fully summarized the characteristics of Vietnam's marine coral ecosystem in the East Sea Monograph, volume IV (2003). Their research results show that coral reefs with different levels of development are found along the coast and islands in the waters of Vietnam. The geographical location and climatic conditions of Vietnamese waters create favorable conditions for the formation of coral reefs. Coral reefs are mostly found in exceedingly limpid, shallow, near-shore waters. In Vietnam sea, it is possible to distinguish four main coral distribution zones: the Paracel Islands and Spratly Islands;

Central coastal coral area and Southeast islands; the coral area west of the Gulf of Tonkin; and the South West Marine Coral Region (*Dang Ngoc Thanh et al., 2009*). Among important marine ecosystems, the coral reef ecosystem is considered as the "undersea tropical rainy forest" and is also the most vulnerable ecosystem due to climate change (*MONRE, 2019*). Moreover, coral reef ecosystems in Vietnam also have high biological productivity, estimated at 30-100 mg c/m^3 of primary production per day, nearly 100 times more than reefs in open water (*Latypov, 2017*).

Research by Vietnamese experts on coral has recorded nearly 400 species of coral reefs in Nha Trang Bay, Ninh Thuan, and Con Dao, each with more than 300 species (*Vo Si Tuan, 2003*); There were 236 species of coral in the southwestern region (*Nguyen Huy Yet, 2007 and 2009*); from the results of surveys and studies of corals and reefs in 2010, 2011 and 2015, a total of 444 species of coral have been identified in 19 islands in the Vietnamese sea, of which 378 species of hard corals (*Do Van Khuong et al., 2015*). Nguyen Van Long and Vo Si Tuan (2014) based on a set of previous and recent additional data have recorded 403 species of hard coral reefs belonging to 75 genera in coastal areas of Vietnam.

Researches on biodiversity in coral reefs in Vietnam show that coral reefs have a very diverse and rich species composition. It can be said that the reef habitat has the largest number of species compared to other marine habitats, with representatives of most phyla and classes of ocean-dwelling fauna. Studies show that the fauna living in coral reefs in Vietnam has about 2,100 species, of which, the most diverse are coral reef fish with 763 species, followed by molluscs with nearly 700 species, crustaceans with more than 250 species, polychaetes with about 170 species, and echinoderms with nearly 100 species (*MONRE, 2019*).

There were a wide range of data on coral reef areas in Vietnam according to different authors and periods. The total coral reef area in Vietnam was estimated at 1,122 km^2 (*Global Coral Reef Monitoring Network, 2004*), with most of the coral concentrated in the waters of the archipelagos of Hoang Sa and Truong Sa and the central coast (*Vo Si Tuan et al.*). In the period 2008 - 2010, the total actual coral reef area of Vietnam was about 14,130 ha (*Institute of Marine Resources and Environment*). According to the data of Nguyen Van Long and Vo Si Tuan (2014), the total area of coral reefs in Vietnamese waters was 13,355 ha.

Table 7. Distribution and area of coral reefs in coastal waters in Vietnam

(NA: Not available data; *: MPAs planning)

Area	Distribution points	Estimated coral reef area(ha)	Within existing MPA's(ha)	Hard coral
The Gulf of Tonkin	Dao Tran*	NA	NA	48
	Co To*	370	370	121
	Ha Long-Cat Ba*	500	500	171
	Bai Tu Long	NA	NA	115
	Bach Long Vi*	1,578	1,578	93
	Hon Me*	NA	NA	72
	Con Co*	274	274	166
The Coastal Central	Hai Van-Son Cha*	NA	NA	102
	Da Nang	105	NA	226
	Cu Lao Cham*	311	311	227
	Ly Son*	1,704	1,704	79
	Phu Yen	303	NA	139
	Van Phong	1,618	NA	292
	Nha Trang*	731	183	350
	Ninh Hai (Nui Chua*)	2,330	1,070	310

	Hon Cau*	506	506	184
	Phu Quy*	1,488	1,488	239
The Southern waters	Con Dao*	903	903	307
	Nam Du	80	NA	126
	Phu Quoc*	474	292	251
	Tho Chu	80	NA	198
Total		**13,355**	**9,179**	**403**

(Source: Nguyen Van Long and Vo Si Tuan, 2014)

Seagrass (at a depth of below 6m during low tide)

Seagrasses are flowering plants (angiosperms) (phylum Anthophyta, class Monocotyledoneae, order Helobiae). This is a group of flowering high plants that are adapted to marine life. Seagrass beds are a type of coastal ecosystem found in many marine areas in Vietnamese waters. Researches by Nguyen Van Tien et al. (2003, 2004) listed 14 seagrass species belonging to 4 families Hydrocharitaceae, Cymodaceaceae, Zoosteraceae, Ruppiaceae, equivalent to other marine areas in the region. Regarding taxonomic composition, *Halophila* genus has the most species, other genera such as *Ruppia, Zostera, Thalassia, Eubalus* have only 1-2 species. Regarding the distribution of seagrass in Vietnam, we can see the north-south distribution and the water body type.

According to Nguyen Van Tien (2013), the total area of seagrass beds in Vietnam is 18,130 ha. According to newly published statistics using remote sensing technology of Cao Van Luong et al. (2012), the area of coastal seagrass in Vietnam is about 17,000 ha, scattered in bays and coastal areas of islands and in lagoons. The largest area of seagrass is in the shallow waters of Phu Quoc Island (over 10,000 ha) with 9 species (*Nguyen Van Tien et al., 2006*).

A seagrass bed can consist of pure species, only one growing species, or a collection of species. Seagrasses sometimes develop into large seagrass beds ranging from 10 to 1000 ha in coastal and island areas. However, the animal community living in seagrass beds is quite abundant. Seagrass is usually the staple food for dugong (*Dugong dugon*).

1.1.2.3. Marine and coastal ecosystems

Lagoons

In general morphology, a lagoon usually takes the form of a water body lying longshore, separated from the sea by a stretch of sand dunes, on the one hand receiving water from rivers from the mainland through estuaries, on the other side connecting with the sea through one or more gates. However, due to the location of each water body in each area with a range of geological and hydrological conditions, and different types of dynamic development regimes that vary in magnitude, structural morphology, and evolutionary trends, lagoons have developed different ecological and biological conditions.

The lagoon system in Vietnam is distributed along the central coast line, from Thua Thien Hue to Ninh Thuan. The total area of the lagoons is about 447.7 km^2. The largest lagoon system is located in Tam Giang - Cau Hai area with a length of 67 km and an estimated area of 216 km^2. The smallest lagoon is Nuoc Man Lagoon in Quang Ngai province with an area of 2.8 km^2. The lagoons in coastal Vietnam often have fairly flat bottoms, depths of about 2-4 m and salinity from 1-32 ‰, depending on the rainy regime (dry or rainy season).

Many authors have distinguished types of lagoons in Vietnam, but the main basis for the division is dynamic form related to the hydrological regime characteristics of the lagoon, the ability to exchange water between lagoons and seas, and the water balance that takes place in the lagoon between water masses of river and sea, is related to the magnitude of the lagoon gates opening to the sea and the estuaries flowing into the lagoon. Dang Trung Thuan et al., (2000) divided the lagoon along the central coast of Vietnam into three types:

- Near closed (Tam Giang-Cau Hai, Truong Giang, Thi Nai, Cu Mong, Thuy Trieu);
- Partially sealed (Lang Co, Saltwater, Brackish Water, O Loan, Tra O, Nai); and
- Closed (An Khe).

Also according to Dang Trung Thuan et al. (2000), on the basis of salinity, the central coastal lagoon of Vietnam has been distinguished into three groups: saline brackish (Nuoc Ngot, Thi Nai, Tam Giang, O Loan), light brackish (Cu Mong), fresh water (An Khe, Chau Truc/Tra O).

In general, the aquatic communities in the lagoons with characteristic of the coastal brackish water fauna, include groups of plankton (phytoplankton and zooplankton), seaweed, grass, and mangrove plants, benthic (crustaceans, molluscs, insect larvae), fish, amphibians, reptiles and waterfowl. However, due to the nature of water exchange between the inside of the lagoon and the sea outside, and the water salinity, each lagoon has its own characteristic aquatic biome structure. This characteristic is manifested by the seasonal predominance of fresh, brackish, and saltwater aquatic organisms in some semi-enclosed or partially enclosed lagoons, of the brackish or light brackish type. In particular, the structure of freshwater or salt-brackish water communities in some lagoons remains stable throughout the year because it is dominated by fresh water or seawater all year round (*Dang Ngoc Thanh, Ho Thanh Hai, 2007*).

Table 8. Background information of coastal lagoons in Central Vietnam

No	Lagoon's name	Area (km^2)	Depth (m)	Province	River-sea interaction
1	Tam Giang-Cau Hai	216	Average: 1.6 Deepest: 6-7	Thua Thien Hue	It is a shallow water body with more **than** 10 rivers pouring fresh water into the lagoon. Outflows to the sea though gates of Thuan An and Tu Hien
2	Lang Co	16	Average:1.2 Deepest: 2.0	Thua Thien Hue	Due to the great influence of the sea, the salinity is often high
3	Truong Giang	36.9	Average:1.1 Deepest: 2.0	Quang Nam	-
4	An Khe	2.9	Average:1.3 Deepest: 2.0	Quang Ngai	-
5	Nuoc man (Sa Huynh)	2.8	Average:1.0 Deepest: 1.6	Quang Ngai	-
6	Tra O (Chau Truc)	16	Average:1.6 Deepest: 2.2	Binh Dinh	Receives fresh water from watershed streams. Water from the lagoon to the sea through the Chau Truc River is about 5 km long. The lagoon gate is not opened often, encroached by sand in the dry season. Freshening water.
7	Nuoc ngot (De Gi)	26.5	Average: 0.9 Deepest: 1.4	Binh Dinh	-
8	Thi Nai	50	Average: 1.2 Deepest: 2.5	Binh Dinh	Receive fresh water from many rivers pouring in, the largest is the Con River. Water mass and salinity depend on river water flow and tidal current.
9	Cu Mong	30.2	Average: 1.6 Deepest: 3.5	Phu Yen	The lagoon is relatively deep, only connected to the sea by a narrow gate, influenced by the

					sea.
10	O Loan	18	Average: 1.2 Deepest: 2.5	PhuYen	The lagoon has many properties of a saltwater lagoon
11	Thuy Trieu	25.5	-	Khanh Hoa	The lagoon has many properties of a saltwater lagoon
12	Dam Nai	8	Average: 2.8 Deepest: 9m (in creek of lagoon middle)	Ninh Thuan	A deep lagoon, more dominated by the sea, belongs to the salt water body type

(Source: Dang Ngoc Thanh, Ho Thanh Hai, 2007)

Bays

There may be different views of the bay-gulf but, in general terms, bays can be considered as parts of the sea that lie in a depression of the coastline or the coastal sections with an outlying island, in which marine processes dominate in relatively enclosed seawater conditions, without or with very little impact of river processes (*Tran Duc Thanh et al., 2009*). Also according to this author, Vietnam has 48 bays, with the area of each unit ranging from 2-560 km^2 and a total area of about 3997.5 km^2, 9 times the total area of the coastal lagoon system in Central Vietnam.

Bay ecosystems are a mixture of estuarine ecosystems and coastal areas that determine the structural composition of the coastal bay fauna in Vietnam. The main biological feature of the bay ecosystem is the presence of coral reefs, molluscs, crustaceans and fish representative of the coastal waters of Vietnam. Tran Duc Thanh et al (2009) divided the biodiversity level of the bays into three levels:

- Bays with high species diversity: including large or medium, semi-enclosed bays, with rocky shores and barrier islands. Tidal dynamics are dominant, and influence on the river is negligible. Typical are Co To-Thanh Lan, Ha Long Bay, Bai Tu Long Bay, Lan Ha Bay, Minh Chau Bay-Quan Lan.
- Bays with medium species diversity: including coastal bays of medium magnitude, semi-enclosed, with rocky shores, islands and sand banks, with wave dynamics dominant, though the influence of rivers is also quite strong. The sediments of this bay type are often complex. Typical are Tien Yen Bay-Ha Coi, Van Phong Bay, Cam Ranh Bay, Binh Cang Bay, Xuan Dai Bay.
- Bays with low species diversity: including small, semi-enclosed bays, original rocky shores, islands and sand bars, dominated by river dynamics, with some influence of the sea but not too great. Sediments are usually mostly sandy mud or sometimes muddy sand.

Island ecosystems

Vietnam has more than 3,000 islands and archipelagos, most of which are concentrated in the waters of Quang Ninh province in the North, forming the World Cultural Heritage Area of Ha Long Bay. Some large islands in the Central and the South include Cu Lao Cham (Quang Nam province), Ly Son (Quang Ngai province), Phu Quy (Binh Thuan province), Hon Cau (Binh Thuan province), Phu Quoc (Kien Giang province), Tho Chu (Kien Giang province) and Con Dao (Ba Ria - Vung Tau province).

According to Dang Ngoc Thanh et al. (2009), all of the coastal islands have low, hilly and mountainous terrain, and the origin of erosion is directly related to the period of sea degradation. The steep terrain falls down in parallel to the denudation base which is at sea level. The climate on the islands has high temperature, abundant radiation, high rainfall, and no frost. These are very favorable conditions for plants to grow. However, there are also

adverse conditions that affect plant growth, including frequent strong winds and direct effects of storms. The hydrological network is not well developed and there is no reserve water in the dry season.

Most of the coastal islands have terrestrial ecosystems (with terrestrial types of flora and fauna) and in the surrounding sea intertidal ecosystems, coral reefs, and seagrass beds with characteristic species composition, including several distinct species. In general, the flora and fauna on the island are less rich and diverse than the forest on the mainland. However, terrestrial ecosystems in Phu Quoc Island are very diverse. Studies at Phu Quoc NP have identified 1,353 species of vascular plants belonging to 601 genera, 150 families of 4 phyla (*Dang Minh Quan, 2014*); 28 mammals belonging to 14 families, 06 orders; 135 bird species of 42 families, 15 orders; 55 species of reptiles and amphibians belonging to 19 families, 4 orders, including many threatened species listed in the Red Data Book of Vietnam (2007) (*IEBR, 2009*).

Marine communities in island waters are very diverse and plentiful, especially in coral reef and seagrass ecosystems. Studies show that the composition of coral species in the waters around Con Dao is the most abundant and diverse among the islands in Vietnam. Surveys have identified 219 coral species belonging to 61 genera and 17 families. In particular, the hard coral (*Scleractina*) has 217 species. The index of diversity of coral species H '= 1.24 (*WWF-Vietnam, 1995*) is quite high. According to survey data in 1994-1995, the average coverage of living corals on the reefs in Con Dao is 42.6%. This rate is much higher than that of other coastal waters in Vietnam. The waters around Con Dao are considered to be the spawning sites of many marine species including many marine fish, benthic animals, especially sea turtles. Thanks to the ocean currents passing through the Con Dao region, the sources of larvae and young animals of many marine aquatic species are dispersed from here into the Central Coast (in summer) and the South West Sea (in winter) (*Lang Van Ken et al., 1999*).

Therefore, up to 11 islands are planned to be included in the system of 16 marine protected areas in Vietnam according to the Prime Minister's Decision no.742/2010/QD-TTg.

Offshore waters (including the waters around the Hoang Sa and Truong Sa archipelagos).

Vietnam's offshore waters within the exclusive economic zone include (i) Gulf of Tonkin; (ii) Central Vietnam; (iii) Southeast; (iv) South West; and (v) Middle of the East Sea. From an ecological perspective, Vietnam's offshore sea includes the ecosystems (water mass) of the sea and the archipelagos of Hoang Sa and Truong Sa (including the ecosystems on the islands and the coral reef, seagrass bed ecosystems around the islands).

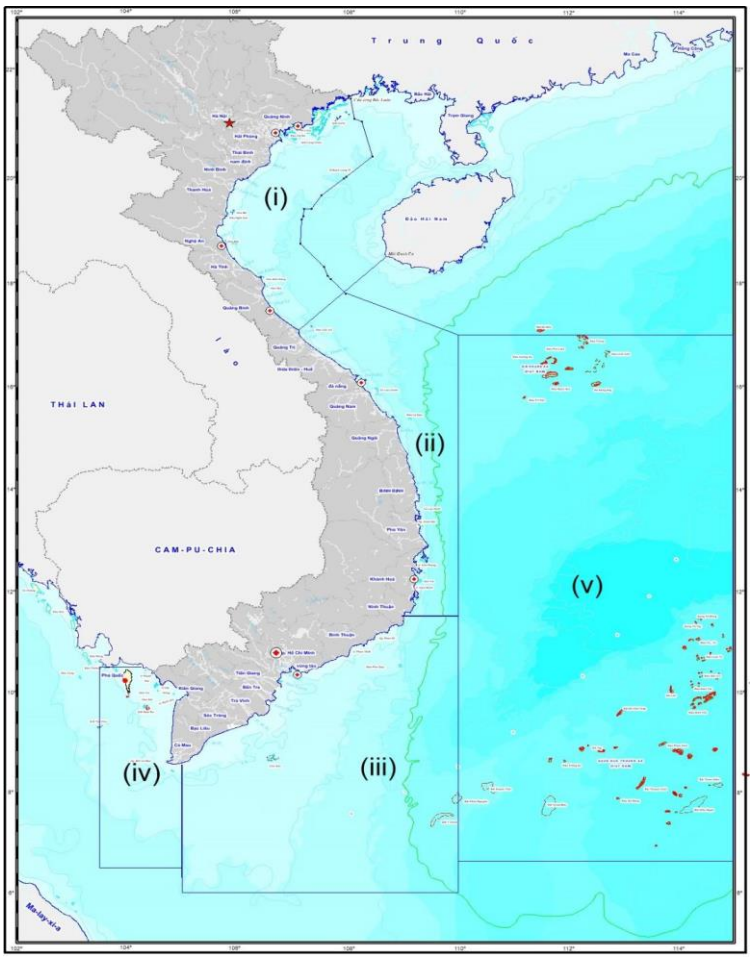


Figure 10. Map of the extent investigated marine areas

This map is under the project "The Master Survey of the current status and changes of marine resources in Vietnam", 2011-2015

(*Source: RIMF, 2016*)

The Hoang Sa archipelagos are a group of coral atolls off the South China Sea, comprising up to 36 islands and shoals (*Nguyen Huy Yet, Dang Ngoc Thanh, 2008*). Truong Sa archipelago has more than 100 islands and shoals. The big islands are Song Tu Tay (170,000 m^2), and Truong Sa (90,000 m^2).

Ecosystem on island: The formation of the islands of the Truong Sa archipelago date from the Late Pleixtocene - Holocene. The surface is flat or slightly concave, floating 2.5-3.5 m above sea level. The climate south of the East Sea is equatorial nature, with a high background temperature. The average temperature is 26-28^oC, the average annual rainfall is 2,500-2,600 mm, focusing on the rainy season. The natural conditions are so severe that the vegetation is poor. Survey data on two typical islands, Truong Sa and Song Tu Tay, shows that there are 19 species of plants on the island.

Coral reef ecosystem of Truong Sa archipelago: there are over 100 coral reefs, but only 10 reefs were studied at different levels. Synthesizing different research documents, the composition of hard corals (*Scleractinia* order) created the reef with 329 species of 69 genera and 15 families (*Nguyen Huy Yet, Dang Ngoc Thanh, 2008*). According to these authors, there are 2 main types of reefs: shoreline and ring reefs. The biome living on coral reefs in Truong Sa includes 186 species of seaweed, 554 species of benthic animals belonging to 192 genera, 106 families belonging to 5 different groups including polychaetes, crustaceans, molluscs and echinoderms. The marine coral fish fauna of Truong Sa archipelago is quite diverse, with 524 species, 138 genera, and 48 families.

The seagrass ecosystem in Truong Sa archipelago has three species: *Thalssia hemprichi*, *Halophila ovalis* and *Thasolasdendron ciliatum*. The seagrass beds on Nam Yet Island form a thick carpet on all three sides of the island, with a coverage of 50-80% and a biomass of 4.8-6.4 kg/m^2.

Vietnam's waters have been studied for a long time in the fields of oceanography, environment, biodiversity and fisheries resources. For example, The Institute of Oceanography of Indochina in Nha Trang used the research vessel De Lanessan (1000 CV) to conduct research trips on oceanography, biology, coral reefs, and minerals in the archipelagos of Hoang Sa and Truong Sa from 1926-1938 and obtained a great deal of baseline data; The Vietnam - (former) Soviet Union cooperation program (period 1964-1965) conducted an investigation of fish resources in the Gulf of Tonkin and the waters of Hoang Sa, Truong Sa. The research results have been published in a number of monographs. In 1993-1997, in the East Sea and Islands Program, the study "*Integrated investigation of marine biological resources and marine environment in the Truong Sa Islands*" was conducted on pelagic fish resources using gill nets, and on coral reef fish fauna surrounding the islands, collecting information on environmental aspects of these waters. In 1999-2003, the project continued to collect data on biological resources in the waters of the Truong Sa Islands. Evaluation of the results of this study has provided a relatively complete assessment of marine life components, including 465 species of phytoplankton, and 358 species of zooplankton. Fish resources have also been assessed including pelagic fish resources, demersal fish resources, and coral reef fishes in islands in the Truong Sa Islands.

Within the scope of Project 47, Subproject I.9: an overall investigation of the current status and fluctuations of marine resources in Vietnam was undertaken by the Research Institute of Marine Fisheries, surveying marine resources in Vietnam sea with gill nets, yellow fishing, bottom trawls and middle-layer trawls in the period 2011-2015. 941 species of seafood, of 462 genus and 191 families of seafood species were found. The Southeast has the largest number of species (619 species); followed by the Central Coast (457 species), the Gulf of Tonkin (430 species) and the Middle East Sea (129 species).

In the period 2011-2015, the average total biomass of major marine resources groups in Vietnam were estimated at 4.36 million tons. The average biomass of resources in the Gulf of Tonkin was estimated at 757 thousand tons (accounting for 17.3% of the total); the Central Coast region was 868 thousand tons (accounting for 19.9%); the South East Sea is 1,119 thousand tons (accounting for 25.6%); the southwestern sea area was 584 thousand tons (accounting for 13.4%) and the Middle East Sea was 1,036 thousand tons (accounting for 23.7%). The biomass of marine resources in the coastal areas (including coastal areas and open areas) was estimated at 1,368 thousand tons (accounting for 31.4%); and in the offshore area about 2,996 thousand tons (accounting for 68.6%).

1.2. Status of species and genetic resources

Vietnam is globally ranked as having high biodiversity with a wide range of natural ecosystems, species, and abundant and endemic genetic resources. To date, in Viet Nam, approximately 61,700 natural species have been identified, including about 7,500 species/varieties of microorganisms, 2,200 species of fungi, 16,977 species of terrestrial and aquatic plants, 1,932 species of terrestrial vertebrates, about 20,000 species of insects; about 2,000 species of invertebrates and fish in freshwater and over 11,000 species of marine life including microalgae, seaweed, sea grass, zooplankton, crustacean, molluscs, echinoderms, coelenterates, sponges, marine fish, marine reptiles, marine mammals. In terms of endemism, the number of endemic species in Vietnam is high e.g. about 30% of terrestrial vascular plant species, 4.6% of species and subspecies of birds, 27% number of freshwater snails and mussels, and about 58% of freshwater shrimps and crabs) (*MONRE, 2021*).

Cervus unicolor

Trachypithecus poliocephalus

Panthera tigris corbetti

Table 9. Number of known natural species in Vietnam

Groups of organisms	Number of known species	Citation source
1. Microorganisms	About 7,500	MONRE (2019)
2. Fungi	2,200	"List of plant species in Vietnam", volume 1. Agricultural Publisher (2001)
3. Microalgae (including cyanobacteria and other microalgae in freshwater and marine)	2,544	"List of plant species in Vietnam", volume 1. Agricultural Publisher (2001)
4. Plants (including mosses, pine needles, pen towers, ferns, gymnosperms and angiosperms)	14,433	"List of plant species in Vietnam", volume 1. Agricultural Publisher (2001) has been added, updated
5. Freshwater Invertebrates	About 900	Dang Ngoc Thanh, Ho Thanh Hai, Duong Duc Tien, Mai Dinh Yen (2002) has been added, updated
6. Marine Invertebrates	About 7,000	Dang Ngoc Thanh et al. (2009)
- Zooplankton	657	
- Zoobenthos (mollusks, crustaceans, echinoderms, polychaetes, cavity intestines...)	About 6,300	
7. Land Invertebrates (land snails, worm, colembolla...)	About 1,000	Dang Ngoc Thanh (2008); Thai Tran Bai; Nguyen Tri Tien (2017)
8. Parasitic fluke	190	Nguyen Thi Le (2000)
9. Insects	About 20,000	Constant et al. (2018)
10. Spider	491	Pham Dinh Sac (2015)
11. Fish	About 3,500	Dang Ngoc Thanh et al. (2009) Nguyen Van Hao (2005)
- Freshwater fish	About 1,000	
- Sea fish	About 2,500	
12. Amphibians	240	Amphibiaweb.org (2018)
13. Terrestrial Reptile	470	Uetz et al. (2018)
14. Marine reptiles (sea snakes, sea turtles)	21	Dang Ngoc Thanh et al. (2009)
15. Birds	918	Le Manh Hung (2020)
16. Terrestrial animals	331	Dang Ngoc Can et al. (2008) Nguyen et al. (2018) Nguyen Xuan Dang and Le Xuan Canh (2009)
17. Sea animals	25	Dang Ngoc Thanh et al. (2009)
Total	**About 61,700**	

Biodiversity in Vietnam brings direct benefits to people and makes a great contribution to the economy, especially in agriculture, forestry and fisheries; as a basis for ensuring national food security; maintaining genetic resources for breeding animals and plants; providing materials for construction and sources of medicinal herbs, food, and other products. Natural ecosystems, apart from being the basis for scientific development of nature discovery,

ecotourism, sightseeing and relaxation also play an important role in climate regulation and environmental protection.

In the period 2010-2020, there were 1 family, 5 new genera and 606 new species and subspecies for science announced by scientists of the Vietnam Academy of Science and Technology published in the world journals and the Journal of Biology. The number of new species and species for science will continue to increase because, due to resource constraints, many groups of organisms have not been investigated and studied carefully, and many areas have not been surveyed in detail (*MONRE, 2019*).

In addition to having a diversity of natural organisms, Vietnam has a high diversity of cultivated plant and animal genetic resources, including about 800 plant species, more than 6,000 rice varieties, 887 livestock varieties and around 30 varieties of them are widely used. Livestock and crops have been developed for hundreds of years and have valuable genetic traits. These are the precious indigenous genomes of Vietnam that need to be protected, preserved and developed (*MONRE, 2021*).

1.3. Traditional and indigenous knowledge on conservation and sustainable use of biological resources

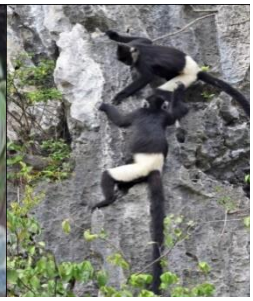
According to information from the website http://thegioidisan.vn/, Vietnam has 54 ethnic minority communities (Kinh people accounts for about 86.5% of Vietnam population), and if divided by language, there are 8 main communities. Vietnam possibly has one of the highest levels of ethnic density in the world. Due to the diversity of ethnic communities and languages together with indigenous cultures and customs, traditional and indigenous knowledge of the conservation and use of natural biological resources in Vietnam is extremely rich and diverse.

Rhinopithecus avunculus

Paphiopedilum armeniacum

Leiothrix lutea

Paphiopedilum callosum



Trachypithecus delacouri

According to the 6th National Report on Biodiversity (*MONRE, 2019*), in Vietnam, traditional and indigenous knowledge on the exploitation and use of biological resources groups has contributed an important part to solving local livelihood problems. However, in the process, the protection of biological resources is also a concern of ethnic minority communities. In recent years, in Vietnam, there have been many researches and scientific seminars on indigenous knowledge in many fields related to the use and exploitation of natural resources such as agriculture (intercropping techniques, breeding, managing pests and diseases, diversifying plants, taking care of animal health, selecting plant varieties); biology (botany, fish farming techniques); taking care of human health (with traditional remedies from traditional medicinal plant resources); natural resource use and management (soil protection, irrigation and other forms of water source management); education (oral knowledge, local languages) and overall poverty reduction.

Use of medicinal plants: For many years the Institute of Ecology and Biological Resources, the Institute of Medicinal Materials, the University of Pharmacy, and the Institute of Social Sciences have built a new research direction and conducted research on ethnic botany aiming to investigate, evaluate, preserve and develop the indigenous knowledge of mountainous

ethnic groups in conservation and use of biological resources. As a result, hundreds of medicinal plants and traditional remedies were collected from the ethnic groups in the mountainous regions of Vietnam.

The Institute of Medicinal Materials has carried out surveys on indigenous knowledge, collected medicinal plants and experiences in using medicinal plants and remedies of ethnic minorities such as H'Mong (Lao Cai), Muong (Thanh Hoa, Hoa Binh, Yen Bai and Nghe An provinces), Dao (Ba Vi, Lao Cai, Hoa Binh and Vinh Phuc provinces), Co Tu (Thua Thien Hue province), Van Kieu (Central Highlands), Tay (Ha Giang, Cao Bang, Bac Can, Lang Son and Thai Nguyen provinces), Nung (Lang Son province), San Diu (Vinh Phuc province), and Khmer (An Giang province), compiling a list of medicinal plant species of 15 major ethnic groups and collecting 1,296 ethnic group folk remedies that have served screening research, research and development to create disease prevention products (*MONRE, 2019*). Ethnic minorities have had knowledge about tree species, wild animals in the forest, experience in cultivation and husbandry, the cycle of weather and other characteristics of nature.

Knowledge of using materials from forest trees for community housing, daily tools, weaving and other purposes.

Knowledge and experience in cultivation and breeding: According to authors Pham Quoc Hung and Hoang Ngoc Y (2009), many generations have drawn upon indigenous knowledge in agricultural and forestry production of H'Mong people in Hang Kia-Pa Co, Son La province building experience through production practice. That experience has been gathered by word of mouth from generation to generation, in every family and in each community. It is knowledge of trees, wildlife in the forest, experiences with farming and livestock, weather cycles and other features of nature. Regarding the issue of management, protection and development of forest resources, indigenous knowledge of the people is really effective, such as knowledge of land use in cultivation, identification of forest trees, forest animals, and knowledge about exploitation and use of forest products. This is a favorable factor for community participation in local forest management, protection and development activities. Forests are of great importance to the life of the community. Through interviews with villagers, most of them want to participate in forest protection and development activities. This is also an important factor as the basis for the development of community organizations and laws on forest resource management and protection.

The communities of ethnic minorities in Vietnam have proposed many customary laws to preserve and protect the living environment, and to conserve and sustainably exploit forest and aquatic resources.

Local customary law protecting forests: Since ancient times, the community of ethnic minorities in Vietnam has been very aware of preserving and protecting the living environment in general, including forest protection. This awareness led to, the birth of customary laws observed by family groups. Some very active practices such as protection of sacred forests and sacred waters (habitat and breeding grounds of many species of wild animals, plants and fish) of ethnic minorities have been maintained and developed by all levels of government. According to Tran Cong Khanh, Nguyen Ngoc Sinh (2016), the Ede ethnic custom law in the Central Highlands has 236 articles with about 8,000 sentences, defining the responsibilities of each individual, of the individual to the community, etc. in order to create equality among everyone. There was no discrimination, favoring of the upper class, or mistreatment of the lower class in all areas of life in the village.

In particular, the laws relating to environmental protection are concerned with protection of forests, birds, animals, land, and water sources. With the protection of forests, according to the Ede customary law, the protection of watershed trees and forest trees on the banks of streams, water terminals, old forests, protection of residential trees in young forest. Because forest trees are the roof of the community, losing trees will erode land, water resources will

dry up, and people and all species will be destroyed. Therefore, protecting forest trees is protecting the ecological environment of the community.

Article 231: Land, rivers, streams and trees are the baskets and household items. Grandparents are the keepers of the cave, the forest, the K'tơng tree, the Kdjar tree.

Article 232: All children must be taught: It is forbidden to put stakes on the K'tơng tree, not to climb the Kdjar tree. Non-complying with that prohibition is considered equal to the crime of cutting the elephant's tail, groping the wife of a rich chief, and adultery with the wife of a brother. That crime must go to trial.

"Walking in the forest see straight trees that cannot be cut, and big trees that cannot be cut. The old forest is not to be cleared. Forests with big trees are not allowed to be cultivated for agricultural crops. Losing the forest, the weasel, the porcupine has no place to stay, no place to feed. Humans don't have forests to live in, etc."

"It is forbidden to clear old forests when working in the field. Do not cut big trees when building a house. In cutting down a tree you must plant seven trees. Cut big trees to leave seedlings. In doing so, the forest is not lost. By doing that, the forest will stay green forever, etc."

"We must protect birds and animals in the forest. Seeing birds and animals you should not give chase. In getting the weasel it is not allowed to catch the mother. In getting the bird you cannot catch the mother. In catching the fish it is not allowed to catch the mother. Forcing out the rabbit is not to capture the mother, etc.".

In addition, according to Xuan Tien (*Dai Doan Ket 20/4/2017*), in the Ede customary law, there are laws on forest fires, regulations on not burning indiscriminately, being mindful when going to the forest; advising everyone to pay close attention when using fire. Anyone causing a fire, will be severely punished.

"Men used to make fires indiscriminately, women used to make filthy fires, there were those who lit it and acted like the deaf and blind, there were those who lit the fire and acted like mad, foolish people". In the fields, doing the milpa farming then walking out leaving smoldering fires can destroy the whole forest. The fire will go into the forest and burn away all grass, trees and all things. I am afraid that the fire will spread, burn the whole village, all the huts, the whole huts, the barns they have built up in the forest, in the fields, but the surroundings have not been cleared yet, etc.

Meanwhile, the Law on Thai custom (Hi khong Muong Ban) also has a passage: "use fire or water so there is no more accidents; use water to avoid the flow of water; use fire to keep fire".

Thus, the regulations on how to protect, prevent and fight forest fires are very specific and practical and everyone responds very well to comply and it is ingrained in each person's mind. Residents are often happy to follow community regulations.

This is an issue that the Law on Environment Protection as well as other legal fields of our State has not been able to achieve.

In addition to forest fires, customary laws provide very specific provisions on the management, exploitation and protection of forests, and violations of customary laws on forest protection are severely punished.

Normally, people think that forests and the natural environment are the common property of everyone, not only just one, and they are their indispensable source of life. Therefore, everyone has the responsibility to protect forests and protect the natural environment.

The customary law of the M'nong people in Dak Nong province has 215 articles with about 7,000 sentences, of which the issue of forest protection is regulated: "the primary forest is not

of a deer, that forest belongs to the ancestors, that forest is for our children and grandchildren, that forest belongs to our grandparents, that forest belongs to us". Therefore, if anyone carries out deforestation they will be condemned by: "build a house, stop using trees; do huts, don't use trees anymore; cultivation does not clear forests anymore; when hungry, don't dig tubers anymore".

Thai ethnic customary law provides for the ecological balance between people and forests; it is shown in the custom of classifying forests into regions to serve different needs of life such as: protective mountain forests located on watersheds are absolutely forbidden to be exploited; mountainous forests for the exploitation of bamboo and timber for house construction and living needs are not allowed to be cut down and burned for cultivation; mountain forests serve the spiritual life, called by the common name "sacred forest".

It can be said that the management, protection and use of forest resources are regulated very closely and specifically in the terms of customary laws. In addition, the protection, exploitation and use of these forest resources are widely reflected in the customs and daily living practices of each different ethnic group without being recorded in writing.

With the way of protecting forests like that of the ethnic minorities in our country in the past, for a long time, evergreen forests have been protected. Therefore, in the current market economic development, if we know how to properly apply the customs, practices and laws of forest management and protection on the basis of the Law on Forestry of the State to building a regulation on forest protection and development in each facility, the management, protection and exploitation of forest resources will be more effective.

Local customary law on fisheries: the Customary Law on the protection of aquatic resources in rivers and streams is a customary law of the Muong ethnic group, raised into a custom by the Lang, Dao and dignitaries. Almost all year round, only 1-2 times a year on the occasion of the death anniversary of the Lang, Muong people celebrate the new fishing festival in the forbidden river sections. On rivers and streams, selected sections are divided and in normal days no one is allowed to fish in these sections. Outside of prohibited places, Muong people are free to fish for food. The ban on fishing, protecting those sections and river sections is also divine and spiritual, so in addition to fear of Lang and Dao, the Muong people are also afraid of showing disdain for the place of water gods like dragons, etc. so the observance of the ban is treated very seriously.

Prohibited rivers often share factors such as: half-deep river, moderate water flow, gentle underground sand or underground rock caves and, holes, which are very convenient for fish to breed and to avoid predators. Prohibited places are a source of sustainable aquatic breeds for stable and long-term regeneration and development of fish species. Material fines for violators are also very heavy. Although there is a belief that each person self-consciously upholds the observance of the village's conventions and customs, law enforcement remains very strict. Some folk festivals such as the Fisherman's Festival of the coastal fishing community are also held annually.

This can be considered as a natural response of ethnic minorities, safeguarding sustainable exploitation and use of biological resources in order to prevent the degradation of ecosystems and biodiversity.

In recent times, many organizations, researchers, and managers are interested in indigenous knowledge of ethnic minorities and the management and protection of forests, rivers and seas. There have been projects that bring new experiences and knowledge to people with the aim of changing living conditions and improving the efficiency of nature protection. However, not much is known about the implementation results of these projects (*MONRE, 2019*).

In Vietnam, there is no single national action plan to protect, preserve and promote the knowledge, initiatives and practices of indigenous and local communities and to encourage

the sustainable use of biodiversity. However, issues of researching, investigating, preserving and promoting indigenous knowledge of the community, especially ethnic minorities, on the exploitation, use and protection of biological resources for protection and promotion of health and well-being is integrated in national strategies and action plans on biodiversity and programmes for hunger eradication and poverty reduction.

To support local ethnic communities in conservation, exploitation and use of genetic resources of biodiversity, specific policy documents have been issued. The Biodiversity Law (2008) and the Nagoya Protocol fundamentally protect access to genetic resources, copyright of traditional knowledge about genetic resources and a fair and reasonable sharing of benefits from genetic resources within the framework of the CBD to which Vietnam is a party.

The Law on Forestry (2017) stipulates that the State shall allocate and land to ethnic minority people and communities whose income mainly comes from forest for combined forestry-agricultural-fishery production; facilitate cooperation in forest protection and development with forest owners and benefits sharing arising from forests; facilitate practice in culture and beliefs associated with forests according to the Government's regulations (Article 4, Clause 6).

II. ECOSYSTEM SERVICES IN VIETNAM

Ecosystem services in Vietnam can be classified into four categories including provisioning, regulating, cultural and supporting services.

2.1. Provisioning services

Forest ecosystems provide a range of goods and products that can be classified into two groups: timber and non-timber forest products (NTFPs). Timber can be used as raw material for production of wooden products (e.g. medium density fibreboard (MDF), plywood, paper, pulp, furniture, woodchips, mine pole, scaffold). It is also an important source of energy for home consumption (e.g. heat for cooking and agricultural processing) and electricity generation (in thermal electricity plans). The uses for NTFPs, on the other hand, are sub-classified into 6 groups: (i) fiber products such as bamboo, rattan, and leaves; (ii) food stuffs including bamboo shoots, vegetation, leaves, fruits, grains, spices, honey, wildlife, swallow nests and edible insects; (iii) medicinal plants and aromatic substances; (iv) extracted products such as resins and oils, essential oils and stains; (v) animals and products of animals, birds and insects; and (vi) other products such as decorative plants and leaves for packing food. NTFPs are of great importance to the livelihoods of local people, especially those living in mountainous areas (*FSIV, 2009*).

Rivers, streams, reservoirs and lakes are not only critical for the entire country's agriculture and crop land, however, are also vital for the survival of people there (i.e. provision of drinking water). Rivers and streams are home to many aquatic species that contribute a huge number of fisheries resources (*Truong Hong et al., 2013*). Reservoirs also provide an opportunity to develop fisheries resources that can provide additional livelihood and subsistence support to local communities. In Vietnam, farmers fish in all types of waterbodies. Baran et al. (2011) estimated that the cumulative capture fisheries production in Gia Lai, Kon Tum and Dak Lak provinces was about 500 tons annually in the Sea San River, which was likely a gross underestimate of the actual catch. The authors also concluded that at least 41 migratory fish species are commonly caught by fishermen in the Se San River, and these migratory species represent 60% of the fishermen's total catch.

Estuarine ecosystems supply plants (e.g. reeds, sedges, mangroves) and animals (e.g. fish, crabs, worms, prawns) that are consumed or traded by coastal communities. They also provide water for industrial uses (e.g. cooling, rinsing, chemical reactions) and finite raw materials (e.g. sand from dynamic environments that only naturally renews after a few centuries). A valuation study in Van Uc Estuary (Tien Lang district, Hai Phong city) showed

that the ecosystem provides a value of up to 108 USD/ha for clam collection, 622 USD/ha for aquaculture and 10 USD/ha for timber and fuelwood (*USAID, 2015*).

Peatland ecosystems consist of five typical ecological units: (i) *Melaleuca cajuputi* (Myrtaceae) forests; (ii) mixed *Melaleuca cajuputi* forests; (iii) water surface with aquatic plants; (iv) reeds and low brushes; and (v) bold land. *Melaleuca cajuputy* forests are home to many wildlife species with 32 mammal species, 186 bird species, 50 reptile and amphibian species, 60 fish species, 203 insect species and many aquatic species distributed at different depths throughout the ecosystem. Of these, 72 rare and precious plant and animal species are listed in the Vietnam Red Book 2007 and IUCN 2012 list. These forests also provide a large amount of timber and fuelwood to local communities. According to the Vietnam Environment Administration (VEA) (2014), the average income of households from harvesting timber and non-timber forest products in U Minh Thuong peatland was around 5.40 million VND/year (equivalent to 270 USD/year).

Mangrove, coral reef, and seagrass bed ecosystems provide necessary provisioning services under food and nutrition; fiber, biomass, raw materials, and medicines; fresh water; and energy production. Examples of goods and services provided by marine and coastal ecosystems are found in table 10. Marine aquaculture is a largely growing industry across Vietnam and is seen to provide services such as food security to the growing population, poverty alleviation, and export value. For instance, one study in Nha Trang (*Quach Thi Khanh Ngoc, 2019*) found that marine aquaculture in coral reef zones provided over 30% of a household's revenue, and the value added from aquaculture associated with coral reefs was estimated to be 5.10 million USD as shown in table 11. Overall, the loss in economic value of coral under climate change and fishing effort scenarios was estimated to range from 2.75 million USD to 30.64 million USD annually, in Nha Trang, alone (*Quach Thi Khanh Ngoc, 2019*). There are more than 20 identified coral reef aquaculture sites across the Vietnam coast, therefore in simplest terms, the economic value of coral reefs found in Nha Trang can be multiplied by at least 20 times, to estimate what a grand scale coral reefs play in providing food for provisioning services.

Table 10. Goods and provisioning services provided by marine and coastal ecosystems

Ecosystem type	Use values	Examples
Mangrove forests	Wood supply	In Thua Thien Hue and Quang Nam provinces, wood is supplied for domestic and international timber and furniture industries and international pulp and study manufacturers
	Fruits and leaves	
	Bark (tannin & dye)	
	Medicinal herbs	
	Sugar and honey	
	Seafood and aquaculture production (fish, shrimp, crab, soft body, worms)	
Coral reefs	Building material	In 2015, fisheries and sea food production in the coral reefs surrounding Nha Trang were valued annually to be 2.70 million USD.
	Raw material for the fine arts/craft and product development	

	Seafood production (fish, shellfish, molluscs)	
Seagrass beds	Raw material for the fine arts/craft and product development	Decline of seagrass distribution in Van Phong Bay, Vietnam started in 2004. Findings by Trong-Thach et al., (2020) revealed that the distribution of seagrass meadows had declined by 22.1% with a decreasing annualtrend of 12.2 ha. The main causes of seagrass bed loss were related to the conversion of the seagrass meadows into shrimpponds. This is an example of when a provisioning service such as shrimp cultivation in seagrass meadows, harms the ecosystem, despite the economic benefits of developing aquaculture
	Medicinal herb	
	Alternative fertilizer and food source	
	Supplies fish, shrimp, and molluscs	

(Source: Adapted from Xun (2018), Paudyal et al. (2020), *Trong Thach et al. (2020).*

Table 11. **Annual aquaculture value associated with coral reefs in Nha Trang Bay in 2015**

Species Group	Quantity (tons)	Total revenue (million USD)	Value added (million USD)
Lobster	220	13.08	4.97
Grouper	37	0.41	0.13
Total aquaculture value		**13.49**	**5.10**

(Source: Quach Thi Khanh Ngoc, 2019)

2.2. Regulating services

Forest ecosystems play an important role in the protection of watershed areas in Vietnam by retaining soil, controlling erosion and preventing sedimentation and accumulation of mud and sand from runoff. Forest ecosystems help regulate water flows, reduce surface flow (which is especially important during major storm events), increase the absorption of water into soil, reduce flooding and improve water quality (*FSIV, 2009; Thai Phien, Tran Duc Toan, 1996*). According to Thai Phien and Tran Duc Toan (1998), surface flow beneath forests is 2.5 to 2.7 times lower than in agricultural areas and surface flow in natural forests may be 3.5 to 7 times less than in plantation forests (*Vo Dai Hai, 1996*). In natural forests, the velocity of absorption of water into the soil is 16.8 mm/minute compared to 10.2 mm/minute in plantation forests and 2.1 mm/minute in grass plots or shrub covered areas (*Vu Van Tuan, 2003*). Evergreen broad-leaved forests with a cover of 70-80% can prevent 9.5-11.7% of rainwater from falling to the ground while a vegetation cover of 30-40% can only prevent 5.7% in this context. If vegetation cover is reduced from 70-80% to 30-40%, soil erosion will increase by 42.2% and flow on the ground will increase by 30.4%. Similarly, if the cover of *Pseudoxytenanthera* spp. is reduced from 70-80% to 40-50%, erosion will increase by 27.1% and surface flows will increase by 33.8% (*Nguyen Ngoc Lung and Vo Dai Hai, 1997*). Forests, especially those with multi-layered canopies, are very useful and efficient in retaining water in the wet season and supplying water in the dry season. In recent years, floods have had serious impacts (e.g. property destruction, loss of human lives) in some Central and Northern provinces. Some of this was the result of deforestation (*Bann et al., 2017*). The disappearance of forests due to unplanned exploitation or change in land use can bring serious consequences related to changes in the level of protection for the watershed area (*FSIV, 2009*). Forest ecosystems in Vietnam are also best known for their capacity for sequestering and storing carbon as well as

their potential to regulate the climate at local and global scales. A recent study undertaken by USAID (2018) showed that if the forest protection and development plan for 2016-2020 is implemented, forest ecosystems in Quang Nam and Thua Thien Hue provinces could sequester up to 10,074,201 tons of carbon dioxide (tCO_2) and 5,956,347 tCO_2 respectively if natural growth of protected forests is not taken into account and 26,266,001 tCO_2 and 5,956,347 tCO_2 respectively if natural growth of protected forests is taken into account. On average, each hectare (ha) of forest in Quang Nam and Thua Thien Hue has the capacity to absorb 10.64 million and 12.11 million tCO_2 per year respectively. In addition, forest ecosystems act as a natural water treatment and purification plan that helps to reduce the cost of producing drinking water, helps to maintain water quality in hydropower reservoirs and prevents hydropower turbines from corroding. Hence, the services provided according to the Government's Decree no.99/2010/ND-CP dated September 24, 2010, on policy of payments for forest environmental services, such as drinking, electricity generation and industrial production are now paid for by users. Finally, natural forest ecosystems provide shelter for many animals such as birds, bees, bats and other insect and reptile species that help to control pests and facilitate pollination in the surrounding area. A study by Emerton et al. (2014) estimated the economic value of pollination and seed dispersal services provided by forest ecosystems in Cat Tien NP by examining the value added to farm crops that are dependent on insect pollination. The results showed a baseline value of 304.16 billion VND (equivalent to 14.38 million USD) for wild insect crop pollination, pest control and seed dispersal services.

Inland freshwater ecosystems provide provisioning services, and less obvious, yet fundamentally crucial regulating services such as water purification, groundwater stock balancing and feeding, salinity stabilization, flood mitigation and sediment transport and retention.

Estuarine ecosystems the process of water exchange through the river mouths of estuarine ecosystems enhances the circulation of water inside estuaries and lagoons, cleans the environment, mitigates pollution and floods for coastal areas and lagoons, maintains water flow by scattering sediment (e.g. from agricultural processes) to the sea and contributes to improving the micro-climate in the region. River mouths are the only natural way to maintain and stabilize water salinity in estuaries and lagoons, maintain ecological balance and community structure and maintain biodiversity in the water area. Species sensitive to water salinity spawn and breed in lagoons and coastal waters, enriching food and coastal resources (*Le Duc An et al., 2011*).

Peatland ecosystems also provide various regulating services, including water supply and storage, flood control and carbon sequestration and storage. A study carried out by Tran Triet (2016) shows that the U Minh peatlands absorb a large amount of rainwater in the wet season and gradually release it during the dry season, providing potable freshwater for local people as well as for wildlife and agriculture. In addition, peatland ecosystems play an important role in regulating the global climate. Although peatlands only cover 3% of the Earth, they store 20-35% of the Earth's total carbon stock with a capacity of 2,000-6,000 tons of CO_2 per ha. According to Truong Hoang Dan, Quach Truong Xuan and Bui Truong Tho (2014), 10-year-old *Malaleuca* forests on peatlands in U Minh Thuong National Park have stored about 26.05 to 26.92 tons of carbon per ha.

Marine and coastal ecosystems can help governments save money. Natural benefits of healthy marine and coastal ecosystems include savings in damages during storms and floods, reductions in erosion, water purification, climate regulation, and reductions in the costs of engineering for coastal protection, as depicted in figure 11, scheme showing general mechanics of wave height reduction through habitats, using the example of coral reefs, seagrass beds and mangroves.

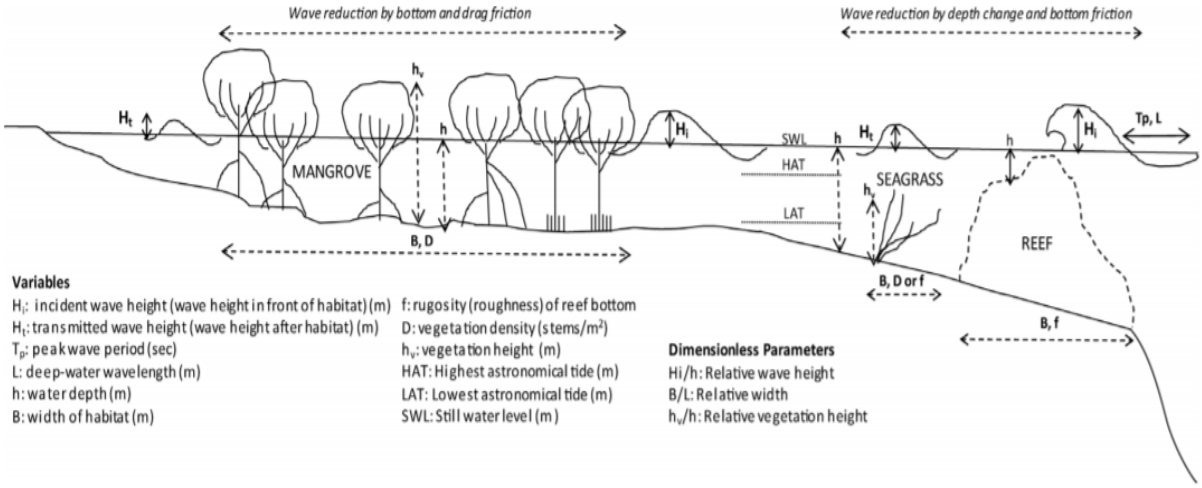


Figure 11. Scheme of wave height reduction across coastal habitats

(Source: Narayan et al., 2016)

2.3. Cultural services

Forest ecosystems play an important role in supporting local livelihoods, especially for ethnic groups (53%) who mostly live in remote, mountainous forest areas *(Bann et al., 2017)*. Ethnic groups in the Central Highland are well-known for their traditional culture which is in harmony with the forest. Uses of the forest by local communities include timber harvesting to build houses and family furniture as well as the collection of non-timber forest products such as honey, bamboo and vegetables which provide additional income and/or are sources of nutrition. Forest ecosystems also promote tourism sector development, especially ecotourism, through the system of national parks, nature reserves, cultural and historic areas, and a wide range of natural beauty spots throughout the country. Ecotourism is taking off in Vietnam with a high and stable economic value. Especially in national parks, nature reserves and beauty spots, ecotourism has brought many local benefits.

Marine and coastal ecosystems support living organisms both cultural and biotical. A list of all the cultural services provided by key marine and coastal ecosystems of Vietnam, on the other hand is listed in the table below:

Table 12. Goods and cultural services provided by marine and coastal ecosystems

Ecosystem type	Use values	Examples
Mangrove forests	Existing values of genes, species, and populations	Research indicates that ecosystem services have greatly contributed to the economic development of the country, to livelihoods, and human life. It has been estimated that the economic value of mangrove ecosystems fluctuates depending on the geographic location from 0.204 to 1.67 billion VND/ha/year (equivalent to 9,700 to 79,500 USD/ha/year); coral reef ecosystems: 1.71 to 11.42 billion VND/ha/year (equivalent to 81,500 to 543,800 USD/ha/year); seagrass ecosystem: 0.656 billion VND/ha/year (equivalent to 31,240 USD/ha/year) (*ISPONRE, 2016*).
	Species migration	
	Rare species	
	Existing value of ecosystem	

	Spiritual thought & faith	
	Historical value	
	Local activity	
	Aesthetics	
	Education and scientific research	
Coral reefs	Reserve for biodiversity	In 2015, fisheries and sea food production in the coral reefs surrounding Nha Trang were valued annually to be 2.70 million USD.
	Secondary productivity	
	Food sources for other organisms	
	Existing value of ecosystem	
	Aesthetics	
	Tourism	
	Education and scientific activity	
Coral reefs	Reserve for biodiversity	Seagrass research in Vietnam is increasing according to Fortes et al. (2018), based on the number of research papers that have been produced in the last decade. This shows drastic improvement for the understanding Vietnam has about it is ecosystem and how to better manage it. Opportunities for scientific activity and research also provide opportunity for international funding. For example, between 2011 and 2015, 18.65% of Official Development Aid was directed to environmental and urban development. This is equivalent to 3.58 billion USD. The increase in research and scientific studies in seagrass areas and communities is allowing for the increasing awareness, action, protection, and sustainable development of these areas.
	Species migration	
	Rare species	
	Aesthetics	
	Tourism	
	Education and scientific research	

(Source: Adapted by Xun (2018), Quach Thi Khanh Ngoc (2019), Fortes et al. (2018), Open Development Vietnam (2018), ISPONRE, 2016).

2.4. Supporting services

Supporting services differ from the other services in that their impacts on people are either direct (via provisioning, regulating or cultural services) or occur over a long period time (it is indirect and difficult to see). Therefore, this part will be focused on the three first ecosystems

services, including: provisioning, regulating and cultural services. Supporting services will be described in details in the Part III "Contribution of key ecosystems to the socio-economy".

III. TRENDS OF ECOSYSTEMS

3.1. Vietnam's forest cover area is tending to increase mainly by new plantations

Vietnam is witnessing a shift from pure deforestation to reforestation between 1943 and the present. In 1943, the national forest cover rate was 43.8% but then it decreased significantly to 27.8% in 1990 due to war and unsustainable use and management (*FAO, 2009*). In 1990, Vietnam's forest area was only 9,175,000 ha, forest coverage was only 27.8%, but due to afforestation development programs by 2020, the area of forested land qualified for calculating the national coverage rate was 13,919,557 ha, and the forest coverage rate was 42.01% (*MARD, 2021*). According to the report of the Government in 2018, in the 3 years 2016-2018, the area of damaged forest averages 2,430 ha/year. Statistics from MARD, from 2010 to 2020 showed the natural forest area was tending to decrease from 10,304,816 ha in 2010 to 10,279,185 ha in 2020, while the area of planted forests was increasing from 3,083,300 in 2010 to 4,398,030 ha in 2020.

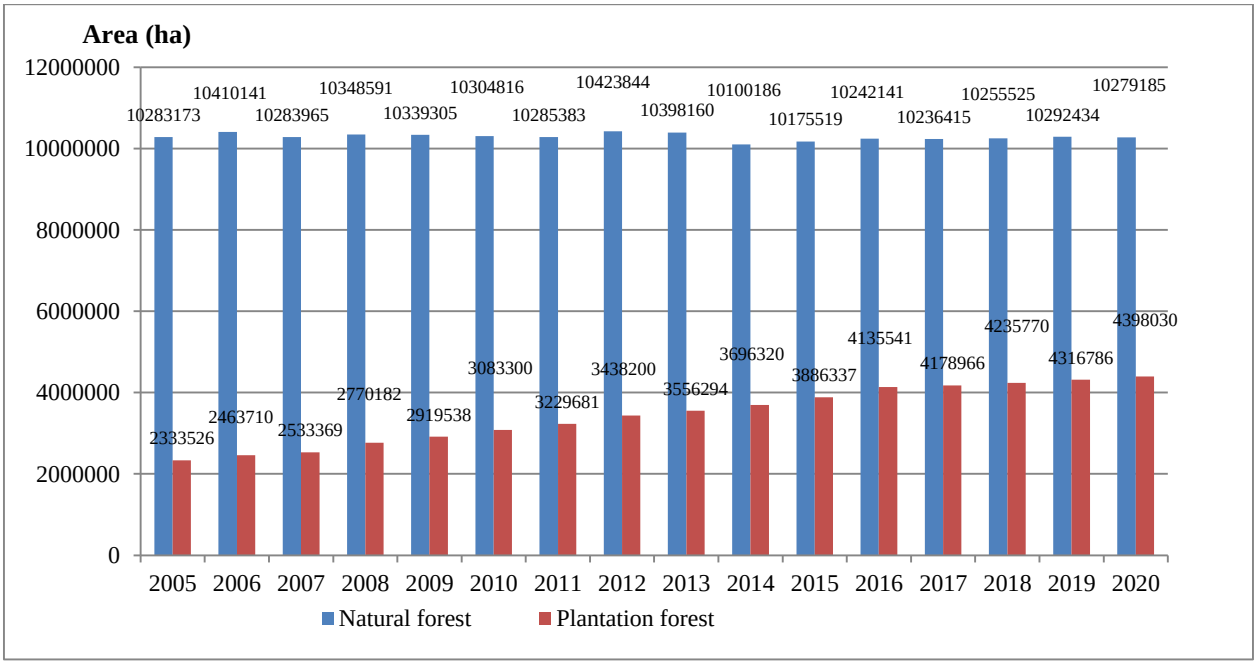


Figure 12. Area (ha) of natural and planted forests from 2005-2020

(Source: MARD, 2006-2021)

As the area of planted forests increases, often as a single species monoculture, the diversity of fauna, flora, microorganisms, fungi, etc. living in the forest is also much less diverse than the natural primary forest, which is a tropical evergreen forest with many layers of plants (*MONRE, 2019*). Degraded forest quality directly affects the habitats of wild flora and fauna, biodiversity and the ability to provide important ecosystem services to the economy, especially for the agricultural production, ecotourism and industrial sectors (*UNDP, 2018*).

Mangrove ecosystem: The mangrove ecosystem is well developed in estuarine and coastal areas in both North and South Vietnam. The evolution of coastal mangroves in Vietnam from 1943 (408,500 ha), to the 1960s, saw the total mangrove area in Vietnam was estimated at 400,000 ha of primary and dense forest (*Hong et al., 2007*). The subsequent destruction of mangroves due to the war, along with the conversion of land use to agriculture and brackish water aquaculture caused the area of mangrove forests in Vietnam to decrease significantly. Until 1990, the mangrove forest area was only about 73,000 ha (*Tuan, 2016; VEPA, 2005*). Currently, notable efforts to restore and maintain mangroves in Vietnam are mangrove

protection policies, such as the Biodiversity Law, and both Government and afforestation funds have increased the forest area to 156,608 ha in 2001 and reaching 270,000 ha in 2015 including secondary forest and plantations (*Tuan, 2016; VEPA, 2005*). Only a small area of remnant primary mangrove forest is left in Quang Ninh. The fluctuations of mangroves in Vietnam from 1943 (408,500 ha) to 2009 showed a very strong downward trend to extremely low in 2003 (83,288 ha), i.e. after 60 years, lost 4/5 mangrove areas. Thanks to the policy on mangroves planting, the area of mangroves from 2007 to 2017 showed an increasing trend.

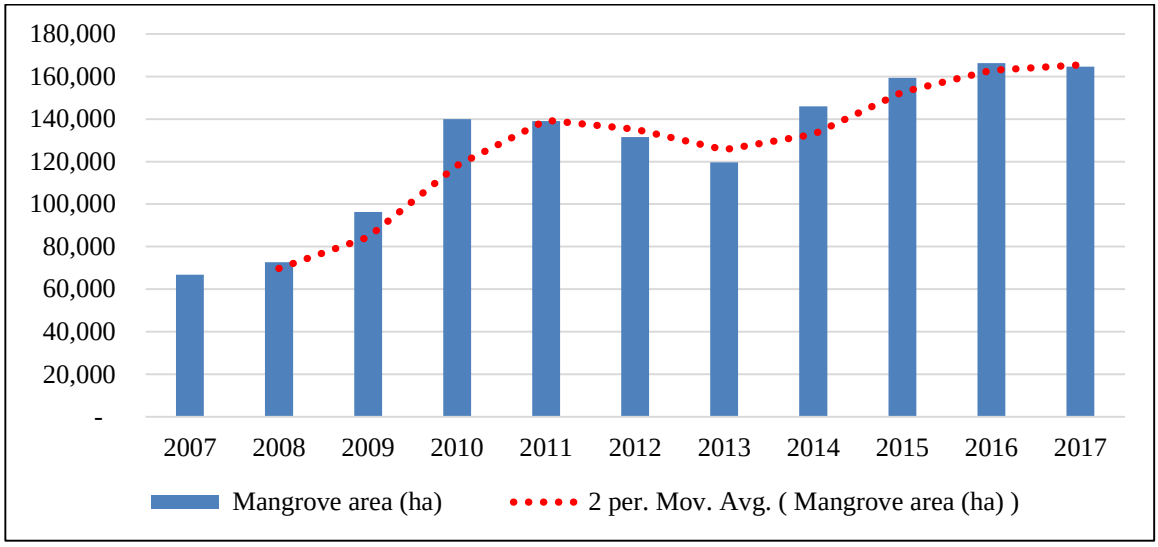


Figure 13. Evolution of mangrove area in the period 2007-2017

(Source: VNFOREST, 2008-2018)

3.2. Ecosystems of rivers, streams, lakes, reservoirs and estuarine areas are degraded and biodiversity is reduced

The process of rapid urbanization and industrialization in river basins, estuarine areas and coastal areas has seriously affected the hydrological regime, water flow, and sediment quality of downstream rivers. According to the National Environmental Status Report, most of the major rivers flowing through urban and industrial zones are polluted, such as the Cau River, Day River, Saigon-Dong Nai River and Thi Vai River (*MONRE, 2020*).

The extensive exploitation of sand in large rivers leads to the erosion of hundreds of hectares of agricultural and residential land along the river each year. Water pollution leads to an increase in treatment and production costs of supplies of clean water, aquaculture and public health protection. Water pollution also causes a strong decline in many populations of high economic value such as *Semilabeo obscurus*, *Hemibagrus guttatus*, *Bagarius rutilus*, lobster, abalone and oysters (*UNDP, 2018*).

It is especially evident that due to the large number of hydroelectric dams built on the Mekong mainstream in the middle and upstream areas, the amount of water in the Mekong River including the sediment flows to the Mekong River Delta has been significantly reduced, including a decrease in flood levels and duration. Erosion of the river banks of the Cuu Long River system has also recently increased to a serious level (*MONRE, 2019*).

Natural lakes and reservoirs: The area of natural lakes is shrinking due to urbanization and industrialization. According to statistics, at the beginning of the nineteenth century, in the old city of Hanoi, there were 602 large and small lakes. However, over time, this number has decreased significantly.

Major hydroelectric dams and reservoirs are built mostly on large rivers in mountainous areas where forest vegetation is well developed and biodiversity is high, in addition to flooding

valleys with natural forest. They also create barriers to river-sea, sea-river migratory fish species, changing the rhythm of life such as the cycle of reproductive, growth, and feeding habits of aquatic organisms in the river formed over thousands of years, while at the same time also having many impacts on the river downstream from the dam, even on the coastal estuary (*MONRE, 2019*).

A resulting remarkable feature is the process of reservoir ecological succession. The basic feature affecting the morphology of the reservoir, this process involves sediment deposition with the gradually filling up of the reservoir bed. Over time, the volume of water and surface area of the reservoir will decrease the reservoir will become a swamp, even a terrestrial ecosystem (*Dang Ngoc Thanh, Ho Thanh Hai et al., 2002*). Another example of succession is the Tra O lagoon (Binh Dinh province), where during the river-sea interaction and the sand dune displacement, the morphology and position of the lagoon's mouth are changed. In particular, recently due to the human impact in the rehabilitation of the lagoon, the succession rate of Tra O lagoon has been accelerated in the direction of becoming a peat swamp and in the future it will become a lowland area. Currently, local people have been exploiting peat in the eastern part of the lagoon.

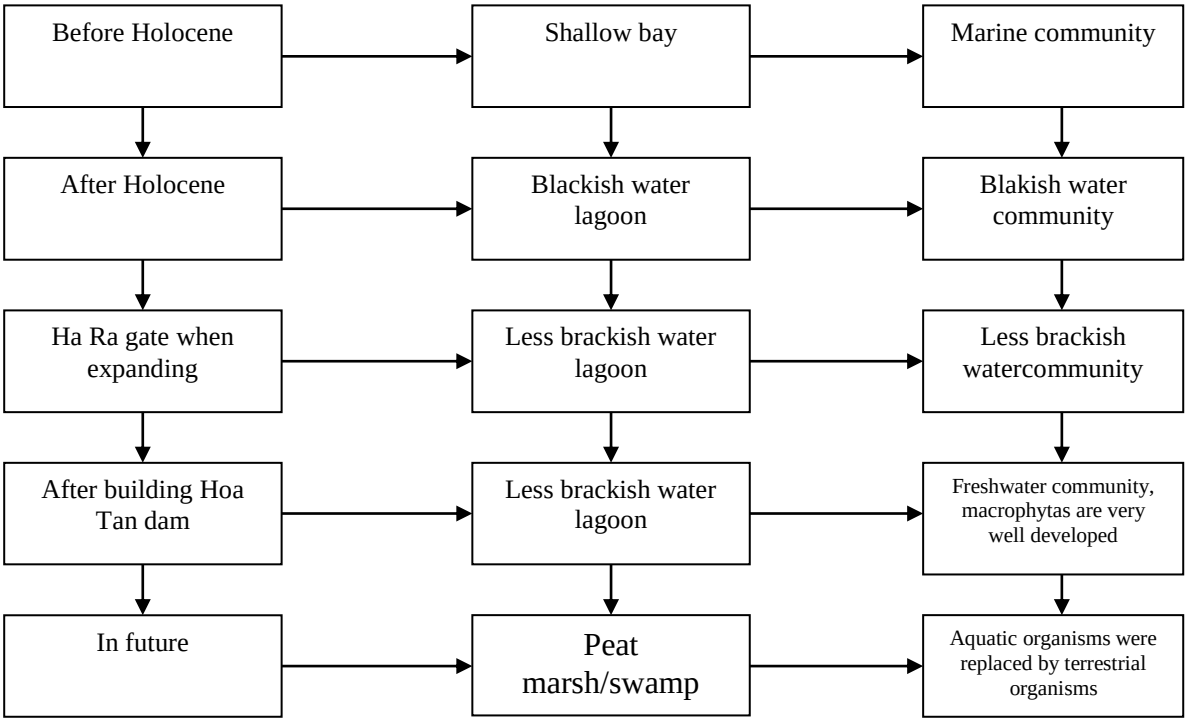


Figure 14. Diagram describing the succession process of Tra Lo Lagoon, Binh Dinh province

(Source: Vu Trung Tang, 1999)

Untreated domestic and industrial wastewater discharged into free-flowing rivers, lakes, and seas has polluted the environment, degraded aquatic ecosystems, and reduced biodiversity: causing algal bloom *(Microcystis* spp.*)* in inland freshwater lakes, and red tides in some coastal areas, killing a lot of aquatic animals, especially fish (*MONRE, 2019*).

3.3. Peat swamps are reduced in area and in thickness of the peat layer

Peat swamps are scatteredly distributed in Vietnam. U Minh Thuong (Kien Giang province) and U Minh Ha (Ca Mau province) are two places with large areas of remnant *Melaleuca cajuputi* forest on peatland in Vietnam. According to previous data, in 1950 the U Minh region had 400,000 ha of *Melaleuca* forest, but by 1970, it had as only about 200,000 ha.

Similarly, peat ecosystems in Vietnam have faced a sharp decline in both quantity and quality. A survey conducted in 1976 by the Vietnam Geological Survey Agency recorded 12,400 ha of

peatland in U Minh Thuong and 20,200 ha of peatland in U Minh Ha. However, these peat land areas are constantly shrinking, the thickness of the peat layer is also continuously being reduced due to forest fires, expanding agricultural areas, and changes in hydrological flow and exploitation of resources for fuel and fertilizer. Currently, the area of peatland is only 2,800 ha in U Minh Thuong and 7,500 ha in U Minh Ha with the thickness of peat layers ranging from 0.4 to 1.2 m (*Tran Triet, 2016*).

3.4. The natural tidal flats are affected

A large area of tidal flats is used for coastal aquaculture. Indiscriminate exploitation of aquaculture has caused many serious ecological consequences such as imbalance of different ecosystems in the tidal zone. Environmental pollution in the tidal zone comes from intensive or unmanaged industrial farming and other human activities that occur on a large scale in the coastal zone. Decision no.3529/2016/QD-BNN-TCTS approving the adjustment of planning for development of centralized commercial mollusc culture to 2020, with a vision to 2030 has as its objective to adjust the plan to 2020 for the total farming area molluscs concentration to be 40,200 ha, in which, clam farming area is 23,110 ha; oysters 2,770 ha; snails 1,000 ha; oysters 12,720; Lutrinae 190 ha; abalone 150 ha; and pearl-oysters: 260 ha. In the orientation to 2030, the mollusc farming area is to be 42,800 ha. Raising molluscs such as clams on the tidal flats at high density can affect the mechanical properties of the site, and also reduce the diversity of other mollusc groups on the tidal flats.

In Decision no.79/2018/QD-TTg promulgating the National Action Plan for Vietnam shrimp industry development until 2025, specific objectives included: in the period 2017-2020, the total brackish water shrimp farming area will reach 710,000 ha, and in the period 2021-2025, the total brackish water shrimp farming area will reach 750,000 ha.

3.5. Lagoons are degraded in different degrees

According to research results of Nguyen Van Quan et al. (2015), due to economic development in coastal areas, and due to the lack of appropriate management and exploitation of natural resources, most of the lagoon ecosystems are currently experiencing a recession. All 12 ecosystems of lagoons in the Central Coast have been degraded to different degrees in both structure and function, and the distribution area and volume of lagoon water have been reduced in terms of space and time. There have been manifestations of local environmental pollution in some lagoons such as Tam Giang - Cau Hai and Nai lagoons, with heavy metal elements such as As, Cu exceeding the permitted standards of ISQG at the top of the lagoon and along the sluice gates, transported by canals from the mainland into the lagoon. Moreover, the rate of sediment deposition and sludge has increased rapidly in most of the lagoons in the last 30-40 years, along with the aquaculture development and urban expansion along the lagoon (*Nguyen Van Quan et al., 2015*).

3.6. Seagrass beds are reduced in area

Seagrass species play an important role in coastal ecosystems and human life. The area of seagrass in Vietnam is tending to decrease over time. Over the past two decades, the area of seagrass has decreased by 45.4% and the average annual reduction rate was 4.4% (*Nguyen Thi Thien Huong et al., 2017*). Cao Van Luong et al. (2012) have shown that the seagrass area has decreased by 50% compared to 1999, while the area of seagrass beds in Tam Giang-Cau Hai lagoon have decreased by 60% of compared to 1999. In the North of Vietnam, including Quang Ninh and Hai Phong, seagrass species such as *Halaphila beccarii* have been identified and recognized in the red list of IUCN in 2010 for endangered species.

The causes of the decline in the area of seagrass beds include human activities such as fishing and boat anchoring that cause erosion of seagrass beds in coastal areas; aquaculture and environmental pollution increasing water turbidity, slowing seagrass growth; port construction activities; and changing land use to build houses and facilities for tourism. In

addition, factors such as natural impacts (tropical storms, turbidity and sedimentation and fresh water flows) also contribute to the decline of seagrass beds (*MONRE, 2019*).

3.7. Coral reefs in the sea of Vietnam are declined in area and coverage of live coral

In the period of 2008-2010, the total area of Vietnam's coral reefs was about 14,130 ha (*Institute of Marine Resources and Environment, 2010*). According to data from Nguyen Van Long and Vo Si Tuan (2014), the total area of coral reefs in Vietnam's waters was 13,355 ha. The live coral cover of coral reefs in coastal areas is decreasing over time. Only about 1% of the reefs have a high coverage (with a coverage > 75%) while the number of reefs with a low cover accounts for over 31% (with a coverage of < 25%), the number of reefs with medium and slight coverage accounts for 41% and 26% respectively (*Institute of Oceanography, 2008*).

Table 13. Changes in % hard coral cover at some key areas for Vietnam - comparison between 1994-2012*

Area	1994	2000	2006	2012	Overall Interval Decline (%)	Degradation rate/year
Cu Lao Cham	21.4	NA	16.0	NA	-5.4	-0.54
Nha Trang	35.1	NA	23.2	20.4	-14.7	-0.92
Ninh Hai	NA	NA	27.5	22.2	-5.3	-0.88
Hon Cau	26.4	NA	21.5	21.0	-5.4	-0.36
Con Dao	41.0	20.1	22.2	NA	-18.8	-2.09
Phu Quoc	49.1	37.5	43.4	20.8	-28.3	-1.77

* *Year 1994 included data from 1994-1995. Year 2006 included data from 2004-2006. Year 2000 included data from 1999-2000. Year 2012 included data from 2010-2012.*

(*Source: Japan Wildlife Research Center, 2014)*

Identified threats to coral reefs include: overexploitation, destructive fishing, sediment deposition, pollution, outbreaks of predatory organisms such as starfishes, black urchins, invasive real effects of the sea, and natural disasters. Examples include algal blooms on a large scale in Ca Na Bay in 2002; booming starfish numbers in Nha Trang, Van Phong bays and Cu Lao Cham (2002-2004); cumulative effects of high temperature and low salinity in a short period in Con Dao (2005); flood waters from the mainland affecting coral reefs in Cu Lao Cham (2006); and mass bleaching of corals in the waters of Phu Quoc (2010) (*Vo Si Tuan et al., 2005, 2013*). Studies on the current status of reef life resources in coastal areas of Vietnam have also reflected the poor status of species composition of fish, mollusk, echinoderms and crustaceans (*Vo Si Tuan et al., 2008*).

Tropical storms also have the potential to cause damage to corals. Major storms during the wet monsoon season lead to an increase in freshwater resources (5-400 million m^3) and up to 200 tons of sediment from land to sea (*Latypov, 2017*). According to Latypov (2017), the daily sedimentation rate of suspended matter in Vietnam's coral reefs reaches 70-100g/m^2 and increases exponentially during tropical storms. These numbers are expected to increase with climate change increasing both the frequency and intensity of storms and threatening the natural development of the stabilization of the coral; and with sediments reducing water clarity and can causing coral suffocation - these two factors interfering with coral uptake, growth, multiplication, and recovery (*EPA, 2018*).

Other threats to Vietnam's coral reefs from climate change include acidification and abnormal increases in sea water temperature. The oceans absorb a quarter of the total CO_2 emitted from fossil fuel burning operations. Human activities on land also generate currents that increase the acidity of the seawater. Increased acidity will slow coral growth and general growth of

both reefs and the dissolution of the coral framework. Warming seawater also causes the destruction of the coral. The microalgae that produce food for coral will disappear if the environment is too warm. The loss of food and color (known as coral bleaching) threatens to cause disease and coral death (*EPA, 2018*).

The combination of scuba gear and cyanide fishing to capture ornamental or economically valuable coral reef fish such as grouper and sea bass causes loss of marine resources living on the reef at a rapid rate.

Human activities such as coal mining, marine transportation and garbage all contribute to the serious disturbance of the coral reef and sediment areas in the Ha Long and Bai Tu Long bays. Water pollution is also a major threat to the health of coral reefs, especially in areas adjacent to industrial zones and urban areas. Two areas that clearly show this influence are Ha Long and Cat Ba with the development of tourism, industry, coal mining and high urban density. All of these factors contribute to an increase in the pollutant load. During the rainy season, the turbidity and eutrophication measured in these areas are quite high, sometimes 10 times higher than the maximum tolerance limit, causing death for many coral reefs located near the source of the polluted wastewater.

All this shows a general situation that coral reefs in coastal areas of Vietnam are tending to seriously decline due to overexploitation, improper use and environmental pollution.

3.8. The number of threatened species increases

In the Viet Nam Red Book (2007), the total number of threatened species is listed as 882 species, consisting of 418 animal species and 464 plant species. Of them, nine species are considered extinct in the wild in Viet Nam, namely *Dicerorhynus sumatrensis*, *Bos sauveli*, *Tapirus indicus*, *Cynogale lowei*, *Procypris merus*, *Anguilla japonica*, *Cyprinus multitaeniata*, *Cervus nippon*, and *Crocodylus porosus*.

The number of endangered species is increasing according to the project: "*Survey and assessment of endangered species that should be given priority for protection aiming at amending the Vietnam Red Book*" conducted in 2014-2017. The IEBR under the Vietnam Academy of Science and Technology was the lead agency in coordination with a number of other research institutes that have proposed to list 1,211 species with new ranking levels in the next edition of the Vietnam Red Book including: 600 plant and fungi species and 611 animals. Thus, compared with the Vietnam Red Book 2007, the number of species proposed for the next version of the Red Data Book of Viet Nam is much higher (*MONRE, 2019*).

3.9. The number of individuals of endangered species has either declined or not been seen for a long time

Notably, in 2011, the Vietnamese rhinoceros subspecies (*Rhinoceros sondaicus annamiticus*) was officially declared to be extinct in Vietnam (*Gersmann, 2011*). In term of the flora, the Vietnamese orchid (*Paphiopedilum vietnamense*) is extinct in the wild.

The results of multi-year monitoring in some important bird areas show that the number of individuals of rare and precious species, especially globally endangered migratory birds in the PAs has decreased, such as the spoonbill (*Platalea minor*) in Xuan Thuy NP and cranes (*Grus antigone*) in Dong Thap NP and Phu My Wetlands NR (Kien Giang province), and even some species have not been seen again for many years.

According to a survey conducted by WWF in 2003, Phu Quoc and Con Dao are two of Vietnam's last marine areas to have sea dugongs (*Dugong dugon),* but the population numbers no more than 100. However, according to the management board of Phu Quoc Marine Protected Area (2016), *Dugong dugon* has not been seen recently in the reserve's seagrass beds due to hunting and degradation of habitat.

PART III. CONTRIBUTIONS OF KEY ECOSYSTEMS TO THE SOCIO-ECONOMY

Key Findings

1. Ecosystems which provide the most services and are high in biodiversity and biological productivity contribute significant benefits to the socio-economy

All three key ecosystems make substantial contributions to the economy and human welfare through four groups such as provisioning services; regulating services; cultural services; and supporting services. If these ecosystems and their related ecosystem services are degraded, the economy and people will suffer great damage in both physical and non-physical aspects.

According to the Statistical Yearbook (2021), the agriculture, forestry and fishery sectors contributed significantly to the gross domestic product (GDP), their export value increased from 19 billion USD in 2010 to 41.25 billion USD in 2020, accounting for 14.60% of the country's export turnover and 14.85% of GDP in 2020, and 12.36% of GDP in 2021.

About 20 million Vietnamese people derive either their main or partial income from aquatic resources and about 25 million people live in or near forests and 20-50% of their income comes from non-timber forest products, including hundreds of species of medicinal plants, oil crops, dyes (*MARD, 2020*).

2. Forest ecosystems in Vietnam contribute to the socio-economy in a range of ways, including to local livelihoods through payments for forest environmental services

Thanks to the policy on payment for forest environmental services (PFES), in the period 2011-2020, the total amount of money collected from parties using forest environmental services is more than 16,746 billion VND (equivalent to 728.09 million USD) or 1,674 billion VND/year on average (equivalent to 72.78 million USD/year on average). This money has been used to pay for more than 250,000 households (with an average payment of 15% of the total income of households) and 10,000 communities (with an average payment of about 50 million VND/community/year), contributing to increased income for people living in and around forests, especially ethnic minority communities living in remote and mountainous areas (*VFD, 2021*).

According to the Winrock International (2021), PFES has always been and will be an extremely important policy of the forestry sector. However, this policy has revealed some shortcomings and limitations such as some unclear and inappropriate regulations, making them difficult to apply especially those related to the monitoring and evaluation system. Thus, the Decree no.147/2016/ND-CP dated 2 November 2016 on PFES should be revised, adjusted for higher implementation efficiency.

3. Evaluation studies of ecosystems in Vietnam show how significant these services are in the socio-economy

The forest ecosystem services in Cat Tien NP were estimated to have generated goods and services worth 51.60 million USD/year in 2012 *(Emerton et al., 2014).* The total direct use value of wetland ecosystem services in Xuan Thuy NP in 2010 was estimated at 81.71 billion VND/year (equivalent to 4.09 million USD/year); the total indirect use value was estimated at 6.51 billion VND/year (equivalent to 325,550 USD/year); and the biodiversity conservation value was estimated at 399 million VND/year (equivalent to 19,950 USD/year) (*Dinh Duc Truong, 2010).*

The total economic value of marine ecosystem services ranged from 94 million VND to 307 million VND (equivalent to 4,200 USD to 13,650 USD)/ha/year. The total economic value of marine ecosystems services around selected islands in Vietnam was estimated to fluctuate between 267.50 billion VND (equivalent to 12 million USD) to 599 billion VND (equivalent to 26.62 million USD). The total economic value of marine ecosystems in the island Bach Long Vi island (Hai Phong city) was estimated to reach 599 billion VND/year (equivalent to

26.62 million USD/year), with an average of 94 million VND/ha/year (equivalent to 4,200 USD/ha/year); in Con Co island (Quang Tri province) it reached 267.50 billion VND/year (equivalent to 12 million USD/year), with an average of 307 million VND/ha/year (equivalent to 13,650 USD/ha/year); and in Tho Chu island (Kien Giang province) it reached 565.20 billion VND/year (equivalent to 25 million USD/year), with an average of 125.47 million VND/ha/year (equivalent to 5,576 USD/ha/year) *(Tran Dinh Lan et al., 2015).*

If key ecosystems and their associated ecosystem services are degraded, the people and economy will suffer great material and immaterial loss. Meanwhile, most of the studies on the evaluation of system services are small research projects. As a result, existing information on the value of ecosystem services is fragmentary, non-representative, and cannot be easily transferred from one place to another when needed. In order to conserve and enhance ecosystems, thereby maintaining the valuable services they provide to the economy and human welfare, Vietnam needs to continue to promote research on ecosystem services and soon develop a database on the value of major ecosystem services so that it can be easily integrated into the decision-making process related to the management and use of these ecosystem services.

4. The services provided by Vietnam's ecosystems are on a declining trend

Most of Vietnam's important ecosystems such as primary/natural forests, mangroves, coral reefs, seagrass beds, etc., are reduced in area, experiencing ecosystem degradation, and biodiversity levels are decreased, such as the number of threatened species increased, number of individuals of endangered species decreased, or some species have not been seen for a long time. In addition, population growth has led to an increased demand for resources and energy resulting in an increase in resource extraction activities. The increasing demand leads to overexploitation of valuable products provided by ecosystems, resulting to a decline in goods and services of the ecosystem overall.

According to the report of the Government in 2018, in the 3 years 2016-2018, the area of degraded forest averages 2,430 ha/year. Statistics from MARD show that the natural forest area decreased from 10,304,816 ha in 2010 to 10,279,185 ha in 2020, while the area of planted forests increased from 3,083,300 in 2010 to 4,398,030 ha in 2020.

The fluctuations of mangroves in Vietnam from 1943 (408,500 ha) to 2009 showed a very strong downward trend, to an extremely low area in 2003 (83,288 ha), i.e. after 60 years, lost 4/5 of the country’s mangrove areas. Thanks to the policy on mangroves planting, the area of mangroves from 2007 to 2017 showed an increasing trend.

Nguyen Thi Thu and Cao Van Luong el at. (2011) reported that in 10 years an average of 40-50% of coastal seagrass has been lost. Over the past two decades, the area of seagrass has decreased by 45.4% and the average annual reduction rate was 4.4% (*Nguyen Thi Thien Huong et al., 2017*). The Institute of Oceanography report showed that only about 1% of coral reefs have a high coverage while the number of coral reefs with low coverage accounts for over 31%, and the number of coral reefs with average or slight coverage was 41% and 26% respectively.

5. Societal awareness on the value of the benefits of ecosystem services is still low

In Vietnam, management agencies from central to local levels, ecosystems have been mainly seen as biodiversity with their main value coming from biological resources (e.g. tree and animal resources) and along with precious and rare genetic resources. Even in laws on biodiversity in Vietnam, the concept of *ecosystem services* is not mentioned. From the above-mentioned biodiversity-centred approach, the common perception of society about the contribution of ecosystem services to the national economy and human welfare can be said to be superficial. Among some local leaders, biodiversity conservation is also a notion of luxury, or even an obstacle to socio-economic development.

I. KEY ECOSYSTEM SERVICES SERVING THE SOCIO-ECONOMY

1.1. Benefits from ecosystem services in Vietnam

Vietnam has three key ecosystems such as forests, wetlands, and marine and coastal ecosystems, which, besides having the highest levels of biodiversity, also provide many important goods and services to the economy (especially for agriculture, forestry, fisheries, industry, tourism), to the environment and to human well-being through their four groups of ecosystem services.

As described in Part II, ecosystem services are divided into four groups: (i) provisioning services: products obtained from forest, wetland and marine ecosystems (food, firewood, fibers, construction materials, etc.); (ii) regulating services: climate regulation, water regulation, carbon storage and sequestration, etc.; (iii) cultural services: non-material benefits (spiritual and religious, recreational and ecotourism, aesthetics, etc.); and (iv) support services: nutrient cycle, soil formation, photosynthesis, etc. (*MA, 2005*).

Although not often recognized, the exploitation and use of ecosystem services in Vietnam has contributed significantly to the national economy, especially in the fields of agriculture and forestry, fisheries, tourism and health. According to the Statistical Yearbook (2021), the agriculture, forestry and fishery sectors contributed significantly to the gross domestic product (GDP), their export value increased from 19 billion USD in 2010 to 41.25 billion USD in 2020, accounting for 14.6% of the country's export turnover and 14.85% of GDP in 2020 and 12.36% of GDP in 2021.

About 20 millions Vietnamese people earn either their main or partial income from aquatic resources and non-timber forest products and are exploiting and using more than 300 species of seafood and more than 50 species of economically valuable freshwater fish; about 25 million people live in or near forests and 20-50% of their income comes from non-timber forest products, including hundreds of species of medicinal plants, oil crops, dyes (*MARD, 2020*). Natural ecosystems with high biodiversity are also the foundation for ecotourism, which is becoming a popular service in PAs, providing opportunities for tourists for meaningful exploration and education on nature protection, as well as being a source of benefits for sharing with the local people that join in providing the service. In addition to socio-economic and cultural values, ecosystems also provide many other important services: types of forest vegetation on land as well as in coastal waters help regulate the climate and respond to climate change through carbon storage, air and water filtration, waste decomposition, and reduction of the negative impacts of natural disasters such as landslides and floods.

Ecosystem services do not just generate products and raw materials, but also provide the primary productivity and vital life support services that are critical to the economy and to human well-being (*MA, 2005*). According to GIZ (2012), individuals, households, business and industries all, to some extent, depend on ecosystem services for their growth. If ecosystems do not provide enough food, clean water, and medicine, human well-being will be significantly reduced. As well, if ecosystems do not provide enough regulating services, human health and well-being will be critically affected, and if ecosystems are degraded, the spiritual and cultural life of nearby communities will be negatively impacted. Similarly, if ecosystems do not provide enough raw materials, production activities will soon end. In general, humans and the economy will bear significant costs and losses if ecosystem services are degraded or depleted.

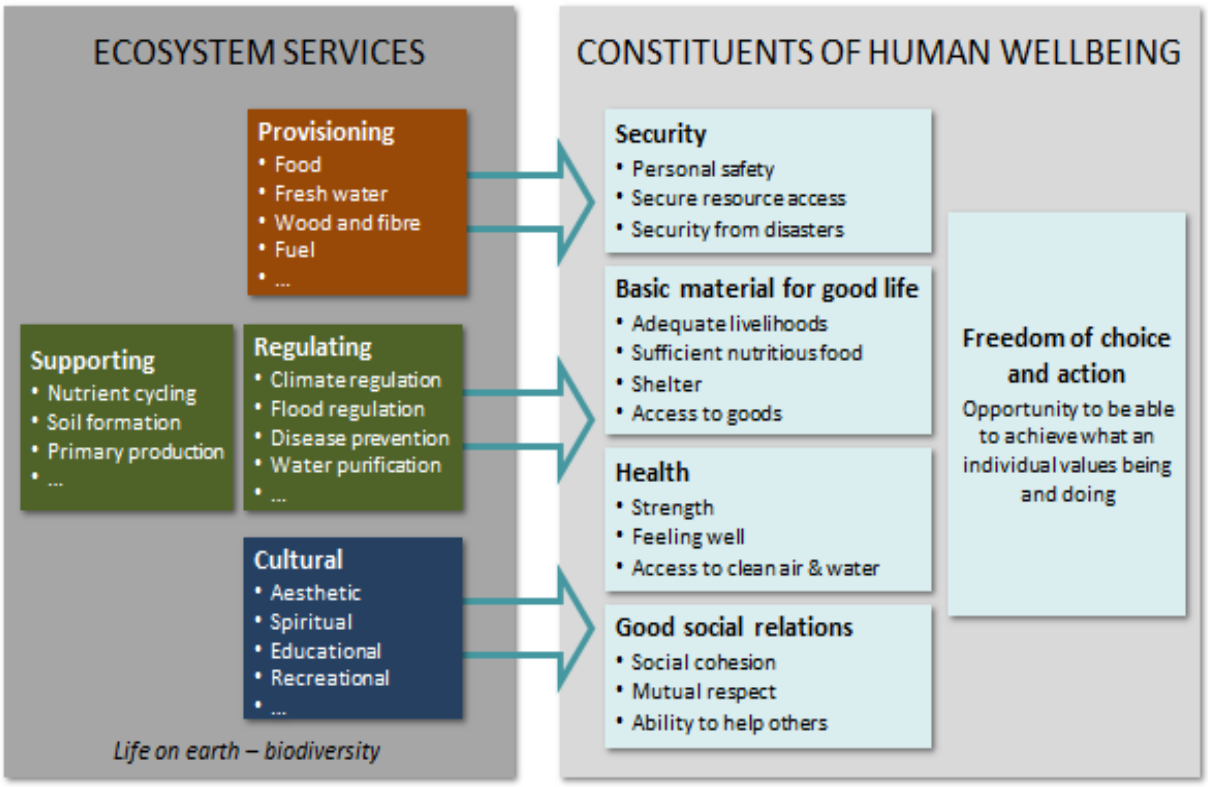


Figure 15. Ecosystem services and human well-being

(Source: MA, 2005)

1.1.1. Contribution of provisioning services

1.1.1.1. Forest ecosystems

In 2019, the forest ecosystem provided nearly 30 million m^3 of timber harvested from planted forests and natural forests, providing raw materials for pulp production, artificial board and wood and many other forest products for export, contributing to significant development of the forestry sector - the industry currently attracts nearly 5 million laborers (including 500,000 employees working in wood and forest products processing enterprises; 1,000,000 employees engaged in the operation afforestation and supply of raw materials, and nearly 3,500,000 laborers participate in forest protection and management). In 2019, Vietnam's export value of wood products reached 10.50 billion USD, accounting for 4.3% of the country's export turnover. Non-timber forest products are significant for the livelihoods of 25 million forest-dependent people (with 20-25% of total income coming from non-timber forest products) and are significant for the national economy with a total export value in 2019 of 600 million USD (*MARD, 2020*), making Vietnam the largest wood exporter in Southeast Asia, the second largest in Asia and the fifth largest in the world.

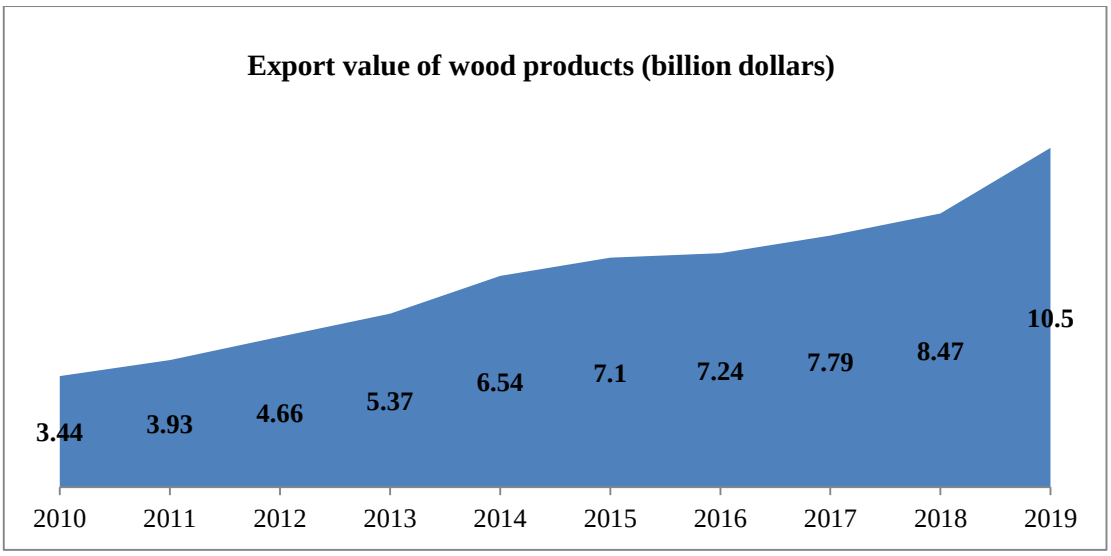


Figure 16. Export value of wood products of Vietnam, 2010-2019

(*Source: MARD, 2011-2020*)

Forest ecosystems are also the main source of energy for the country. Recent inventory and assessment show that about 20% of firewood is traded with the rest comprising branches remaining after harvest or wood collected by local users. Firewood is used as fuel for industrial thermal energy uses including food processing, beverage production, pulp and paper production and for household cooking and heating. Within the framework of the Vietnam Forests and Deltas Program (VFD), grant-funded by USAID, a study was carried out to assess the value of the firewood chain in Thanh Hoa and Nghe An provinces. The study surveyed selected industrial facilities using firewood as fuel and 220 households in 14 communes in the two target provinces. The results showed that forest ecosystems in Thanh Hoa and Nghe An provided 1,905,039 tons of firewood per year while local firewood demand was only 1,453,740 tons per year (*Greenfield, 2014*).

In addition, the forest ecosystems provide over 60,000 tons of valuable non-timber forest products (NTFPs) to local communities and to the economy. As of 2017, these products include about 3,830 medicinal species (of which, 1,800 species of pharmacological value), 500 essential oil species, 620 fungus species, 820 algae species, 40 rattan species, 76 balsamic species, 600 tannins species, and 823 fatty oil species (*MARD, 2018*). NTFPs are used widely in daily life, especially by ethnic minorities who live in mountainous and remote areas (i.e. leaves for livestock; firewood for cooking; fruit, flower, honey, bark, and leaves for food and medicines). These products also provide raw materials for the production of many valuable commodities such as essential oils, handicrafts, fine art, and jewelry for both domestic use and export (*Dzung, 2017*). Cao Thi Ly (2008) surveyed 106 households living in the buffer zones of three national parks: Chu Mom Ray NP (Kon Tum province), Yok Don NP (Dak Lak province) and Chu Yang Sin NP (Dak Lak province) on their collection of forest products and concluded that 90% of ethnic minorities depend on the forests around these national parks.

1.1.1.2. Wetland ecosystems

With an area of 11,847,975 ha (accounting for 37% of the natural area and distributed in most ecological regions), inland water ecosystems are important for the economy and human well-being in Vietnam. They are habitats to 1,028 species of fish and about 800 species of invertebrates, while about 300 other vertebrates (frogs, water birds, and mammals) have a life associated with the inland water environment.

Inland water ecosystems make a substantial contribution through the provision of aquatic products for human food, meeting the needs of domestic use and export. In 2019, the catch of

aquatic products in domestic freshwater ecosystems reached 208.500 thousand tons. The total area of aquaculture including both brackish-salty and freshwater farming in 2019 was about 730 thousand ha, with an estimated output of 4,432 thousand tons, making a major contribution to seafood export turnover in 2019 (about 8.60 billion USD) (*Directorate of Fisheries, 2020*). In addition, wetland ecosystems play an important role in the development of many sectors, such as aquaculture, forestry, transportation, energy, tourism, and mining.

The Mekong River Delta is the largest wetland area with an area of over 4 million ha, accounting for 41% of the country's total wetland area. The region is home to nearly 20 million people and is one of the most fertile and productive deltas in the world. By providing 55% of the country's rice (22-24 million tons of rice that feed 145 million people worldwide), 65% of the country's fruit (4 million tons) and 74% of the country's aquaculture output (3.5 million tons), the Mekong River Delta is the most important agricultural region in Vietnam, contributing 20% of the country's GDP (*Unique, 2018*).

1.1.1.3. Marine and coastal ecosystems

Vietnam's exclusive economic marine waters of over 1 million km^2 have more than 3,000 islands, large and small, and two archipelagos of Hoang Sa and Truong Sa, with a coastline of over 3,260 km. There are about 20 types of marine and coastal ecosystems, home to nearly 12,000 known marine species. Important marine and coastal ecosystems include coral reefs, seagrass beds, lagoons, bays, coastal islands, and offshore seas (*MONRE, 2019*). The average total reserves of major marine resources groups in Vietnam are estimated at 4.36 million tons. In 2019, seafood exploitation was estimated at 3,560 thousand tons, and aquaculture production was estimated at 4,432 thousand tons. Export turnover of the fishery sector in 2019 reached 8.54 billion USD, lower than in year 2018's total of 8.80 billion USD (*Directorate of Fisheries, 2020*).

Coral reef ecosystems

Capture fisheries: Coral reefs in Vietnam support many (often high value) fish and crustacean species, providing livelihoods, poverty alleviation, and food security for fishing communities. Data on reef-associated capture fisheries, both commercial and subsistence, is very limited. Reef species are not disaggregated from other marine species in national government statistics but can be approximated based on the diverse range of fishing activities used for catching different species.

Table 14. Main fishing activities and marine resources collected from coral reefs in Vietnam

Fishing activity	Main marine organisms fished
Hookah air diving with or without dynamites and poisons	Groupers, sweetlips, top shells, triton shells, giant clams, lobsters, ornamental fish, and live corals
Net (gill net, purse seine, drift net)	Sweetlips, snappers, cardinal fish, coral breams, anchovies
Light fishing	Anchovies and cuttlefish
Long line	Cuttlefish and fish
Fixed net	Mackerel, tuna, snapper, jacks
Trap net	Cuttlefish and fish
Gleaning on Tidal Flat	Seaweeds, gastropods, and fish

(Source: Vo Si Tuan et al., 2005)

A small number of case studies provide some insight into the potential direct production and value of reef fisheries in areas with significant reef area. Data from a case study in Ninh

Thuan (*Vo Si Tuan et al., 2007*) in the central coast region, shows that the strongly reef-associated grouper *Epinephelus* spp. accounted for 10% of total demersal fish catch in the province. The annual catch of adult lobsters harvested from the coral reefs ranged between 30-50 tons with the price ranging from 200,000-300,000 VND (equivalent to 12.40-18.60 USD) per kilogram. Production of giant clams collected around Con Dao islands reached 10 tons during April-July of 1994, but in 2001, there were only 4 tons of gastropod and bivalve shells exported to Nha Trang and Da Lat cities.

Reefs around the offshore island, Nam Yet support 2,128 kg of commercial fish per ha, with a value of about 170 million VND (equivalent to 10,000 USD) *(Quan, 2007-2008*). Quan (2007-2008) reported 206 fish species living on Con Dao's reefs, among them 61 were commercial species and 108 were ornamental or aquarium fish. The study also identified 21 crustacean and 54 mollusk species of commercial value.

In 2018, a case study on a total of 736 species belonging to 263 genera of living resources was recorded in Cu Lao Cham MPA (*Cu Lao Cham MPA Management Board, 2018*), of which more than 300 species of coral, dominantly soft coral, inhabit an area of 311 ha with a coverage of 47%.

The economic value of coral reefs in Nha Trang Bay was calculated in 2015 using market values. The fishery and aquaculture valuations determined through this study are as follows:

Table 15. **Annual fishery value associated with coral reefs in Nha Trang Bay, 2015**

Species group	Quantity	Total revenue (USD million)	Value added (USD million)
Reef-associated fishery (tons)	324	0.89	0.62
Lobster seeds (individual)	212,000	2.99	2.09
Ornamental fish (individual)	1000	0.04	0.03
Total fishery value		**3.92**	**2.74**

(Source: Quach Thi Khanh Ngoc, 2015)

Table 16. **Annual aquaculture value associated with coral reefs in Nha Trang Bay in 2015**

Species group	Quantity (tons)	Total revenue (USD million)	Value added (USD million)
Lobster	220	13.08	4.97
Grouper	37	0.41	0.13
Total Aquaculture Value		13.49	5.10

(Source: Quach Thi Khanh Ngoc, 2015)

This sector may also seek a potential source for further economic growth through the implementation of tracking technologies like VMS and electronic catch and documentation technology as per the Fisheries Law (2017) and other recent national initiatives. Legitimizing Vietnam's seafood products will help to remove the European Commission's yellow card, improve the reputation of the products abroad, and increase sales and therefore revenue.

Genetic resources: Coral reefs have the highest biodiversity of all ecosystems in the world and Southeast Asia has the highest biodiversity of all coral reefs (table 17). There are 1,206 species of reef fish and more than 1000 coral dwelling species connected with coral reefs in Vietnam (*Quan et al., 2006*). In recent years, several coral reef species have been discovered, some of which are now listed in Vietnam's Red Book and the IUCN's red list of threatened species.

Table 17. Diversity of fish species on the coral reef

Region	Marine fish species diversity	Hard coral species diversity
South East Asia	2,500	400-500
Great Barrier Reef	1,500	395
Caribbean	500-600	100-200

(Source: Vo Si Tuan, 2007)

Biochemical, natural medicines and pharmaceuticals: Biochemical research on reefs is relatively new in Vietnam. According to the studies cooperatively undertaken by the Institute of Marine Environment and Resources and the Institute for Natural Chemistry Compounds, several soft corals and sponges in Vietnam contain molecular compounds that may be used to produce drug tablets to treat cancer-related illnesses (*Chau Van Minh et al., 2004*). There have been recent research results by Chau Van Minh et al (2012) on the chemical composition and biological activity of some groups of marine organisms in Vietnam, including extensive groups and groups of soft coral and echinoderms. Compounds of the saponin class, steroid, diterpene, glycolipid, and several other compounds have been isolated and structured. Among the compounds obtained, there are those that show cytotoxic activity on some tested cancer cell lines, along with antibiotics. In addition, a number of compounds have been assessed for their anti-inflammatory, anti-osteoporosis and antioxidant properties.

Construction materials: Dead coral and coral rubble located nearshore when used for preparing cement and slaked lime contributes to coastline erosion and affects other marine resources by removing critical habitat for settling larvae of several species such as lobster, a species of high economic value in the aquaculture sector.

Seagrass beds

Food: A typical seagrass bed supports as many as 91 fish species and 106 species of zoobenthos. The live fish food trade brings substantial income for the local people; they can harvest economically valuable species belonging to the Serranidae, Lutjanidae, Nemipteridae and Siganidae families from seagrass beds (*Tien N.V. et al., 2006*). In Tam Giang-Cau Hai lagoon, local fishers can have an income of about 461,870 USD from a total of 100 ha of seagrass (*Tien N.V. et al., 2004*).

Raw materials: Seagrass itself can serve as a raw material for the manufacture of consumer goods such as packaging materials and carpets (*Hemmings & Duarte, 2000*). It can also be used as fertilizer in the agricultural sector. In two communes in Tam Giang-Cau Hai Lagoon, people can collect 20,000 USD annually from selling the seagrass as fertilizer.

Genetic resources: The total number of species living in seagrass areas is often 2-8 times higher than in offshore water (*N.H.Dai, 2002*). The seagrass bed in Thuy Trieu Lagoon (Khanh Hoa province) is an important nursery ground for juvenile tiger prawns and has contributed to Vietnam becoming one of the largest shrimp exporters in the world. The tiger prawns' seed productivity is dependent on the presence of near-shore seagrass nursery grounds (*N.H.Dai, 2002*). Seagrass is also the principal food source for dugongs (*Dugong dugon*). The dugong, an herbivorous mammal, is strictly marine and is listed as vulnerable to extinction by IUCN. Seagrass is also a major food source for the green turtle (*Chelonia midas*).

Biochemicals, natural medicines and pharmaceuticals: Some seagrass dwelling species such as seahorses (*Hippocampus* spp.) have been used as ingredients for traditional medicines (*N.V. Tien et al., 2006*).

Lagoons

Food and livelihoods: The lagoon ecosystem is a vital natural site (encompassing land and water) and is a favorable location for economic activities in many sectors including agriculture, fisheries and forestry. Fishing in lagoons has largely been happening under a system known as co-management. One location known as Tam Giang-Cau Hai Lagoon (Thua Thien Hue province) in central Vietnam, after introducing co-management practices, noticed an increase in fish size and diversity in the lagoon, with a stable number of fish (*Ho Thanh Hai et al., 2016*). Species are popular in this lagoon for fishing include, orange spotted spinefoot (*Siganus guttatus*), and greasyback shrimp *(Metapenaeus ensis*). The lagoon is a critical source of income, and an estimated 30% of the provincial population from Hue city of Thua Thien Hue province, earns its living through fisheries and aquaculture (*Ho Thanh Hai et al., 2020*). Lagoons also serve as sites for tourism away from the major cities. Nevertheless, lagoons continue to serve most typically, as spaces for fishing and aquaculture, for older generations, while younger generations move to cities in search of other forms of employment.

Raw materials: The flora and fauna inside the lagoon provide a source of raw materials for small-scale business such as seagrass leaf used for making bags and fertilizer for the agricultural sector. Largely lagoons raw materials are marine products, such as the increasing cultivation of shrimps, oysters, and gracillaria; this is a type of algae/seaweed, important in recent efforts to diversify livelihoods and for export. There are six cultivated species of gracillaria at the commercial level (*Gracilaria firma, Gracilaria tenuistipitata, Gracilariopsis heteroclada, Kappaphycus alvarezii, Kappaphycus striatum, and Eucheuma denticulatum*), many being red algae, primarily used as an alternative to mangrove destruction (*Nguyen, 2014*). Red algae are found in lagoons is also used across Vietnam to produce Agar powder. Agar is widely used in human consumption like food, a filler in paper sizing fabric, as a clarifying agent in brewing, pharmaceutical purposes such as a laxative and an appetite suppressant, traditional medicines, chemicals in industries, bioengineering, or as feed for animals. There are 82 species of Vietnamese seaweeds which are considered "economically valuable" (*Nguyen, 2014*). However, according to Nguyen (2014), "culturing seaweeds remains a largely marginal activity in Vietnam". The reason for this is an absence of a phycolloid industry in Vietnam, therefore Vietnam exports large amounts of raw seaweed, at a low price, and then imports the purified phycocolloids at a much higher price. There is much potential for growth in the agar/carrageenan industry as it is an alternative to gelatin that can help to mitigate climate change, along with the growing trend towards sustainability, veganism, and vegetarianism (*Thang Tran, 2015*). Nevertheless, the steadily growing demand also poses a threat to pressures on coastal and marine ecosystems such as lagoons, due to risks over overharvesting natural populations such as brown algal genus *Sargassum*. Sea products found in lagoons can also be later made into fish sauce, and other byproducts for neighborhood villages. Similar findings can be found across the country, meaning a

significant amount of people rely on lagoons for its raw materials for food and livelihood (*Tuyen et al., 2010*).

Genetic resources: The flora and fauna in the lagoon are composed of marine species, freshwater species and others adapted with variable environmental conditions. In Tam Giang-Cau Hai alone, 839 aquatic species have been recorded, among which 40 species are valued for multiple uses (*Ken LV and Quan NV, 2007*). Information about Vietnamese lagoons, and species within lagoons such as seaweeds, is scattered throughout many regional and international publications and, hence, difficult to access. The marine macroalgae of Vietnam alone makes up 827 reported species (figure 17) with new species being discovered as research expands into sites yet unreported and tested in literature (*Nguyen Van et al., 2013; Le H.N et al., 2020*). As Nguyen (2014) noted, there is a need for sustainable exploitation of natural resources and continuous integrity of marine habitats in habitats such as lagoons, and where flora and fauna are diverse.

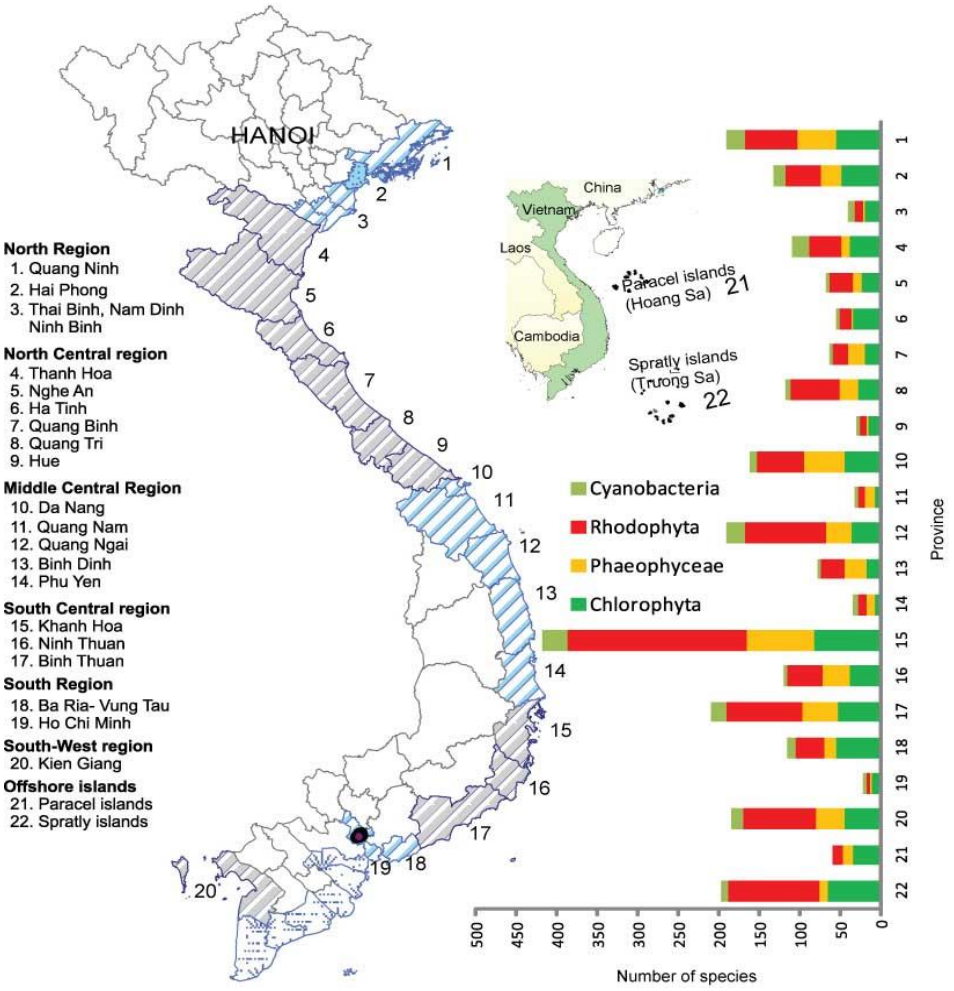


Figure 17. Distribution of seaweeds by province along the coast of Vietnam

The number of publication per province is indicated in brackets next to each bar.
(Source: Van Nguyen et al., 2013)

Mangrove forests and coastal tidal flats

Food and livelihood: Vietnam's largest area of mangroves is currently in the South of the country, in the Mekong River Delta and Ca Mau Province (figure 18). Mangrove ecosystems provide several marine products for human consumption and they also provide feed for livestock. A wide range of species live in mangrove forests from shrimp, crab, and fish, such as *Scylla paramamosain, Crassostrea gigas, Anadara granosa, and Meretrix lyrate*. Mangroves are also the nursing grounds for commercial and non-commercial fish species,

providing local communities with a source of income (*Veettil et al., 2019*). The conversion of mangroves for export-oriented intensive shrimp production remains a substantial threat in many areas; however those shrimp farms that have been abandoned present themselves as opportunities for restoration sites of mangrove forests, such as those in Ben Tre and Tra Vinh provinces in southern Vietnam. Mangrove forests provide a source of livelihood primarily for those in the South, however those households and organizations allocated or contracting submerged land can only use 40% of the area for agriculture or aquaculture and must maintain at least 60% mangrove canopy cover (*Decision no.186/2006/QD-TTg*), meaning there is not as much personal incentive for development of shrimp-mangrove farms under the current laws.

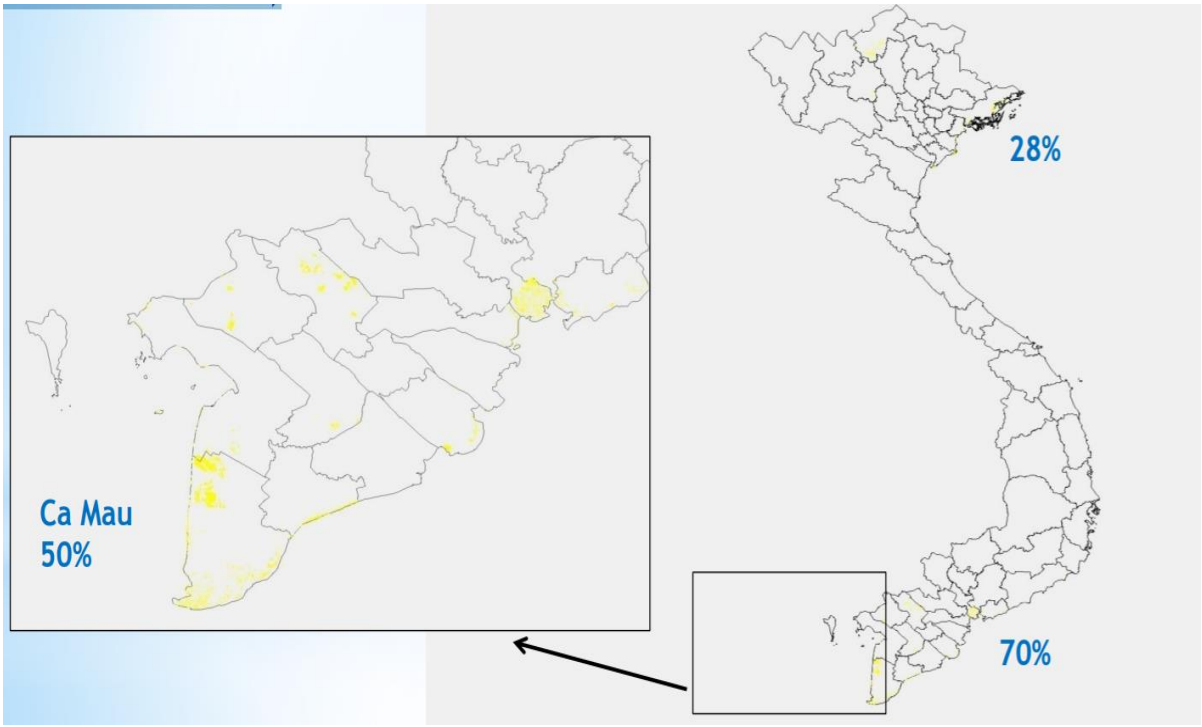


Figure 18. Distribution of mangroves in Vietnam

(Source: Brunner, 2014)

Raw materials: Branches, roots and mangrove stands are valuable sources of firewood and charcoal material. The need for biomass fuels and construction materials such as leaves and stems for roofs and walls, and timber for poles, means mangroves are often exploited as versatile materials for economic development. Mangroves support the production of traditional, natural medicines and foodstuff such as honey. There are some mangrove species that can be used for medicine production, pharmaceuticals, tannin extraction, and making sugar (*Nho et al., 2020*). Traditionally, mangrove ecosystems were popular *Periophthalmus schlosseri* catching sites as well as for shellfish collecting in tidal mudflats, clam farming, and bee raising (*Brunner, 2014*).

Genetic resources: The diversity of genes of mangroves and other species in mangrove/mudflats are valuable at the local, national, and global levels (e.g. Cat Ba World Biosphere Reserve). Mangrove forests are important sites for migratory bird species, which also allows these ecosystems to play important roles as areas for tourism, education, and research, as natural signifiers of environmental and ecosystem health. The genetic material of actual and future value in mangroves can be documented in dramatic increase in brackish-water habitats for aquaculture cultivation and marine production in Vietnam. Brackish water

is not only favorable for mangroves but also for fish breeding and the irrigation of crops that have a high tolerance for salinity. From 1980 to 2015, the increase in brackish water, increased aquaculture production from 3,960 to 793,176 tons and 3,240 to 213,968 tons, respectively, within mangroves largely becoming favorable sites for agricultural/aquaculture production (figure 19).

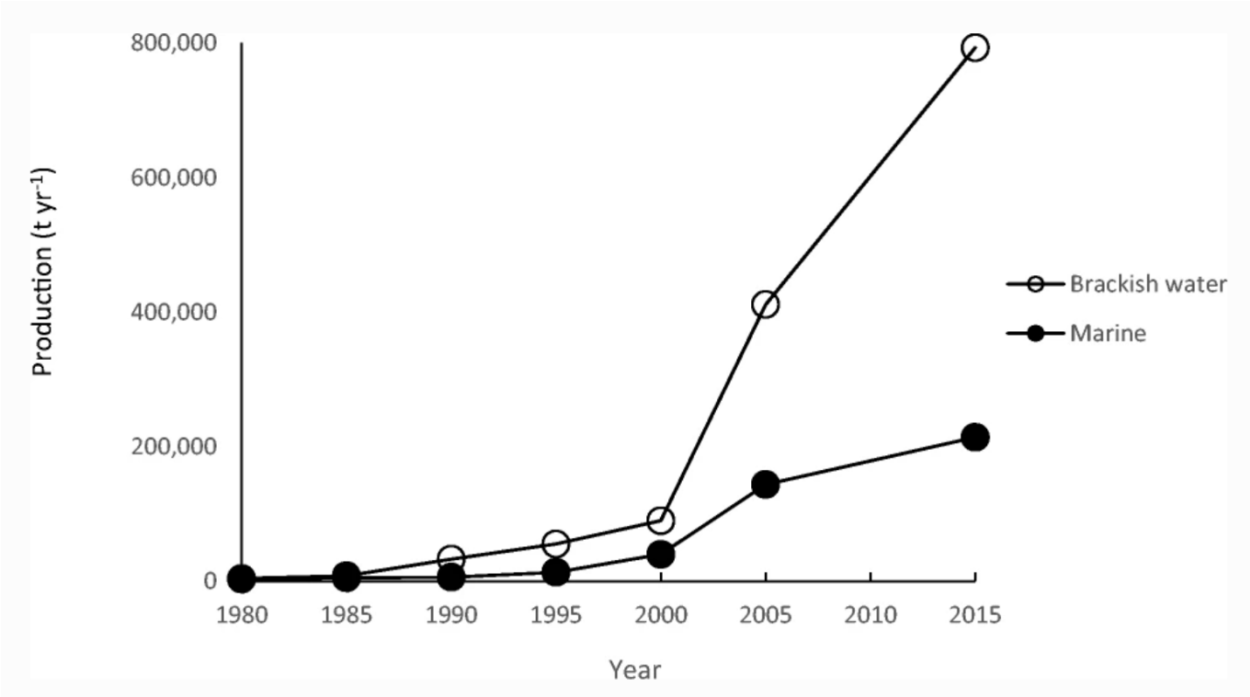


Figure 19. Aquaculture production in Vietnam since 1980 (t yr-1) to 2015

(Source: Hai et al., 2020)

1.1.2. Contribution of regulating services

1.1.2.1. Forest ecosystems

Forest ecosystems play an important role in watershed and coastal protection including protection against soil erosion and sedimentation, and in controlling water flow, floods and water quality. The loss of forest cover due to unplanned harvesting or land use conversion will result in serious consequences for the watershed-related functions of forests. Forests are very important in reducing surface water flow and increasing infiltration. Watershed forests, especially natural forests with a multilayered canopy are very important in maintaining water flow rates during rainy seasons and in supplying water during dry seasons for local use, hydropower generation and irrigation. Over the past few years, floods have occurred in many provinces in the central and the northern areas of the country. One of the main causes is forest destruction (*MARD, 2021*). A study conducted by MARD, USAID and Winrock International (2008) to estimate water regulation and soil conservation services of Da Nhim watershed (Lam Dong province), which accounts for 4,800 ha of the country's natural forests, indicated that one hectare of forest was valued at 69 USD/year to the Da Nhim hydropower plants, of which 14.60 USD was attributed to the benefits accrued from water regulation and 54.40 USD for reduction of sediment into the reservoir. Another recent study by Vuong Van Quynh (2014) to estimate water regulation and soil conservation services of natural forests in 66 watersheds distributed throughout the whole country showed that value of watershed functions ranges from 24.60 USD to 69.80 USD/ha.

Forest ecosystems also help stabilize local and global climate through carbon storage and sequestration services. Carbon sequestration services are the largest commercialized forest environmental services in the world market and have always been the focus of international

dialogues on reducing greenhouse gas emissions (*Pham Thu Thuy and Nguyen Van Dien, 2019*). In recent years, with the technical and financial support of many domestic and international organizations, MARD and MONRE have conducted many studies on the mechanism of PFES mechanism as for carbon sequestration services. On August 7, 2019, a workshop was held by MARD to consult extensively on the draft implementation of the pilot for the PFES policy for carbon sequestration services in Quang Ninh, Thanh Hoa, Thua Thien Hue and Quang Nam provinces. Accordingly, coal and cement thermal power production and trading establishments in the four provinces will pay indirectly to forest owners through the Provincial Fund for Forest Protection and Development with specific payments of VND 4/kwh of commercial electricity and VND 2,100/ton of clinker. On the side of MONRE, this ministry, on July 8, 2021, also conducted a workshop to consult extensively on the draft decree on reducing greenhouse gas emissions and protecting the ozone layer including regulations on the roadmap for developing the domestic carbon market and implementing credit exchange projects at home and abroad. Accordingly, the period of 2021-2025 is the preparation period, from 2026-2027 is the period when the domestic carbon market will be piloted and in 2028 the domestic market will have been in operation and Vietnam will have participated in the world market. On October 22, 2020, MARD and the World Bank - the trustee of the Forest Carbon Partnership Fund (FCPF) - also signed an Agreement on Payment for Emissions Reductions in the North Central Region (ERPA). With this Agreement, Vietnam will transfer to FCPF 10.30 million tons of CO_2 to reduce emissions from forests in six provinces in the North Central region (including: Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri and Thua Thien Hue) for the period 2018-2024. FCPF will pay Vietnam 51.50 million USD. Most recently, on October 31, 2012, MARD signed a Letter of Intent with the Forest Financial Enhancement Organization (Emergent) - the Trustee agency of the Alliance to reduce emissions through enhanced financing for the forestry sector (LEAF). With this Letter of Intent, Vietnam will transfer to LEAF/Emergent 5.15 million tons of CO_2 to reduce emissions from forests in the South Central region and Central Highlands in the period 2022-2026 with a total value of 51.50 million USD (*Pham Thu Thuy and Nguyen Van Dien, 2019*).

1.1.2.2. Wetland ecosystems

Inland water ecosystems provide humans and the economy with a wide range of regulating services. They regulate water quantity, groundwater recharge, and can contribute to regulating floods and the impacts of storms. Inland wetlands also help in erosion control and sediment transport, thereby contributing to land formation and increasing resilience to storms. All these ecosystem services improve water security, including security from natural hazards and climate change.

1.1.2.3. Marine and coastal ecosystems

***Coral** reefs*

Erosion prevention: Coral reefs are ‘sea dikes’ that protect coastlines and islands from erosion. When passing a coral reef, wave energy is reduced in proportion to the width and height of the reef (*Kench & Brander, 2006*). Shoreline protection values of the coral reefs are clearly seen in marine areas in the central provinces of Vietnam including Bai Tien and Hon Khoi, Khanh Hoa province, though there has been no direct monetary valuation of the protective roles of reefs.

Recent coastal erosion has eliminated 30% of the total area of floating islands, including some residential areas (*Vo Si Tuan et al., 2005*). The annual cost of construction and maintenance of dikes to protect these areas is extremely high and is at least in part attributable to reef loss.

Vietnam is listed as one of the five countries in the world to be most affected by the serious impacts of climate change. Scientists predict the sea level may rise 1 meter in the next 100

years (*Dasgupta et al., 2007*), which will affect more than 10% of the country's population. According to the United Nations, if this occurs, Vietnam will face losses of up to 17 billion USD a year. Around one-fifth of the population will lose their homes and 12.3% of cultivated land will disappear. A total protection strategy against sea level rise involving dike enhancement, additional pumping, and beach nourishment will cost 9 billion USD (*Huan N.N., 1997*).

Seagrass beds

Climate regulation: Seagrasses are important for nutrient retention and recycling, water quality control, carbon sequestration and for buffering future ocean acidification on adjacent coral reefs. Each square meter of seagrass can generate ten liters of dissolved oxygen that contributes to balancing O_2 and CO_2 in the water environment and assists to mitigate the greenhouse effects due to efficient absorption of the CO_2 in the water (*Tien NV et al., 2004*). Since seagrasses are considered vascular plants and have roots in sediment, stems and leaves, this vegetated coastal ecosystem provides opportunity as a significant carbon sink. The root and rhizome system on seagrasses, when underground, can form long-term carbon sinks (*Heckbert et al., 2011*).

Erosion control: Seagrass meadows also help dampen the effects of strong currents, providing protection to shorelines and preventing the scouring of bottom areas.

Storm protection: Seagrass beds help to protect infrastructure, local people's lives, and fishing vessels from strong winds, waves, and storms.

Water purification and waste treatment: Seagrass ecosystems are involved in absorption, filtering, and deposition of waste. Figure 20 shows the ways in which seagrass beds have the potential for helping the surrounding organisms thrive and raising the economic value of areas such a property and tourism value.

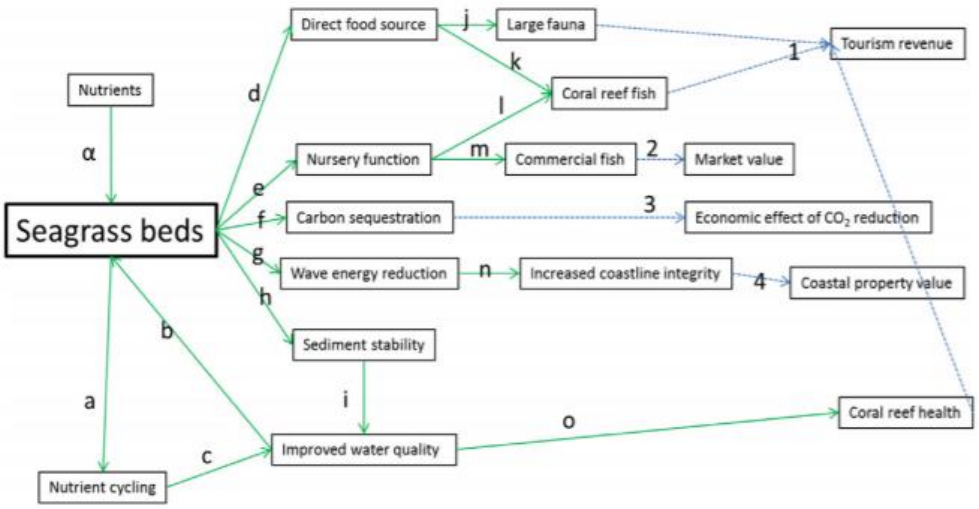


Figure 20. Seagrass Ecosystems Valuation Model

Green arrows represent ecological function, blue arrows represent economic contribution.
(Source: Dewsbury et al., 2016)

Lagoons

Recharge and discharge of groundwater: During the rainy season, when there is a surplus of surface water, lagoons act as storage tanks that allow water to gradually infiltrate into the groundwater system later during the dry season. This is a continuous process that supplies water for groundwater aquifers. In addition, a continuous process of recharge and discharge of groundwater from wetlands and aquifers also contributes to groundwater purification.

Trapping of sediment and toxic substances: Lagoon ecosystems can function as sinks, trapping sediments, pollutants, toxic substances, and other wastes, to purify water and reduce the possibility of marine water pollution. In central provinces, lagoon ecosystems trap sediments flowing from upstream to produce a high quality of soil for rice field development around lagoons.

Microclimate regulation: This function is particularly evident in lagoons with seagrass and mangroves such as Tam Giang-Cau Hai lagoon where they contribute to balancing O_2 and CO_2 concentrations in the atmosphere, regulating microclimate (i.e. temperature, humidity, and precipitation) and mitigating the greenhouse effect.

Flood control: Lagoons can function as water storage tanks, regulating rainfall and surface runoff, to slow the flow of floodwater from upper streams and reduce floods in surrounding areas during storms or rainy the season.

Mangrove forests and coastal tidal flats

Erosion control: Mangrove vegetation is important for erosion control. Due to the adaptive features and intertwined nature of their root system, mangroves can stand firmly in coastal estuarine areas and anchor sediment from tide and wave actions. Every year, pioneer species gradually invade new tidal flat areas, forming a protective layer. According to Narayan et al. (2016), depending on the water depth, mangrove projects in Vietnam can be three to five times cheaper than a breakwater making the contribution of habitats to coastal protection a growing interest in nature-based defense policy. In Vietnam, unit restoration costs are lowest for marshes and mangroves, whereas coral and oyster reefs have higher and more variable costs. Further research regarding mangrove ecosystem and regulatory services are available however are largely outdated such as the following: observations on complex organic materials (*Kishida et al., 2010*), antibiotics (*Le and Munekage, 2004*), sedimentary organic carbon (*Tue et al., 2010*), insecticides (*Thao et al., 1993*), and dioxin contamination in the soil (*Dwernychuk et al., 2002; Mai et al., 2007)* resulting in degradation of the ecosystem.

Climate regulation, storm protection, and wave reduction: Mangroves contribute to balancing O_2 and CO_2 in the atmosphere, regulating the local climate (i.e. temperature, humidity, and rainfall) and mitigating the greenhouse effect. Salt marshes, which are characterized by mangroves and mangrove forests, can sequester up to 3900 g-C m-2 yr-1 acting as very effective carbon sinks. Overall, mangroves are a net sink of CO_2. Mangrove plants help protect sea dikes, infrastructure, crops, settlements and fishing gear from strong winds, waves, and storms. Despite all that mangroves do for human development; mangroves are also impacted by various conditions. For example, because mangrove sediment accumulation rates in areas such as the Mekong River Delta can be so high, it can smother mangrove roots resulting in forest dieback. Dieback of mangroves predominantly because of decreases in velocity making conditions sandier, and slowing down sediment carrying capacity, and ultimately nutrient carrying capacity, can be traced back to tropical rainfall. Despite sediment movement being a dominant feature of tide induced currents, the predicted increase and observation of extreme weather events, and changes in precipitation patters due to climate change, means the significance of heavy rainfall can have a greater result on sediment transport in higher elevation mangrove areas, increasing the chances of dieback in mangroves, and ultimately weakening mangroves as a form of storm protection and wave reduction (*Veettil et al., 2019*). Therefore, the favorable conditions for mangrove ecosystems and growth in the south coast due to low-lying topography, abundant nutrient-rich, alluvial deposits, and hydrology, few storms and weaker water currents, can be expected to change with the changing sea levels and precipitation patterns (*Veettil et al., 2019*).

Water purification and waste treatment: Mangrove ecosystems are involved in the absorption, filtering, and deposition of waste. Mangroves can adapt to large variations in salinity, oxygen content and water levels, allowing for much opportunity and development across Vietnam.

However, the substantial increase in hydropower development in Vietnam has decreased sediment discharge in the Mekong River Delta from 44% pre dam construction to 66% post dam construction, with continued decreases (*Veettil et al., 2019*). Decreased sediment discharge has been noted to affect land and soil quality due to a loss in nutrients, weakening of vegetation, and a change in water purification due to changes in flow of water. A sediment deficit in downstream coastal mangroves may reduce overall growth rates of mangroves and death. Some models project a decrease in rainfall in the dry season together with increased evaporation, which are expected to increase salinity in mangrove ecosystems, leading to a decrease in mangrove productivity, growth rate and seedling survival (*Hai et al., 2020*). Under favorable conditions, an increase in mangrove areas (such as *Kandelia obovata* and *Aegiceras corniculatum*) can increase the population of bees for pollination as a byproduct of mangroves (*Giang et al., 2019*).

1.1.3. Contribution of cultural services

1.1.3.1. Forest ecosystems

Forest ecosystems are a very important part of the Vietnamese culture, both spiritually and recreationally. Anthropological and forest ecosystem management studies in Vietnam indicate a strong link between the natural ecosystem and the livelihoods and culture of ethnic minority peoples. For example, ethnic minority groups in the Central Highlands traditionally depend on the forest for the collection of NTFPs and timber for constructing traditional houses and household furniture, traditional medicine (from medicinal plants), fishing and hunting. Furthermore, cultural ceremonies in the Central Highland all relate to the forest and natural resources (*Bann et al., 2017*).

In addition, most of the natural ecosystems with their charismatic and visible biodiversity have been designated as national parks and special use forests, providing opportunities to develop the recreational industry in Vietnam, particularly ecotourism, which has the potential to serve as a driver of economic growth and can support livelihood diversification and poverty alleviation. Ecotourism could do this by increasing the demand for local agricultural production and the opportunities to market local handicrafts, non-timber forest products such as honey and creating additional off-farm income opportunities. According to the World Travel & Tourism Council (2017), the direct contribution of the tourism sector to Vietnam's GDP was 9.30 billion USD, accounting for 4.6% of the country's total GDP in 2016. This sector also supported 1.90 million jobs (equivalent to 3.6% of total employment) in the same year. According to VNFOREST (2017b), ecotourism has been deployed in 61 of 167 special use forests (i.e. 25 out of 34 NPs and 36 out of 133 PAs). In 2016, PAs welcomed two million tourists and procured a revenue of 114 billion VND (equivalent to 5 million USD). NPs and PAs contributed 32 billion VND (equivalent to 1.42 million USD) to the state budget and invested 9 billion VND (equivalent to 0.40 million USD) to biodiversity enhancement activities.

1.1.3.2. Wetland ecosystems

Like forest ecosystems, inland water ecosystems are intertwined with the culture and beliefs of many communities in Vietnam; they are the origin of wet rice cultivation. The life and culture of many people living near wetland ecosystems are reliant on nature and the products and services these ecosystems provide. Many inland water plants and animals are now used as cultural symbols by many communities and regions.

Many inland water ecosystems with diverse and beautiful landscapes such as those in Cat Ba Island (Hai Phong City), Con Dao (Ba Ria-Vung Tau province), Phong Nha-Ke Bang (Quang Binh province), U Minh Thuong NP (Kien Giang province), Xuan Thuy NP (Nam Dinh province), Can Gio Mangroves (Ho Chi Minh City), and Ba Be NP (Bac Kan province) are all

attractive tourism destinations and incentives for the development of the country's ecotourism sector.

In addition, many wetland ecosystems in Tien Hai NR (Thai Binh province), Xuan Thuy NP (Nam Dinh province), and Cat Ba NP (Hai Phong city) can be the source of useful scientific information, attracting both domestic and international experts to study the values and functions of wetlands, biodiversity conservation, management and wise use of natural resources.

1.1.3.3. Marine and coastal ecosystems

Marine and coastal ecosystems provide natural beauty and opportunities for recreation that result in great value from ecotourism. Two great examples are Quy Nhon and Nha Trang cities.

Many tourism investments projects (e.g. FLC Resort and Tourist Complex) have taken place in Nhon Ly, Quy Nhon city since 2016. In Nhon Ly commune, a highly diverse coral reef of about 4.5 ha stretches from Eo Gio to Cong Coc Cape to Bai Dua; the area is naturally beautiful and has unique architecture - all attractive qualities for tourism. In 2017, approximately 310,000 tourists visited the commune and in 2018, the number of tourists grew by 6.2% to 329,000. Increasing tourism is creating jobs outside of the fisheries sector (e.g. in operating sightseeing tours and the opening of restaurants), alleviating poverty and improving the livelihoods of community members. Previously a poor fishing village with many hardships, the community now has 112 households paying taxes on trade and services which has significantly increased the community's wealth. In 2015, the total community revenue was 340 million VND (equivalent to 16,200 USD), but in 2018, it was 6.10 billion VND (equivalent to 290,500 USD), 42.90 million VND/capita (equivalent to 20,430 USD/capita). The community's employment rate even reached 98.58% by the end of 2018 (*MCD, 2019*). This shows that coral reefs ecosystem services can bring higher income and benefits for human well-being therefore they need to be well-protected and co-managed by local communities and local governing bodies.

For Nha Trang city, ecotourism is the largest source of income and the sector continues to grow. The number of tourist arrivals increased by 18% each year from 2011-2015. The Department of Culture, Sport and Tourism reported that 974,000 foreign tourists (with an average daily expenditure of 97.83 USD per/person/day) and 3,097,000 domestic tourists (with an average daily expenditure of 52.81 USD/person/day) visited the area in 2015, contributing to a total annual revenue of 321.10 million USD (*Quach Thi Khanh Ngoc, 2015*). Direct revenues such as diver fees and park entrances as well as indirect revenues from lodging and restaurants are included in this total. Quach Thi Khanh Ngoc (2015) found that 90% of tourists visiting Nha Trang Bay participate in direct or non-use revenue-producing beach and/or marine recreation activities, including snorkeling, swimming, sunbathing, recreational fishing, and visiting fishing villages. Assuming that at least 600,000 of these tourists (14.3% of the total visitors to the area) visit coral reef sites each year, Quach Thi Khanh Ngoc estimated that the value of Nha Trang Bay's coral reefs for ecotourism has a potential 23.67 million USD net return to the local economy. However, these positive economic returns will only continue if the tourism industry becomes more sustainable. Tourism infrastructure such as airport and hotels, boat trips to coral reef areas, and fishing for a heightening demand for seafood must be restricted and strictly regulated to avoid adverse negative effects on the natural environment (*Quach Thi Khanh Ngoc, 2015*).

1.1.4. Contribution of supporting services

Supporting services do not have a visible and direct impact on the economy and human well-being but they underpin many economic activities that benefit human well-being

1.1.4.1. Forest ecosystems

Agricultural production depends on the provision of forest ecosystem services such as water, soil fertility and pollination. For example, the pollination of many crops depends on there being sufficient natural habitat in the landscape surrounding agricultural fields to maintain sustainable populations of pollinators. Many agricultural crops depend on streams or rivers for water provision, and whether these streams retain adequate water flow depends, in part, on whether the upper catchments of the watershed are forested. Given the dependency of agriculture on the natural functioning of ecosystems, the ability of forest ecosystems to provide services will have important impacts on agricultural productivity; degradation of ecosystem services will therefore negatively affect farming systems (*Bovarnick, et al., 2010*).

Supporting ecosystem services required for agriculture affect not only the location and type of farming, but also farmland's economic value. While determined in part by crop price, the economic viability of agricultural land also depends on production costs linked to ecosystem services such as soil fertility, soil depth, suitable climate, and freedom from the pressures of pest infestations (*Bann et al., 2017*).

1.1.4.2. Wetland ecosystems

Vietnam's transport sector (especially waterway transport) depends quite heavily on the proper functioning of wetland ecosystems (especially inland freshwater ecosystems). Many rivers in the country play an important role in the transportation of goods as well as recreational travel-the Red and Mekong Rivers are now important international trade routes. Recent studies have showed that transporting large quantities of goods across long distance by waterway is the cheapest and most efficient method.

1.1.4.3. Marine and coastal ecosystems

Coastal and marine ecosystems in Vietnam support the development of the aquaculture sector. For example, coral reefs are a critical nursery habitat for numerous marine species and create important nearshore fishing grounds. Grouper, commanding a high price in the live food fish trade, often aggregate to spawn at the reef slope in the breeding season (*Saldovy, 2001*). It is widely held that the reefs associated with the offshore islands function as a larval source for many areas in the South China Sea (*McManus, 1994*). It has also been suggested that the Spratley Islands are a likely source of the seed collected for lobster culture along the central coast of Vietnam (*Williams, 2004*). In recent years, the value of this industry has been estimated at 50-60 million USD per annum. Seed harvesters have captured in excess of 1 million pueruli (first post-larval stage) in some years, which are sold to dealers for up to 10 USD/individual, depending on the species and current demand for seed from farmers.

1.2. Forest ecosystems in Vietnam contribute to the socio-economy through payment for forest environmental services

Payment for forest environmental services is a breakthrough policy in the forestry sector in Vietnam. After 10 years of implementation, this policy has achieved considerable successes in economic, social, and environmental aspects and has been recognized as one of the greatest achievements of the forestry sector from 2011-2015 (*MARD, 2017*). PFES revenue currently accounts for 18.5% of the total annual investment of the whole society in the forestry sector.

Under this policy, forest environmental service beneficiaries are requested to pay the relevant forest environmental service providers. Decree no.99/2010/ND-CP defines five types of forest environmental services entitled to payments: (i) soil protection, restriction of erosion and sedimentation of reservoirs, rivers and streams; (ii) regulation and maintenance of water sources for production and social life; (iii) carbon sequestration and retention and reduction of GHG emissions by preventing forest degeneration and forest area decrease and developing forests in a sustainable manner; (iv) protection of natural landscape and conservation of

biodiversity of ecosystems for tourism services; and (v) provision of spawning grounds, sources of feed and natural seeds and use of water from forests for aquaculture. It also identifies PFES payers, including hydropower plants, water supply companies, industrial production facilities, tourism providers and those liable to pay for the forest environmental services of carbon sequestration and aquaculture production support.

From 2011-2017, only two of the five identified forest environmental services (watershed protection and water regulation for daily use and production) have been accounted for in payments. These services were paid because of the Government provided detailed regulations on payment level and payment mode. For example, hydropower plants must pay forest owners at a rate of 36 VND per kilowatt-hour of commercial electricity, which was recently increased from 20 VND per kilowatt-hour. Additionally, producers/suppliers of clean water must pay forest owners 53 VND per m^3, which has recently increased from the initial rate of 40 VND per m^3.

Regulating PFES for the remaining three types of forest environmental services (carbon sequestration, natural landscape protection and aquaculture production support) has been assigned to MARD by the Government. MARD is to lead and coordinate the development of guidance on implementation with relevant ministries and agencies. Over the past 5 years (from 2012-2017), with the technical and financial support of ADB/PFES, USAID/VFD and USAID/Green Annamites projects, MARD has actively undertaken studies and piloted PFES mechanisms in new areas such as industrial production, aquaculture production and tourism in Lao Cai, Thanh Hoa, Nghe An, Ha Tinh, Thua Thien Hue and Quang Nam provinces. Although these pilot programs are still in early stages and have not yet been evaluated, there are many positive signs indicating the possibility of expanding PFES to new areas nationwide in the near future (*Ha et al., 2018*).

By the end of 2020, three out of the five types of PFES have generated payments, including: (i) soil protection and erosion control services; (ii) services for regulating and maintaining water sources for production; and (iii) natural landscape protection and biodiversity conservation services for tourism. Two out of five types of PFES have still not yet yielded payments, including: (i) storing and absorbing carbon and (ii) providing spawning grounds, food sources, natural seed, and water sources for aquaculture activities. However, according to the evaluation report of the Vietnam Forest and Delta Program Project (VFD) (2021), the policy of payment for forest environmental services has recorded many remarkable achievements.

Since its implementation, PFES mechanism has generated a total revenue of 16,746 billion VND (equivalent to 728.09 million USD) or 1,674 billion VND/year on average (equivalent to 72.78 million USD/year on average), equivalent to 95.3% of the total state budget and 18.5% of social budget for forestry sector. These figures grew quickly and then stablised over 2018-2020, providing a sustainable funding source for forest protection and development in Vietnam, and greatly contributing to the reduction of presure on the state budget

Figure 21 below presents PFES revenues collected from forest environmental service users by year from 2011-2020 (Unit: billion VND)

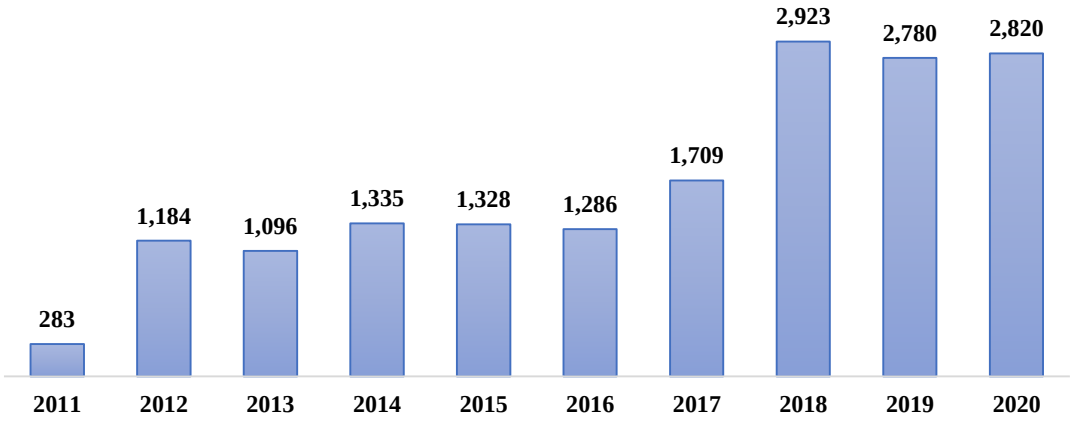


Figure 21. Revenue generated through PFES during 2011-2020

(Source: VFD, 2021)

From the environmental aspect, PFES revenue has supported to the management and protection of over 6.50 million ha of forests (equivalent to 45% of total forest area of the country), helping to maintain forest cover, improving forest quality and the ecological environment, and mitigating negative impacts caused by climate change.

From the social aspect, PFES revenue has been paid to more than 250,000 households (with an average amount that accounts for 15% of the total household's income) and 10,000 communities (with an average amount of 50 million VND/community/year, equivalent to 2,174 USD/community/year), contributing to raising incomes for forestry workers, especially for ethnic minority communities living in remote mountainous areas. In addition, PFES policy has created jobs and positive changes in the awareness and responsibility of stakeholders towards forest protection and management.

According to a recent study implemented by VFD, the PFES policy will still be an important policy in the period of 2021-2030. The expected PFES revenues are 3,500 billion VND (equivalent to 152.17 million USD) in 2025 and over 4,000 billion VND (equivalent to 173.91 million USD) in 2030 (equivalent to 30-35% of social investment in the forestry sector). Approximately, 300,000 individuals and households will be paid at the rate that is equivalent to 20% of their total income, and 7 million ha of forests will be managed and protected.

According to the Vietnam Administration of Forestry (VNFOREST), MARD, in 2019 alone, the whole country collected 2,780 billion VND of PFES to pay support in the management and protection of 6.3 million ha of forests, accounting for 43% of the total forest area nationwide, helping to maintain forest cover, improve forest quality, gradually improve the ecological environment, and mitigate impacts caused by climate change.

According to the thematic report "Summary of 10 years implementation of PFES policy in the period 2011-2020 and development orientation in the period of 2021-2030" carried out by Winrock International (2021), PFES has always been and will be an extremely important policy of the forestry sector. However, this policy has some shortcomings and limitations as follows: (i) PFES potential has not been fully realised, especially in the areas of ecotourism, aquaculture and carbon sequestration; (ii) the direct payment mode is limited because there are too many service providers; (iii) there has been a large difference in payment levels among different watersheds, localities, communities and households; (iv) PFES income is still low; (v) awareness of PFES and the forest protection fund is limited and inconsistent; and (vi) some regulations are still unclear and inappropriate, making them difficult to apply, especially those related to the monitoring and evaluation system to adjust the quality of paid services.

Overall, although PFES policy is not fully implemented, its contributions to forest management and development (especially when the Government budget to fund forest protection and conservation activities has declined) as well as poverty reduction and sustainable development throughout the country, particularly in the forestry sector, are significant.

II. VALUATION STUDIES ON ECOSYSTEM SERVICES IN VIETNAM

2.1. An overview on valuation studies on ecosystem services in Vietnam

Ecosystem services contribute substantially to human welfare and in some cases are fundamental to sustaining life (e.g. climate regulation, nutrient recycling). The natural resources from which these services flow are, however, finite and cannot necessarily be regenerated or replaced. With growing human populations and consumption per capita increasing over time, it is highly likely that human use of natural resources will surpass their availability - current human consumption of environmental services is unsustainable. These simple realities of resource limitation mean that choices have to be made between alternative uses of available resources; every time a decision is made to do one thing, this is also a decision to not do something else. In other words, we are implicitly placing values on each option. This valuation is unavoidable and is the essence of decision making. So if valuation of alternative resource uses is unavoidable in making decisions, it is arguably better to make these values explicit and ensure that they are well-informed in order to aid decision making. The economic valuation of natural resources and ecosystem services attempts to do this.

The economic value of ecosystem services is a quantitative measure of the contribution of these services to human well-being (*Pascual et al., 2010*). Economic values for ecosystem services are generally expressed in monetary units so they can be directly compared with other economic values in decision-making processes. In market-based economies, economic values for goods and services are conventionally observed as market prices that reflect the benefits of consumption (demand) and the costs of production (supply). For most ecosystem services, however, markets do not exist due to their open-access nature so economic values are not readily observable. In such cases, economic values can be estimated using non-market valuation methods.

The concept of total economic value (TEV) of an ecosystem is used to describe the comprehensive set of utilitarian values derived from that ecosystem. This concept is useful for identifying the different types of value that may be derived from an ecosystem. TEV comprises of use values and non-use values. Use values are the benefits that are derived from some physical use of the resource; direct use values may derive from on-site extraction of resources (e.g. fuel wood) or non-consumptive activities (e.g. recreation); indirect use values are derived from off-site services that are related to the resource (e.g. downstream flood control, climate regulation); option value is the value that people place on maintaining the option to use an ecosystem resource in the future; and non-use values are derived from the knowledge that an ecosystem is maintained without regard for any current or future personal use. Non-use values may be related to altruism (maintaining an ecosystem for others or for animals), bequest (for future generations) and existence (preservation unrelated to any use) motivations. The constituent values of TEV are represented in figure 22.

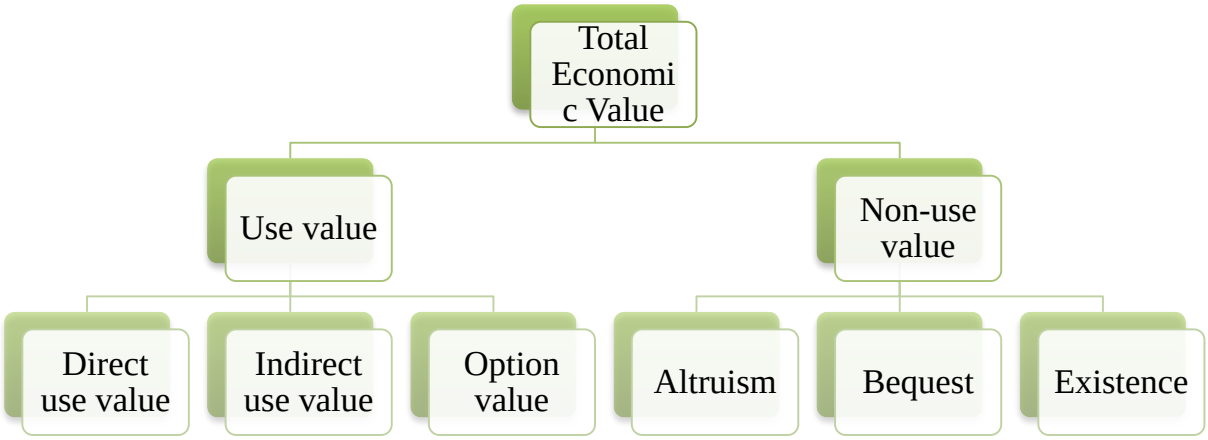


Figure 22. The components of total economic value

(Source: Brander, 2013)

The classification of different types of economic value within the concept of TEV is complementary to the classification of ecosystem services. Table 18 sets out the correspondence between categories of ecosystem services and components of TEV.

Table 18. Correspondence between ecosystem services and components of total economic value

Ecosystem services	Total economic value			
	Direct use	Indirect use	Option value	Non-use
Provisioning	X		X	
Regulating		X	X	
Cultural	X		X	X

(Source: Brander, 2013)

Valuing ecosystem services is not a new concept in Vietnam. The very first valuation studies were undertaken in the late 1990s, focusing on goods and services provided by the mangrove ecosystems in Nam Dinh province and Ho Chi Minh City. Shortly afterward, valuation of ecosystem services had attracted attention from government officials and scholars.

In addition to early ecosystem service evaluation studies focused on mangrove ecosystems in Nam Dinh and Can Gio (Ho Chi Minh City) by Nguyen Hoang Tri et al. (1996, 2000), Nguyen Duc Thanh (1996) studied the ecotourism value of Cuc Phuong NP, and Pham Khanh Nam (2003) estimated ecotourism values of Hon Mun Nature Reserve (now Nha Trang Bay NP).

In the early 2000s, the Department of Science, Technology and Environment (DOSTE) of several provinces started to explore the values of their important ecosystem services. DOSTE of Hai Phong city attempted to estimate the value of rare fruit and medicinal resources from mangroves; DOSTE of Khanh Hoa province conducted a study on the value of recreational services provided by coral reef ecosystems; and DOSTE of Thai Binh province compared the values of intact mangroves and degraded mangroves, etc.

During the mid-2000s and mid-2010s, MARD deployed a series of studies to estimate the economic values of goods and services provided by terrestrial forests (both plantations and

natural forests) and mangroves inthe country's main ecologicial regions, providing inputs to establish forestry policies. For example, from 2005-2007, the Forest Science Institute of Vietnam (now known as the Vietnamese Academy of Forest Sciences) carried out a ministerial-level study to assess the economic value of goods (i.e. timber, fuelwood and other non-timber products) and services (i.e. watershed protection, coastal protection, carbon sequestration and recreational values) of plantations and natural forests of different forest types in Northern, Central and Southern regions of Vietnam. The study assisted MARD and Provincial People's Committees in identifying forest use levies for when the State allocates forests, calculating forest rents when bidding processes are not used, calculating compensation payments when the State recovers forest areas and calculating monetary compensation for damage caused by persons who violate the Law on Forest Protection and Development (*Vu Tan Phuong et al., 2007*). MARD has continuously facilitated valuation studies for forest ecosystem services used in industrial production, tourism, aquaculture, and other sectors, serving the development of policy surrounding payments for forest ecosystem services (*Fenn & Ha, 2017*).

Also in this period, Nguyen Minh Huyen et al. (2010) and Nguyen Quang Hung et al. (2013) estimated the economic value of mangrove ecosystems in Quang Ninh, Hai Phong, Nghe An and Ca Mau provinces.

In 2013, the value of goods and services of Bidoup-Nui Ba NP in Lam Dong province was estimated. Tran Dinh Lan et al. (2015) estimated the value of groups of goods and services of the marine ecosystems of Bach Long Vi, Con Co and Tho Chu archipelagoes.

Along with MARD, MONRE and the Ministry of Science and Technology (MOST) have also facilitated valuation studies for wetland and marine ecosystem services. Within the framework of the MONRE/UNDP/GEF project "Conservation of Critical Wetland Protected Areas and Linked Landscapes", a valuation study was used to estimate the economic values of wetland ecosystem services for two planned wetland conservation areas in Thai Thuy district (Thai Binh province) and Tam Giang - Cau Hai lagoon (Thua Thien Hue province). The result showed that 13,100 ha of wetland in Thai Thuy district generated an annual economic value of 23.06 million USD, while Thua Thien Hue's lagoon provided a value of nearly 6 million USD (*ISPONRE, 2017*). Meanwhile, Tran Dinh Lan et al. (2016) also attempted to assess economic values of marine ecosystem services around select islands in Vietnam through a national-level study, providing inputs for building long-term socio-economic development plans for sustainable use and management of natural ecosystems on these islands. The study showed that the total economic value of marine ecosystems fluctuated between 267.50 billion VND (equivalent to 12 million USD) to 599 billion VND (equivalent to 26.62 million USD).

By the end of 2017, there have been hundreds of studies evaluating ecosystem services across the country conducted by institutes and international organizations. The quality of the evaluation studies has been greatly improved by adopting standardized evaluation methods at an international level as well as the use of updated input information.

Most studies on the economic value of ecosystem services in Vietnam often focus on terrestrial natural forest and mangrove ecosystems. Some studies of the on economic values of a number of other important coastal ecosystems such as coral reefs and seagrass beds have also been undertaken. Other ecosystems such as inland wetlands, lagoons and coastal bays have had little research on the evaluation of ecosystem services. Especially, the ecosystem services for offshore islands, mainland slopes and deep sea areas have not been studied (*MONRE, 2019*). Figure 23 below presents some of the most outstanding valuation studies on ecosystem service in Vietnam from 2000-2017. Several studies are also discussed in greater detail below in section 2.2.

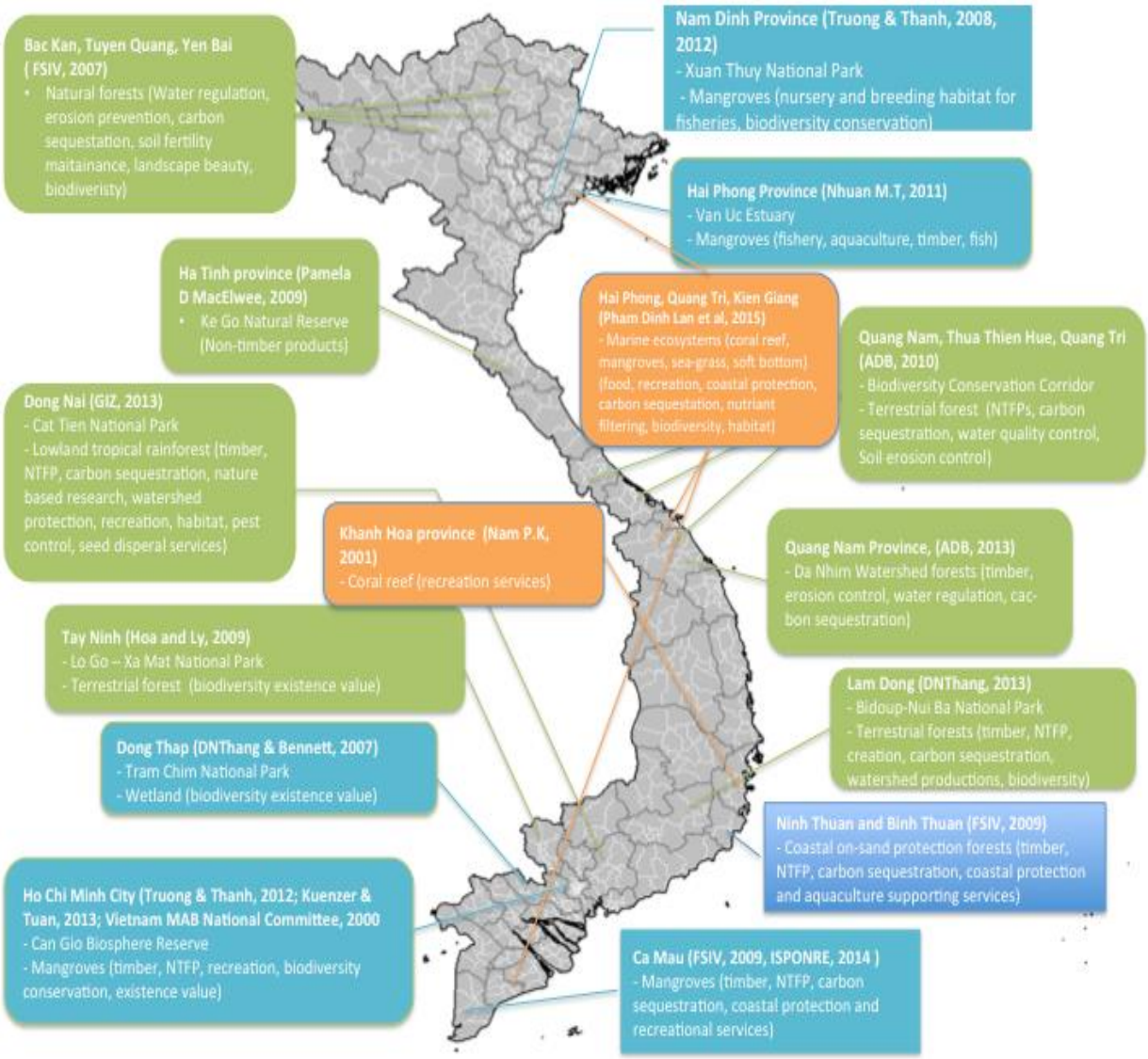


Figure 23. Ecosystem service valuation studies in Vietnam

(Source: Mark Fenn and Tran Thi Thu Ha, 2017)

2.2. Case studies on the economic values of ecosystem services in Vietnam

2.2.1. Economic values of forest ecosystem services

Cat Tien NP is located in the South of Vietnam, approximately 150 km North of Ho Chi Minh City, and is known as a World Biosphere Reserve. It has an area of about 72,000 ha and comprises of a highly biodiverse area of lowland tropical rainforest. The park faces intense pressures from resource exploitation, land conversion and infrastructure development in both core and buffer zones.

The study on the economic value of Cat Tien NP was carried out under the GIZ project "ValuES: Methods for integrating ecosystem services into decision-making" and the GIZ/MARD project "Conservation of Biodiversity in Forest Ecosystems in Viet Nam". The study aimed to assess the economic value of conserving biodiversity and ecosystems in Cat Tien NP, assisting MARD and other stakeholders to justify biodiversity and ecosystem conservation as an economically beneficial use of public lands, resources and funds. It focused on the following key ecosystem services, for which sufficient data were available to enable valuation: wood and non-wood forest products; water flow and quality regulation; carbon sequestration; pollination and seed dispersal; and nature-based tourism, recreation and education.

Different valuation methods were applied in this study. Market prices and surrogate prices were used for estimating values of wild foods, fibers and medicinal products, wood-based energy and timber, cultivated food and cash crops, carbon sequestration, and nature-based recreation and education services. Meanwhile, benefit transfer, replacement costs and damage costs avoided were selected for calculating economic values of watershed protection, hydrological services and recreational services. Finally, effects on production were used to value habitat for key fauna and pollination, pest control and seed dispersal services.

The study found that Cat Tien NP's ecosystem services generated economic goods and services worth 1,091 billion VND (equivalent to 51.60 million USD) in 2012. A detailed breakdown of the economic values of key forest ecosystem services is summarized in table 19 below:

Table 19. Economic value of forest ecosystem services of Cat Tien National Park

Ecosystem service	**Billion VND**	**Million USD**
Wood products	8.79	0.42
Plant-based non-timber forest products	34.4	1.63
Animal-based non-timber forest products	15.45	0.73
Water flow & quality regulation	536.01	25.34
Carbon sequestration	175.54	8.30
Pollination and seed dispersal	304.16	14.38
Nature-based recreation and education	16.33	0.77
Total	**1,091**	**51.60**

(Source: Emerton et al., 2014)

The study results also showed that direct income generated from the utilization of forest land and resources accounted for only around 6% of this value. By far the largest share, almost two thirds, came from regulating and supporting services that help other sectors to avoid costs and damages (i.e. through the protection of settlements, farms, infrastructure and other production processes as well as via the mitigation of climate change). Just over a quarter of the total value is accounted for by the value added by ecosystem services to production in other sectors, most notably agriculture and tourism.

In addition, in the absence of Cat Tien NP and its associated conservation management regime, it is likely that agricultural land uses (particularly perennial tree crops) would expand to fill the area that it currently occupies. Natural forests, shrublands, grasslands and wetlands are gradually being converted to farmland. At the same time, infrastructure and housing are expanding in response to the increase in human population and spread of farming into the area that is currently the core zone of Cat Tien NP. These land use and land cover changes impact the provision of ecosystem services. It is likely that intensifying human demands on land and natural resources will result, initially, in an intensification of ecosystem use. However, over time, the value derived from ecosystems will decrease and flatten out as ecosystems are progressively converted and degraded and the ability of the Cat Tien NP landscape to provide key goods and services is eroded. The cumulative losses and ecosystem values foregone if biodiversity and ecosystems are not protected in Cat Tien NP is estimated to be more than 2,255 billion VND (equivalent to 107 million USD) over the next 25 years.

2.2.2. Economic values of wetland ecosystem services

Xuan Thuy NP, located in Giao Thuy district, Nam Dinh province, is the first wetland area in Southeast Asia to be recognized as a Ramsar site and as an internationally significant migratory bird habitat. With a total area of 15,100 ha, the park is home to over 100 species of migratory birds and 215 species of resident birds. The Park's water is a habitat for approximately 500 species of sea creatures, including crab, shrimp and fish. Moreover, the Park contains a huge number of medical and edible plants, including rare and precious species of algae and seaweed.

Truong (2010) undertook a study to assess the partial and total economic values of wetland ecosystem services, providing inputs for wetland management. The study attempted to apply advanced valuation methods and procedures to estimate values of both direct and in-direct use values as well as non-use values of goods and services provided by the wetland area in Xuan Thuy NP. The study results are summarized in table 20 below:

Table 20. Economic values of goods and services provided by the wetland ecosystems in Xuan Thuy National Park

No.	Ecosystem service	Economic value (VND million/ year)	Economic value (USD/ year)	Economic value (VND million/ha/ year)	Economic value (USD/ha/ year)	Share of economic value of service in the total value
DIRECT USE VALUE						
1	Shrimp cultivation support	7,388	369,400	4.20	210	7.42
2	Clam cultivation support	38,100	1,905,000	84.00	4200	42.5
3	Clam larvae supply	12,000	600,000	60.00	3000	13.4
4	Crab cultivation support	7,000	350,000	11.60	580	7.81
5	Seaweed supply	3,600	180,000	6.00	300	4.02
6	Honey	2,100	105,000	0.60	30	2.34
7	Aquatic products supply in the core zone	9,100	455,000	2.90	145	10.20
8	Recreation	2,421				2.70
Total use value		**81,710**	**4,090,000**			**90.40**
NON-DIRECT USE VALUE						
1	Aquaculture production support	3,071	153,550	16.60	830	3.43
2	Coastal protection service	1,520	76,000	0.49	24.5	1.70
3	Carbon sequestration	1,920	96,000	0.62	31	2.15
Total non-direct use value		**6,510**	**325,550**			**7.28**
NON-USE VALUE						
1	Biodiversity conservation	399	19,950			0.45

(Source: Adapted from Truong, 2010)

2.2.3. Economic values for marine and coastal ecosystem services

Bach Long Vi, located in the North region (Hai Phong city); Con Co, located in the Central region (Quang Tri province); and Tho Chu, located in the south region (Kien Giang province) are three of the most ecologically important islands in Vietnam. These regions have typical

and unique marine and coastal ecosystems including mangroves, coral reefs, seagrass beds, and soft bottom habitats.

In a state-level research project, Tran Dinh Lan et al. (2015) examined the economic values of marine ecosystems in Bach Long Vi, Con Co, and Tho Chu Islands. The values of these marine ecosystems are both direct (e.g. fisheries, recreation) and indirect (e.g. storm protection, carbon sequestration, nutrient filtration, habitat provision), and include non-use value (e.g. cultural, conservation).

Secondary data and information on biological, non-biological, and environmental resources as well as primary data and information collected from a survey of 800 households on capture and aquaculture fisheries were used for the valuation analysis. Table 21 below summarizes the valuation methods and key findings of the study.

Table 21. Economic values of ecosystem services of Bach Long Vi, Con Co and Tho Chu islands

Value type	Ecosystem	Ecosystem service	Valuation method	Value (VND million/year)		
				Bach Long Vi	Con Co	Tho Chu
Direct use value	Tidal ecosystem	Food (fish, crab, shrimp, clam)	Market price	309	6,399	5,742
	Coral reef and soft bed ecosystem	Food (fish, crab, shrimp, clam)	Market price	378,341	144,994	324,978
	Marine ecosystem as a whole (including tidal and coral reef and soft bed ecosystems)	Recreation (tourism)	Travel cost method (zonal approach)	11,750	14,980	24,600
Indirect use value	Coral reef and soft bed ecosystem	Storm protection, soil erosion prevention	Avoided cost from sea dike construction to protect the island	17,236	23,012	44,108
	Marine ecosystem as a whole (including tidal and coral reef and soft bed ecosystems)	Carbon sequestration	Market price (carbon credit price)	107	12	3.34
		Nutrient filter	Cost of water treatment/ Avoided cost from water pollution treatment	113,595	45,418	99,216
		Biodiversity, breeding ground, habitat	Benefit transfer (Alan White, 1998)/ Contingent valuation	75,730	30,279	66,144
Non-use value	Marine ecosystem as a whole (including tidal, coral reef and soft bed ecosystems)	Non-use value, option value, and bequest value	Contingent valuation	1,950	2,425	444

(Source: Tran Dinh Lan et al., 2015)

Tran Dinh Lan et al. identified: the total economic value of marine ecosystems services around selected islands in Vietnam was estimated to fluctuate between 267.5 billion VND (equivalent to 12 million USD) to 599 billion VND (equivalent to 26.62 million USD). The total economic value of marine ecosystems in the island Bach Long Vi island (Hai Phong city) was estimated to reach 599 billion VND/year (equivalent to 26.62 million USD/year), with an average of 94 million VND/ha/year (equivalent to 4,200 USD/ha/year); in Con Co island (Quang Tri province) it reached 267.50 billion VND/year (equivalent to 12 million USD/year), with an average of 307 million VND/ha/year (equivalent to 13,650 USD/ha/year);

and in Tho Chu island (Kien Giang province) it reached 565.20 billion VND/year (equivalent to 25 million USD/year), with an average of 125.47 million VND/ha/year (equivalent to 5,576 USD/ha/year).

Other key findings include:

- The total economic value of marine ecosystem services ranged from 94 million VND to 307 million VND (equivalent to 4,200 USD to 13,650 USD)/ha/year;
- Direct use value accounts for 62.1 to 65.8% of the total economic value of marine ecosystems, followed by indirect use value (34.5 to 37.1%) and non-use value (0.08 to 1%);
- The economic value of Vietnam's marine ecosystems was rather low in comparison to other Asian countries (e.g. the Philippines, Indonesia) and other regions in the world (e.g. Bermuda, Virgin Islands, Guam).

What is not included is the economic value that could be lost in the future due to climate change and overfishing. Quach Thi Khanh Ngoc (2015) estimated the percentage changes in coral cover by 2065 given sea surface temperature rise and overfishing and projects that the total annual losses in tourism could be 11.59 million USD to 15.20 million USD and 0.35 million USD to 0.96 million USD in fisheries and aquaculture. The projected combined losses from both climate change and overfishing in four possible scenarios range from 27.78 million USD to 31.72 million USD annually (shown in figure 24).

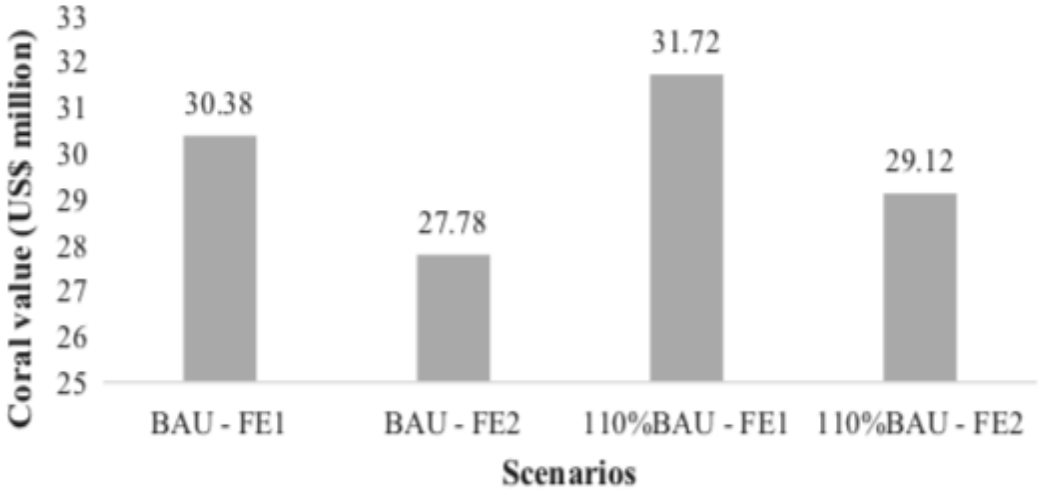


Figure 24. The loss in coral reef value under combined scenarios of sea surface temperature and fishing effort in 2065

(Source: Quach Thi Khanh Ngoc, 2015)

III. TRENDS OF ECOSYSTEM SERVICES

3.1. Ecosystems are changing and being degraded

Most of Vietnam's important ecosystems such as primary/natural forests, wetlands, coral reefs, seagrass beds, etc. have been reduced in area and become degraded while biodiversity levels have decreased, threatened species have increased, and the number of individuals of endangered species has decreased with some species not being seen for a long time. According to MA (2005), over the past 50 years, humans have changed their ecosystems faster and more broadly than at any time in human history, largely with the intention of meeting the rapidly growing demand for food, soft drinks, wood, fiber and fuel. In addition, global climate change also strongly impacts on ecosystems.

3.2. Ecosystem services are tending to decline

In Vietnam, population growth leads to increased demand for resources and energy, leading to increased resource exploitation activities. Some economic sectors such as agriculture, industry and trade, and tourism tend to increase production in order to meet the increasing needs of people. The increasing demand for valuable products of provisioning services leads to the decline in other ecosystem services. The MA (2005) showed that only 4 out of 24 ecosystem services tested in this assessment had growth: crop, livestock, aquaculture (in the recent decades) and carbon sequestration, while another 15 services have been degraded. According to report of IPBES (2019), since 1970, trends in agricultural production, fish harvest, bioenergy production and harvest of materials have increased, but 14 of the 18 categories of contributions of nature that were assessed, mostly regulating and non-material services of ecosystems, have declined. Especially, human infectious diseases such as the pandemic caused by Corona virus since late 2019 have not been controlled.

This can be seen as the downside of achieving a significant high level of development of a number of economic sectors in Vietnam over the years, such as agriculture, forestry, fisheries, tourism and mining, which have made trade-offs with ecosystem degradation, biodiversity degradation, and consequently, degradation of ecosystem services. This shows overexploitation of biological and non-biological resources. The declining trends suggest over-exploitation of biological and non-biological resources; combining these human use factors with the rapid manifestation of climate change impacts leads to declining ecosystem services.

IV. PUBLIC AWARENESS ON BENEFITS OF ECOSYSTEM SERVICES

In Vietnam, management agencies from central to local levels, ecosystems have been mainly seen as biodiversity with their main value coming from biological resources (e.g. tree and animal resources) and along with precious and rare genetic resources. Even in laws on biodiversity in Vietnam, the concept of *ecosystem services* has not been mentioned.

From the above-mentioned biodiversity approach, the common perception of society about the contribution of ecosystem services to the national economy and human welfare can be said to be superficial. For some local leaders, biodiversity conservation is a notion of luxury, or even an obstacle to socio-economic development.

4.1. Public awareness on benefits of forest ecosystems

In Vietnam, forests are considered to be one of the most important ecosystems in terms of their contributions to human well-being and the economy. They are also the most studied key ecosystem in Vietnam. However, there are still gaps in the existing studies on the contributions of forest ecosystems to human well-being and the economy. First, most of the existing studies in Vietnam have focused on direct values (e.g. timber, firewood, non-timber forest products, tourism) of terrestrial natural forests and pay less attention to other values or services of these ecosystems (e.g. watershed protection, water regulation, climate regulation). Second, many ecosystem studies have been repeated in the same national parks and reserves (i.e. Biduoup-Nui Ba NP, Cat Tien NP, Phong Nha - Ke Bang NP, and Kon Ka Kinh NP) and many important forest ecosystems in other locations have not been sufficiently considered. In addition, most of the ecosystem and ecosystem service studies have been conducted at a small scale. Therefore, the existing information on ecosystems and their services is fragmented, unrepresentative and cannot be easily transferred from one context to another when needed. Finally, findings on the contributions of forest ecosystems to human well-being and the economy are not seriously considered or included in decision-making processes relevant to the management and use of forest resources, leading to large-scale forest land conversion in many localities.

4.2. Public awareness on benefits of wetland ecosystems

Studies on the contributions of wetland ecosystems also focus on the ecosystem services of some coastal wetlands (e.g. Xuan Thuy NP, Tram Chim NP and Ca Mau Cape NP). The contributions of inland freshwater ecosystems (including rivers and marshes) have been largely neglected. This is one of the main causes of the limitation in social awareness and knowledge on the importance of these ecosystems to human well-being and Vietnam's economy.

4.3. Public awareness on benefits of marine and coastal ecosystems

Coral reefs

In May 2010, the Prime Minister approved the *Planning the system of Vietnam's marine protected areas till 2020* with the target of establishing 16 MPAs covering an area of 270,271 ha, of which 169,617 ha is marine area covering 57% of all known coral reefs in Vietnam's coastal waters (*Japan Wildlife Research Center, 2014*). Results from monitoring activities via MPA monitoring and evaluation have positively contributed to the enhancement of managing coral reefs. Therefore, continuing these activities is essential to engaging the public and increasing public awareness.

Despite the release of many studies on coral reefs in Vietnam over the years, the understanding of coral reefs is still limited. Most studies have focused on coral reef taxonomy, while a few have focused on the quantitative linkages between the impacts of human-influenced reduction of ecosystem service quality that directly contribute to human well-being. The linkages between ecosystem services and human well-being can be understood as the consequences of negative impacts from human-driven activities. In fact, poor people (namely fishermen) will be most affected due to loss of capital resources and their lack of technical skills needed to change livelihoods, unless further action is taken.

Examples of actions which can engage the public and decrease the gap in knowledge include doing reef checks in combination with international and local indicators to monitor coral reef species richness, diversity, health, and ways they contribute to key ecosystem services (*Japan Wildlife Research Center, 2014)*. With appropriate support, infrastructure, and funding, developing a monitoring MPA network of programs in Vietnam should be considered as a method of employing and engaging a greater range of people in the community.

Co-management in MPAs is also an effective way to protect marine and coastal ecosystems and their ecosystem services. On July 13, 2013, the People's Committee of Quang Nam Province issued Decision no.20/QD-UBND, a regulation on co-management in aquatic resource protection in Bai Huong Sub-MPA of Cu Lao Cham. The Decision assigned an area of 19.05km^2 to the Bai Huong village community for management and protection. As of 2019, coral reef coverage in Bai Huong has increased from 3.13% to 35% (though the density of indicator organisms has neither increased nor decreased); there are abundant seaweed beds (though still a decline in seagrass beds); and the economic structure of the community has changed, with services and tourism accounting for 55% of income. A major indicator of management in Bai Huong Sub-MPA of Cu Lao Cham is communication and awareness raising. The Sub-MPA Management Board regularly communicates conservation-related content through a loudspeaker system and broadcasts articles on the radio; members from the community are involved in patrols; and the local community participates in management decisions in this community-based management approach (*MCD, 2019*).

Seagrass beds

There are few studies on the relationship between trend dynamics in the link between ecosystem services of seagrass bed ecosystems and poverty alleviation. Researchers have different focuses when studying coastal ecosystems; they neither integrate natural and social

science perspectives nor explain the relationship between the two. Also, indirect factors that come from ecosystem services such as mitigation of climate change through absorption of CO_2 in the seawater or shoreline protection values are overlooked.

Lagoons

There are no direct studies done at the local level that highlight the linkages between the reduction of ESs (e.g. typhoons, floods) and the poverty conditions of fishing communities in the coastal lagoons of Vietnam.

Mangrove forests and coastal tidal flats

There is a lack of quantitative data to demonstrate the linkages between poverty alleviation and mangrove ecosystems in Vietnam. Open access to natural resources and privatization of coastal areas results in an increasing gap between the poor and rich, an increasing gap between women and men, a regeneration of social conflicts between economic sectors, and an increasing gap between different scales such as regional-local long-term and short-term development. The issues of tradeoffs and appropriate measures to ensure sustainable development and poverty alleviation are not discussed adequately; therefore, it is necessary to conduct studies on poverty alleviation and tradeoffs for sustainable development in Vietnam's mangrove areas. In a study done in Rang Dang town, Nghia Hung district, Nam Dinh province, cultivation groups' exposure to natural disasters, especially storms and saltwater intrusion, is relatively high. Therefore proper training is needed to inform people of how to best adapt to these situations. Peoples' awareness about climate change in Rang Dong town is at level of general knowledge and they do not have a clear understanding of what climate change is. Some people understand that the climate is changing due to natural variation and they have heard about climate change mainly through television. In fact, the mass media are very influential tools for widening public awareness of environmental issues (*Cong et al., 2016*).

PART IV. DRIVERS AND PRESSURES TO CHANGES IN ECOSYSTEM SERVICES AND ITS IMPACTS ON THE SOCIO-ECONOMY

Key Findings

1. Seven factors as drivers of change in the status and trends of ecosystems affecting their services were identified by Vietnam's national ecosystem assessment

According to Grant et al. (2008) and MA (2005), drivers are exogenous factors, human-induced factors in an ecosystem. Therefore, the drivers of change in the status and trends of ecosystems services in Vietnam NEA include demographic changes resulting in an increased need for resources; economic development; the overlap of functions and management of biodiversity among relevant agencies; policy and governance of biodiversity conservation; communication, awareness and education; science and technology developed; and limited resources for biodiversity conservation/investment. Drivers are fundamental factors that create pressures affecting the ability of the ecosystems to provide other products and services: e.g. according to Vietnam's voluntary national review on the implementation of the sustainable development goals (2018), as of June 2017, the proportion of urban population supplied with water through centralized water supply systems was estimated at about 84.5% (an increase of 1% compared to the end of 2016); the adjusted Electricity Planning VII, approved by the Government in March 2016, total power production in 2015 was 159 billion kWh, in 2020 it was forecasted to be 265 billion, in 2025, 400 billion, and in 2030, 572 billion kWh; inadequate coordination between MONRE and line ministries; the inconsistency in policy documents; over-use pesticides and uncontrolled, excessive agricultural intensification leaves a lot of consequences for the environment and public health such as soil degradation; etc.

2. Five factors as pressures to change in the status and trends of ecosystems affecting their services were identified by Vietnam's national ecosystem assessment

According to Grant et al. (2008), pressures are endogenous factors. The pressures are resulting from the key underlying drivers. Pressures to change the status and trends of ecosystem services in Vietnam NEA include land/waters conversion includes infrastructure development without proper scientific basis; illegal and excessive exploitation of biological resources and illegal trade in wild animals and their products are tending to increase; environmental pollution; climate change; and the introduction of invasive alien species. These pressures degrade terrestrial and aquatic ecosystems and degrade biodiversity and thereby degrade ecosystem services: e.g. from 2003 to 2009, there were about 25,000 ha of forest land converted each year to other uses (*VNFOREST, 2010*); from 2006 to 2016, there were 2,991 projects, with 386,290 ha of forest transferred to other purposes, of which: natural forest was 300,120 ha (accounting for 78.0%), and planted forest was 86,170 ha (accounting for 22.0%) (*MARD, 2016*); in 2018 and 2019, the national forest protection force detected and handled 466 cases of violations of regulations governing the management and protection of endangered wildlife (in 2018 was 239 cases, in 2019 it was 227) (*DFP, 2020*); Vietnam is also seen as a transshipment country for the transboundary and transnational wildlife trade (*MARD, 2018*); the phenomenon of algal bloom, mainly blue-green algae (*Microcystis* spp.) exhausts dissolved oxygen in lakes in Hanoi city, killing many fish. Red tide phenomenon is increasing in coastal waters (*MONRE, 2019*); According to climate change and sea level rise scenarios for Vietnam (*MONRE, 2016*), a sea level rise of 100cm results in a corresponding risk of flooding of 78 out of 286 "critical habitats", 46 protected areas, 09 biodiversity areas of national and international value and 23 other biodiversity areas in Vietnam would be severely affected; etc.

3. The impact of changes in ecosystem services on the socio-economy shows a trade-off between increased production outputs and ecosystem degradation, leading to reduction in ecosystem services overall

The drivers and pressures on different scenarios affecting ecosystem services (provisioning capacity of ecosystem services), and changing in ecosystem services all have certain impacts on the socio-economy in Vietnam. In the recent decades, the drivers and pressures affecting ecosystem services,

that denote "positive" impacts registered as continuously increasing output, quantity or revenue of a number of economic sectors such as agriculture, fisheries, industry and trade, and tourism meeting the increasing needs of people.

The downside of achieving such economically significant figures is the trade-off in ecosystem degradation, biodiversity loss and consequent reduction in ecosystem services: e.g. natural forests area and seagrass beds area are reduced; coral reefs with lower coverage; endangered species with reduced number of individuals; the yield of natural seafood exploitation is critical; exploitation rates in some species, mainly in sea areas are high, signalling over-exploitation; environmental pollution, together with the unhealthy eating habits of a part of the population, have led to dangerous epidemics for humans at global level such as the SARS, respiratory syndrome epidemic in 2002-2003 and Covid-19 in 2019 to now; etc.

I. DRIVERS OF CHANGE IN THE STATUS AND TRENDS OF ECOSYSTEM SERVICES

Drivers of change in ecosystem services, as the term is used in the Millennium Ecosystem Assessment (2005), are human-induced factors that directly or indirectly cause a change (about structure, function and process) in an ecosystem. MA has distinguished direct and direct drivers. Accordingly, indirect drivers include factors: demography; economic development; technology change; social, cultural and political; energy use and production; increasing consumption trend. Direct drivers includes: greenhouse gas emissions; air pollution; risk of acidification and excess nitrogen loading from air pollution; climate change; sea level rise; land use changes; use of nitrogen fertilizer and nitrogen loads to rivers and coastal marine systems; and disruption of landscape by mining and fossil fuel extraction.

The difference between indirect and direct drivers is that the latter unequivocally influence ecosystem processes, while the former operate more diffusely, often by altering one of the more direct drivers.

When studying ecosystems, many authors have used the DPSIR framework (Driver- Pressure-State-Impact-Response) to describe changes between provision and demand for ecosystem services to assess the impact of environmental change drivers on the provision of ecosystem services. The DPSIR framework has evolved into an interdisciplinary tool for environmental analysis (*EEA, 1995*) and assumes a causal relationship between interactive components of social, economic and environmental systems. Ecosystem services under the DPSIR framework is described in figure 4 at Item III of Part I of this report.

From the figure, the driving force plays an important role in the DPSIR framework and the impact forming pressures on the status of the ecosystem and the trend of ecosystem services.

Or in a clearer way by Grant et al. (2008), the drivers are exogenous factors, including population, economy, society, technology etc., while pressures are endogenous factors such as physical, biological or chemical processes exemplified by environmental pollution, climate change, changes in land / waters use, invasive alien species, amongst others (figure 25).

The provision of ecosystem services is determined by different direct and indirect drivers that take place at the local to global level. Thus, the identification of drivers will change the state and trend of ecosystem services in general through determining the level of change of the status of ecosystems (structures, processes and functions of the ecosystem) and as the result, the ability to provide goods and ecosystem services (figure 25).

Experts believe that the integration of DPSIR with Social Ecosystems (SES) frameworks provides many advantages for managing ecosystem services as well as an appropriate approach to implementation and monitoring of adaptation strategies to reduce vulnerabilities (*Grant et al. 2008*). The indicator system of the DPSIR is well established and embedded in a number of policy decision-making organizations and institutions. Identification of suitable

indicators in the context of the appropriate spatial and temporal nature of the drivers and pressures on the SES will ensure that the system dynamics and response is adequately captured and that adaptation strategies to reduce vulnerabilities can be implemented and monitored (*Grant et al., 2008*).

From the above analysis, in the scope of this topic, it is possible to consider the drivers affecting ecosystem services as factors such as population development; economic development; overlap in organization of biodiversity conservation management; policy and governance, communication, awareness and education; science and technology; and limited conservation resources.

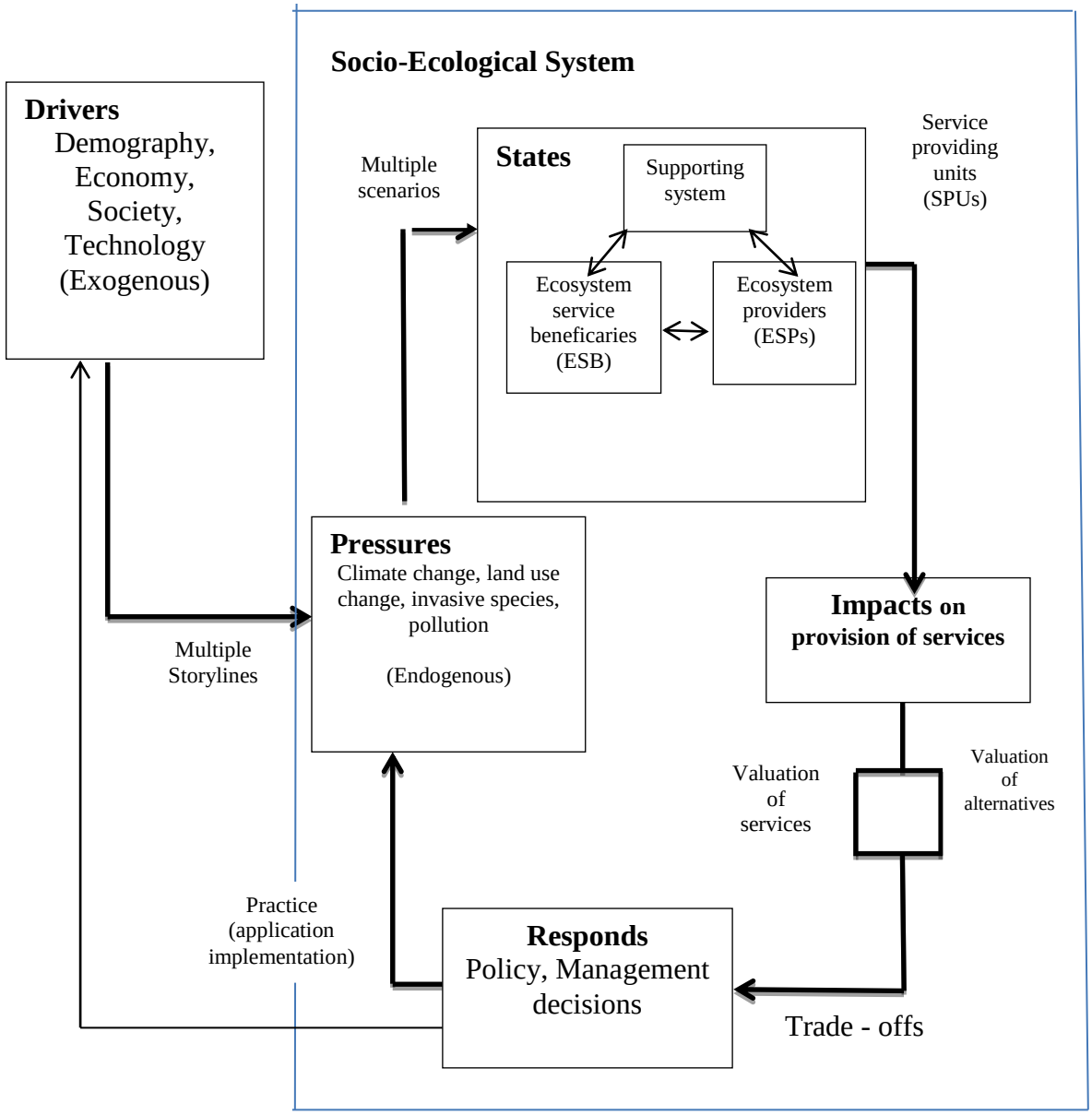


Figure 25. A proposed coupled DPSIR and SES framework for the assessment of the effects of drivers of environmental change on ESs

(*Source: Grant et al. 2008*)

1.1. Demographic changes have increased the need for resources

1.1.1. Population growth

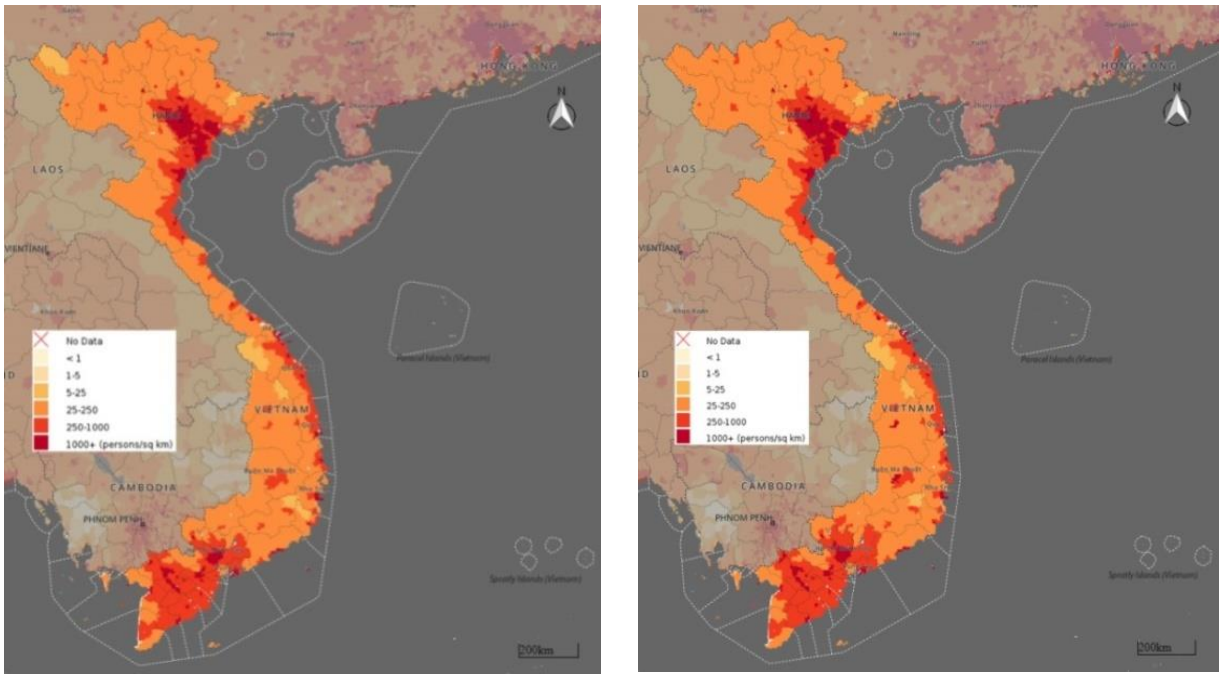
Change in population is important because it will influence the number and kind of consumers of ecosystem services. Furthermore, it will directly affect the amount of energy used, the

magnitude of air and water pollutant emissions, the amount of land required for production/residential areas, and the other direct drivers of ecosystem change. Population scenarios are developed on a regular basis by demographers at the United Nations and the International Institute for Applied Systems Analysis (*IIASA; Lutz et al., 2001*). Both groups also try to express the uncertainties of population projections, either giving more than one scenario (the United Nations) or probabilistic projections (*IIASA*).

In that context, there are different scenarios to predict population growth in Vietnam. According to the General Statistics Office of Vietnam (2016), Vietnam's population has increased from under 73 million in 1995 to over 96.48 million in 2019, making Vietnam one of the most populous countries in Asia, and creating an even greater demand for resource consumption as well as land use. The population of Vietnam in the final year of the forecast period, in 2049, is 108.5 million people according to the medium variant. With such population growth, the increasing demand for natural resources is considered to increase the unsustainable use of biological resources as well as ecosystem services, putting pressure on biodiversity conservation. Moreover, the majority of the population is concentrated mainly in the Northern Delta, the Southern Delta and the coastal areas in the central region (Figure 26). Most of the terrestrial protected areas are located in mountainous areas where many places are facing special difficulties, with a high poverty rate. That poses challenges for the management and protection of biodiversity and ecosystem services in protected areas.

Vietnam is ranked the 14th most populous country in the world. Vietnam's population density is 313 people/km^2. With a total land area of 310,060 km^2. (source: https://danso.org/viet-nam/). According to Nguyen Chu Hoi (2012), about one third of Vietnam's population lives in coastal districts (coastal areas and islands) and about 50% of the population lives in 28 coastal provinces and about 50% of the country's major cities are concentrated in this region. The population living in coastal cities is expected to double in the next 30 years. With these population growth and migration characteristics, and increasing living standards, increasing demand for high-value biological resources is seen as a factor in increasing resource exploitation and use as well as affecting other ecosystems services, putting pressure on biodiversity.

The National Office for Poverty Reduction (Ministry of Labor, Invalids and Social Affairs) indicated that by the end of 2018, the average rate of poor households nationwide decreased to about 5.35%. On average, the poverty rate in poor districts has decreased to less than 35%. Although the poverty rate has decreased, most terrestrial protected areas are in mountainous and forested areas where many places are particularly difficult, with a high percentage of poor households. This creates challenges for the management and protection of biodiversity and ecosystem services in protected areas.



2015 2020

Figure 26. Fluctuation of population density of Vietnam

(*Source: UNBiodiversityLab, 2018*)

1.1.2. Increasing demand for resource consumption

1.1.2.1. Increasing demand for land use for agriculture and aquaculture

The National Assembly's Resolution no.134/2016/QH13 on adjusting land use planning to 2020 and land use plan for the previous period (2016-2020) at the national level shows that the land area used for agriculture in general, and land for production forests and aquaculture in particular (artificial ecosystems) has been increasing gradually from 2015 to 2020, while the land area of protection forest is tending to decrease. This shows the need to increase land uses to meet the need to use wood and fishery resources for people consumption.

According to the report of the Directorate of Fisheries, aquaculture production in 2017 was estimated at 3,858 thousand tons, up 5.5% compared to 2016 and the water area used for aquaculture was 1.10 million ha, exceeded the target of the National Assembly's land use plan for aquaculture.

Table 22. Target of the land use plan for the last period (2016-2020)

Norms of land use	Area status (1,000 ha)					
	2015	**2016**	**2017**	**2018**	**2019**	**2020**
Agricultural land group	26,791.58	26,833.83	26,898.14	26,960.77	27,009.46	27,038.09
Rice cultivation land	4,030.75	3,970.42	3,918.13	3,866.43	3,809.09	3,760.39
In which: Land specializing in wet rice cultivation (2 crops/year or more)	3,275,38	3,240.73	3,213.64	3,189.87	3,157.99	3,128.96
Protection forest land	5,648.99	5,438.50	5,208.02	4,994.01	4,791.14	4,618.44
Special-use forest land	2,210.25	2,240.20	2,271.86	2,304.35	2,334.80	2,358.87
Production forest land	7,840.91	8,131.55	8,452.94	8,754.73	9,035.46	9,267.94
Aquaculture land	749.11	753.34	756.57	760.73	764.50	767.96

(Source: Resolution of the National Assembly no.134/2016/QH13, 2020)

1.1.2.2. Increasing demand for water consumption

Vietnam's surface water resources are globally rated as low to average. If calculated per capita, with domestic water sources, water volume is only 3,600 m^3/person /year (less than the 4,000 m^3/person/year in countries with water shortages). If the external water sources outside the territory of the country are included, Vietnam will achieve 9,650 m^3/person/year (greater than 7,400 m^3/person/year - world average).

According to Vietnam's Voluntary National Review on the Implementation of the Sustainable Development Goals (2018), as of June 2017, the proportion of urban population supplied with water through centralized water supply systems was estimated at about 84.5% (an increase of 1% compared to the end of 2016); the rate of loss was about 23% (0.5% decrease compared to the end of 2016). Although the urban water supply capacity has increased 1.6 times compared to 10 years ago, many industrial zones and new urban areas have been formed and urban population have also increased rapidly, due to the increasing urbanization process, so the water supply system has not yet met the demand for urban water use (*the Ministry of Planning and Investment, 2016*).

1.1.2.3. Energy use and production

Energy use has many indirect effects on ecosystem services. The use of fossil fuels determines the rate of air pollutant emissions and therefore the ambient air quality of the atmosphere. The level of biofuel use affects the type and distribution of land cover and the services provided by forest and other land cover types, while the magnitude of thermal-generated electricity will influence water withdrawals and air pollution.

In Vietnam, according to the revised Electricity Planning VII in 2016, the total electricity production in 2015 in kWh was 159 billion; in 2020 it was forecasted to be 265 billion; 400 billion in 2025; and 572 billion in 2030, with coal-fired thermal power still having a large proportion, over 53%, of total electricity production, hydroelectricity being reduced to just over 12%, electricity from gas nearly 17%, and renewable electricity increasing by 6.5-6.9% in the period 2020-2025 to 10.7% by 2030. Energy production is also one of the main sources of greenhouse gas emissions, which is an important determinant of climate change and changes in ecosystem services.

1.1.2.4. Increasing demand for using biological resources

About 20 million people in Vietnam derive their main income or partial income from aquatic resources and are unsustainably using over 300 species of seafood and over 50 species of freshwater aquatic products of economic value (*MARD, 2020*). In order to meet the demand for seafood, excessive exploitation and use of coastal aquatic resources have been revealed over the entire length of the coast, more than 3,260 km from the North to the South. Pressures to develop the marine economy, population pressure, degradation of ecosystems, environmental pollution and narrowing of natural habitats of aquatic species in coastal areas, along with use inefficient practices have been accompanied by evidence of over-exploitation and unsustainable coastal fisheries.

Meanwhile in mountainous areas, about 25 million people live in or near forests and 20%-50% of their income come from non-timber forest products, including hundreds of medicinal plants, oils dyes and wild animals (*MARD, 2020*).

In general, people's perception and practices are outdated about the medicinal value of some products derived from wild animals (rhino horn, bear bile, tiger extract, etc.) and super profits from the illegal trade of these products also contribute to the loss of biodiversity. Similarly, the habit of using furniture from precious and rare natural wood as a symbol of power and wealth will also reduce forest resources.

1.2. Economic Development

According to Grant et al. (2008), economic development as a driver of the use of ecosystem services comprises many dimensions including income levels, economic structure, consumption, and income distribution. Often, however, levels of per capita income (per capita GDP or GNP) are used as a measure of the degree of economic development. In fact, per capita income is typically the only development indicator used in the literature for long-term scenarios. Assumptions about economic development influence the future of ecosystem services by affecting the drivers of ecosystem changes such as energy use, food consumption and technological progress.

For several ecosystem services, model calculations assume that the higher the income, the greater the per capita consumption of commodities, up to some saturation level (for example, energy consumption per sector or domestic water use). For other services, high income may lead to a decrease in consumption because of a change in consumption patterns (fuelwood consumption).

Vietnam is a developing country moving to join the group of middle-income countries. According to VnEconomy, Vietnam's per capita income in 2018 was estimated at 58.5 million VND, equivalent to 2,587 USD, increasing 198 USD compared to 2017. Vietnam's labor productivity has improved significantly over the years and is a country with a high labor productivity growth rate in the ASEAN region. Labor productivity of the whole economy at current prices in 2019 was estimated at 110.4 million VND/laborer (equivalent to 4,791 USD). At constant prices, labor productivity in 2019 increased by 6.2% compared to 2018 (*GSO, 2019*). As a result, people's life has improved. However, patterns of consumption of ecosystem services are not sustainable and many issues related to biodiversity conservation need to be addressed, such as: (i) how are benefits from biodiversity and ecosystem services to be shared fairly and reasonably and with community participation; (ii) what mechanism can best promote community participation and manage community-based biodiversity conservation and development; and (iii) how to implement preservation and restoration of ecosystems and biodiversity development as an means of adapting to climate change.

The Government has initiated and oriented the development of a green, sustainable economy for the country, but the reality shows that Vietnam's economy has grown rapidly, bringing about many socio-economic benefits but at the same time putting pressure on biodiversity conservation and ecosystem services.

The trend of strong development of marine and coastal economy

According to data of Hoang Van Thang and others (2012), the environment of Quang Ninh province in general, biodiversity and ecosystem services in Quang Ninh in particular are severely reduced due to many different reasons, including the development of economic sectors not in harmony with environmental protection work and conserving natural resources. Research results of the Faculty of Geography, Hanoi University of Natural Sciences show that in the period from 2005 to 2010, the trend of the land area on the mainland and the area of mangrove forests in Ha Long area is tending to decrease and is related to socio-economic development policies such as the expansion of mining industry, construction of cement plants, thermal power plants, especially coastal reclamation for development purposes of residential and industrial zones. For example, the area of mangroves in the period 2005-2010 decreased by 200 ha while industrial land increased to 300 ha. At the same time, in this period, up to 30% of the total area of tidal flats has been reduced rapidly due to leveling of new urban and industrial zones. Over the past years, Quang Ninh province has been facing major challenges in balancing coal mining, environmental protection and tourism development. Making difficult decisions to harmonize international interests (heritage conservation), national interests (energy security), local interests (employment, environmental protection, and tourism development) has become increasingly difficult and requires a recognition of the role

of value of ecosystem services as well as recognizing the consequences of trade-offs caused by unreasonable decisions.

Thai Binh is a coastal province in the Northern Delta. Being a purely agricultural province, in the context of the current economic development, Thai Binh province has determined that marine economic development is one of the five focal points for creating a breakthrough in economic growth of Thai Binh province during next time. On July 8, 2014, Thai Binh Provincial People's Committee issued Decision no.1573/QD-UBND approving the "Project on developing the marine economy and coastal areas in Thai Binh by 2020". On July 29, 2017, the Prime Minister issued Decision no.36/QD-TTg on establishing Thai Binh economic zone in Thai Binh province. According to this Decision, the Coastal Economic Zone consists of 30 communes, one town in 02 districts of Thai Thuy and Tien Hai and the adjacent border with a natural area of 30,583 ha. In particular, Thai Thuy coastal economic zones were established at Thuy Truong commune of more than 350 ha, Xuan Hai of 320 ha and Thai Thuong of 250 ha. It was worth noting that these economic zones were to be built mainly on encroachment land including mangrove forests and tidal flats. Decision no.36/QD-TTg showed that marine economic development is an opportunity for local socio-economic development but it is also a challenge to environmental protection and biodiversity conservation in wetland ecosystems, especially mangrove forests and large tidal flats in the coastal area of Thai Thuy district, Thai Binh province, was established as a wetland protected area.

1.3. Overlapping in functions and management of biodiversity between relevant authorities

The institutional framework for biodiversity in Vietnam currently involves many ministries, though the state management of biodiversity is the main responsibility of both MONRE and MARD, and is overlapping (*MONRE, 2018*). Specifically, MONRE is assigned by the Government to be the focal point for the state management of biodiversity, while MARD manages the system of special-use forests and marine PAs and MONRE manages the wetland PAs.

The biggest challenge to biodiversity management and conservation is the inadequate coordination between MONRE and MARD in issuing policies. Although the organizational system of biodiversity management has been formed from the central to local levels, but the assignment of state management responsibility for biodiversity is unclear between MONRE and MARD as well as between local management agencies leading to overlap and conflict. Overlapping state management on biodiversity and different ecosystems can negatively affect the use and sustainable exploitation of ecosystem services while reducing the provisioning services of the ecosystem.

1.4. Policy and governance on biodiversity conservation

So far in Vietnam, the Government, ministries and agencies have issued around 196 policy documents guiding the implementation of the Biodiversity Law (2008) and other specialized laws related to biodiversity conservation. These policy documents include decrees, decisions, directives, circulars, official letters, technical guidelines, etc. (Annex 3). More information on policy will present in Part VI.

1.5. Communication, awareness and education

1.5.1. Communication and awareness raising activities

The Ministry of Natural Resources and Environment issued Decision no.200/QD-BTNMT in 2015 approving the Communication Programme to raise awareness about prevention and control of invasive alien species in Vietnam in the period 2015-2020.

Celebrate the International Days of Biodiversity and associated events

Annually, under the guidance of international conventions and treaties of which Vietnam is a member, MONRE has issued a letter guiding the implementation of activities to celebrate the international day of Biodiversity (May 22), International Wetlands Day (February 2), World Migratory Bird's Day (May 11-12), etc. according to international themes. These events attract the attention of the people and the community with public education and awareness raising activities on biodiversity through banners on the streets and offices of MONRE and events held in some provinces and cities across the country (such as in Hanoi, Thai Binh, Ninh Binh, and Quang Ninh provinces).

Coordinate with relevant agencies and local authorities to promote and raise awareness about biodiversity

At the central level, MONRE and relevant ministries and agencies have developed and implemented public education sections on nature conservation and sustainable use of biodiversity in the form of scientific documentaries and films in mass media such as radio, television and newspapers.

Most localities have well implemented public education activities related to biodiversity conservation. Provinces often focus on public education as a function of management boards for protected areas in the province, which carry out public education activities to communities in and buffer zones of PA, spreading to other areas in the province in the form of distributing leaflets, hanging banners and posters, communication through radio and mobile vehicles, etc. At the same time, protected area management boards have implemented public education to raise awareness of biodiversity conservation and the importance of biodiversity for encouraging tourists to visit the PA.

Some islands where NPs and PAs are located, such as Cat Ba, Con Dao and Phu Quoc, in coordination with the authorities and high schools, also regularly organize International Biodiversity Day (May 22) and learn about biodiversity. In 2017, MONRE received 23 reports from provinces and cities implementing local activities to respond to International Biodiversity Day.

Continuously from 2009 to 2015, the VEA assigned the Biodiversity and Nature Conservation Agency (BCA) to carry out the task of "Propagating and disseminating the Biodiversity Law and related documents" along with the targets to introduce new documents implementing the Biodiversity Law to relevant local agencies. This task has fulfilled the basic objectives of developing policy messages on the importance of biodiversity for sustainable development, especially emphasizing the connection between biodiversity and economic development, ESs, international tourism and people’s health. Policy messages have been sent to relevant agencies from central to local levels.

In the period of 2012 - 2016, VEA cooperated with WWF to organize the Forum for Nature and Culture Conservation for the sustainable development of the Mekong Delta. Each year, the forum is held in one province of the Mekong River Delta having selected one topic on biodiversity. One of the objectives of the forum is to share lessons on raising awareness of managers in the environmental field through lessons learned about management and implementation of nature and biodiversity conservation activities in Mekong River Delta provinces.

Integrating content on biodiversity into sectors, national and international organizations, universities and programs and projects

Internationally supported projects on biodiversity, each undertake activities associated with public awareness, management of biodiversity in general and specific contents of the Biodiversity Law in particular.

The network of education and technical human resources training and management in the

field of biodiversity conservation in Vietnam has been widely developed. Approximately 20 universities have undergraduate majors related to biodiversity, including biology, environmental management, forestry, agriculture and fisheries, geography, and natural resources that bring the subject of biodiversity and nature conservation into the training process at the school. Many universities have graduate and postgraduate training programs related to biodiversity conservation, sustainable management and use of wetlands, such as University of Natural Sciences (Vietnam National University, Hanoi), Hanoi National University of Education, Hanoi Agricultural University, Forestry University, Vinh University, Nha Trang University, Vietnam National University in Ho Chi Minh City and University of Agro-Forest in Ho Chi Minh City; some private universities with training in environmental science, agriculture, forestry and related areas also bring natural resources and biodiversity into their curriculum; in 2016, the Ministry of Education and Training has assigned a number of universities to compile teaching materials related to nature conservation and biodiversity.

1.5.2. Level of awareness on biodiversity and ecosystem services

Awareness of central state management agencies: At the highest level, biodiversity conservation in Vietnam has been defined in the Constitution (passed by the National Assembly on November 21, 2013). Vietnam's constitution defines that the State has policies to protect the environment, nature and biodiversity conservation; In 2008, the National Assembly of Vietnam approved the Biodiversity Law, which came into force in 2009. Since then, the Government and ministries and agencies have issued many other legal documents directly related to biodiversity conservation as well as integrating biodiversity conservation activities into the sectors, communication to raise awareness about prevention and control of invasive alien species.

Awareness of local management agencies: In the current reality, local authorities often tend to focus on economic development, overlooking environmental protection and biodiversity conservation. The evaluation of development achievements at the provincial level, where most decisions made on land and waters use are based on economic growth criteria, do not encourage environmental protection and biodiversity conservation; and underestimate the value and role of biodiversity and ecosystem services.

Business awareness: Awareness of enterprises on biodiversity conservation has gradually improved. Many enterprises have participated in Vietnam’s PFES’ mechanism.

Community awareness:

From the Project of *Assessing Perceptions, Attitudes and Participation of Local Community in Nature Conservation and Resource Management in Mu Cang Chai, Lao Kai Province* implemented in 2012, some survey results show that in general, the awareness of people in the area include a basic understanding of forests, forest resources and the importance of forests in the region, especially those related to their daily life such as wood sources, firewood, arable land, and animals worth hunting. However, the knowledge of the communities (mostly Mong ethnic people) on natural resources remains low, not fully understanding the risks of impacts on the forest, not knowing the biodiversity and the value of biodiversity in the PA, information on the presence of the PA is limited, and people's attitudes towards forest protection remain weak.

In the Project to develop a dossier for construction of an coastal protected wetland in Thai Thuy and Thai Binh for implementation in 2016-2018, the survey results show that most of the local people (who participate in fishing activities under the mangrove canopy and on tidal flats as well as aquaculture) have a sense of protecting the mangrove forest in coastal estuaries because of the fact that this is a green shield providing cover from storms and waves for communes inside sea dikes as well as aquacultural ponds inside the mangrove strip.

In 2017, the Women's Union of Thua Thien Hue province organized communication events

on the topic of enhancing flood tolerance and ecosystem-based adaptation for nearly 700 women. Members of the Women's Union have participated in training courses on management of small-scale community-based ecotourism models to generate economic benefits directly from mangrove forests. In addition, credit funds linked to women's livelihood support and mangrove conservation are also established and put into operation. Thereby, the flood resilience of 4,800 coastal residents has gradually improved.

In some reports on the results of annual management activities of most PAs, the awareness of biodiversity conservation of local people is not high, especially the awareness of observing the law on natural resource exploitation is very poor, resulting in illegal logging of timber and non-timber forest products right at the PAs, even in strictly protected zones.

Some limitations:

Propagating and raising awareness of current biodiversity conservation only works with some managers at community level. The forms of communication with the people currently working at high-level agencies such as the National Assembly, the Government and the provincial level are still limited.

The results of reviewing legal documents on biodiversity (2018) show that the provisions of the Law on Gender Equality 2006 and the requirements of gender mainstreaming are not clearly reflected in the documents. Therefore, there has been little mention of gender equality in the raising of awareness on biodiversity conservation, especially the role of women in conservation activities.

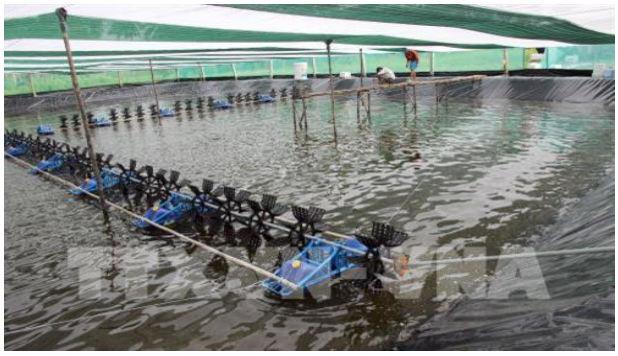
Public education campaign to raise awareness on biodiversity conservation is a process that needs to be implemented regularly and long-term but currently there is not enough funding to conduct these activities regularly every year.

1.6. Science and technology development

According to Grant et al. (2008), the rate of technological change is an indirect driver of changes in ecosystem services because it affects the efficiency by which ecosystem services are produced or used. Most relevant in this context are the factors related to energy, water, and agriculture. A higher rate of improvement of crop yields, for instance, could lead to a lower demand for cropland (to produce the same amount of food), reducing the need to convert forest or grassland. Technological change, however, can also lead to increased pressure on ecosystem services because technological advancements often require large amounts of goods and materials themselves and can cause new ecological risks. For example, the application of chemical fertilizers for increasing crop yields can also lead to nitrogen contamination of surface water and groundwater.

Technological change is a complex and dynamic process. Special innovations emerged from local capabilities and needs and were developed from model designs, which can be applied such as the industrial shrimp farming model, high density catfish farming model, and models of clam culture in tidal flats.

In Vietnam, in the process of socio-economic development, there has been increased investment in and development of science and technology. In the agricultural and fishery sectors, intensive cultivation and industrial shrimp farming has been widely deployed. In addition to the positive aspects of having a high level of food production for the people, and limiting the exploitation of natural biological resources, there are disadvantages from these models including the use of many chemicals such as chemical fertilizers, pesticides, antibiotics, growth and developmental preparations and high animal density, leading to problems of disease, environmental pollution, and biological product safety.



Model of super intensive shrimp farming in Ca Mau province

Model of industrial shrimp farming in the sandy area of South Central Vietnam

Figure 27. Some models of intensive and industrial aquacultures

At the conference "Orientation on plant protection in the new situation", organized by MARD (2018), Minister Nguyen Xuan Cuong said that the abuse of plant protection drugs is inadequate, including being toxic to producers and the community, reducing the competition of products, and causing land degradation and emphasized that there must be a roadmap to ban the use of herbicides and outmoded highly toxic groups currently no longer relevant to the ecosystem.

With 2kg/ha/year, the amount of active ingredient of pesticide used on 1 ha of crops/year in Vietnam is much higher than in comparable developing countries such as Thailand, Bangladesh, and Senegal. Mr. Ho Xuan Hung, Chairman of Vietnam General Association of Agriculture and Rural Development has assessed that Vietnam is one of the countries that over-use pesticides, and find it difficult to control.

Cao Van Hung (2017) commented that excessive agricultural intensification also left a lot of consequences for the environment and public health such as soil degradation, chemical fertilizer abuse and pesticide use have polluted the soil and water sources, degraded the environment, so that the quality of agricultural products does not ensure safety and affects human health and the situation of food insecurity has led to making the whole society having to pay attention to the consequent build-up of anxiety. Furthermore some pests and diseases balloon into epidemics, causing heavy losses without effective control methods, the situation of chemical residues in agricultural products exceeds the permitted level, and many agricultural products such as rice, pepper, and seafood imported by countries must be rigorously inspected and warnings provided and even products returned.

1.7. Limited resources for biodiversity conservation / investment

1.7.1. The implementation of policies, and enforcement of laws and regulations on biodiversity is still difficult

Vietnam has a system of law enforcement agencies engaged in preventing and apprehending violations of the Biodiversity Law (2008), the Law on Forestry (2017) and the Fisheries Law (2017) but the roles and responsibilities of these agencies as prescribed in the laws, decrees, circulars, and decisions are still unclear, confusing and overlapping.

The functions of each protection agency are stipulated in many policy documents. For example, the Department of Forest Protection under MARD has the function of managing and protecting forests, ensuring the observance of forestry laws and is a specialized force in forest fire prevention and fighting; the Vietnam Fisheries Surveillance under MARD is a specialized force of the State, performing the function of enforcing the law of Vietnam and related international treaties to which the Socialist Republic of Vietnam is a party, concerning exploitation and protection of aquatic resources.

The Environmental Police under the Ministry of Public Security is the main force in investigating serious violations of environmental crimes, including violations of the Biodiversity Law. The Economic Police or Criminal Police forces also participate in investigating serious violations of the laws related to biodiversity. The General Department of Vietnam Customs under the Ministry of Finance, despite its role as a state budget collector, together with the Border Guards and Vietnam Coast Guard under the Ministry of Defense is responsible for controlling the land border, airspace and on the sea when enforcing trade laws and to seize illegal timber and CITES wildlife species traded illegally. The right to monitor and manage all activities of law enforcement investigations is under the responsibility of the Supreme People's Procuratorate.

Currently enforcement of biodiversity laws is still limited due to lack of resources, including human resources, and technical and financial equipment. Reasons for the poor implementation of laws on biodiversity include an overlapping legal framework for managing biodiversity conservation, insufficient resources, weak capacity for conservation work, and lack of necessary equipment. The coordination between forces implementing environmental protection and biodiversity is not strict. The inefficient sanctioning of illegal acts on conservation is also the cause of an increasing illegal exploitation and trade in wild plants and animals and their products (*MONRE, 2019*).

1.7.2. Financial investment for biodiversity conservation is not adequate

In Article 73, the Biodiversity Law stipulates funding for the conservation and sustainable development of biodiversity that is formed from the following sources: (i) state budget; (ii) investment and contributions of domestic and foreign organizations and individuals; and (iii) revenues from environmental services related to biodiversity and other sources as prescribed by the Law. The budget for biodiversity conservation at the central level is mainly concentrated in MONRE, MARD and MOST.

Investing in the implementation of biodiversity conservation from the budget has increased but it is still spread out, lacking focus and with low investment efficiency. Most funding of non-governmental organizations depends on short-term and funding-based projects, so it is difficult to implement long-term commitments for conservation (*MONRE, 2019*). In the review report on the implementation of the Biodiversity Law, the main shortcomings of financial investment for conservation are as follows:

- Budget for biodiversity conservation also accounts for a small proportion of the total budget for environmental tasks;
- Lack of financial regulations for biodiversity conservation;
- Investment budget for NPs and PAs is usually balanced and allocated annually from the central or provincial level. Any investment focuses heavily on capital construction. Most of the special-use forests use up to 90% of available funds to maintain the operation of the management board. Funds necessary for biodiversity conservation activities, or conservation assistance activities such as media education and awareness raising among stakeholders, are very limited;
- The distribution of budgets to the NPs directly under MARD and the NPs/NR under provinces is very different. Most of the foreign funding is allocated to the national parks managed by the central government, the protected areas under local management receive much less and limited access to investment opportunities and donors. Especially related to smaller special-use forests (less than 15,000 ha);
- Projects with state budget capital often focus on infrastructure construction, forest plantation, forest management and protection.

II. PRESSURES TO CHANGE IN THE STATUS AND TRENDS OF ECOSYSTEM SERVICES

2.1. Land/waters conversion without a scientific basis

Many studies around the world have identified change of land use as one of the most important pressures affecting the switching of inherent natural ecosystems into artificial ecosystems, thereby reducing the value of ecosystem services. Costanza et al. (2014) estimated the loss of global ecological services from 1997 to 2011 due to changes in land use at 4.3-20.2 trillion USD per year. In Vietnam, land use conversion for many different purposes takes place continuously in the socio-economic development process.

2.1.1. Forest land conversion

Conversion of forest land to other purposes:

In Vietnam, the conversion of forest land into industrial crop land is one of the main causes of the loss of natural forests and even loss of plantations. Many areas of natural forests have been converted into land for industrial crops, including sugarcane, tea, coffee, cocoa, rubber, pepper and most recently cassava (exported to China as raw materials for production of biofuel). In general, conversion of forest land to industrial development or infrastructure construction leads to fragmentation of forest ecosystems, preventing the movement of wildlife.

The area of natural forests has been seriously reduced, and it is estimated that there are only about 0.5 million ha of primary forests, scattered in the Central Highlands and North Central Region. Due to consumer demand, the outputs of many types of agricultural and forestry products used domestically and for export are tending to increase, with the remaining forests increasingly at risk of being converted into industrial crops.

Although the afforestation program has been carried out for many years, it tends to focus on monoculture of eucalyptus trees or pine trees that contribute very little to biodiversity conservation. In 2008, 150,000 ha of semi-evergreen dipterocarp forest considered to be poor forests in the Central Highlands were allowed to be converted into rubber plantations.

According to the statistics of the Vietnam Administration of Forestry, from 2003 to 2009, there were about 25,000 ha of forest land converted each year to other uses.

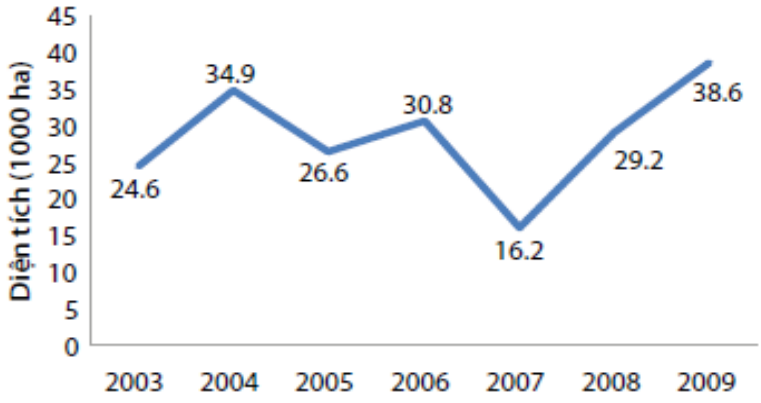


Figure 28. Conversion of forest land to other uses in Vietnam from 2003 to 2009

(Source: VNFOREST, 2010)

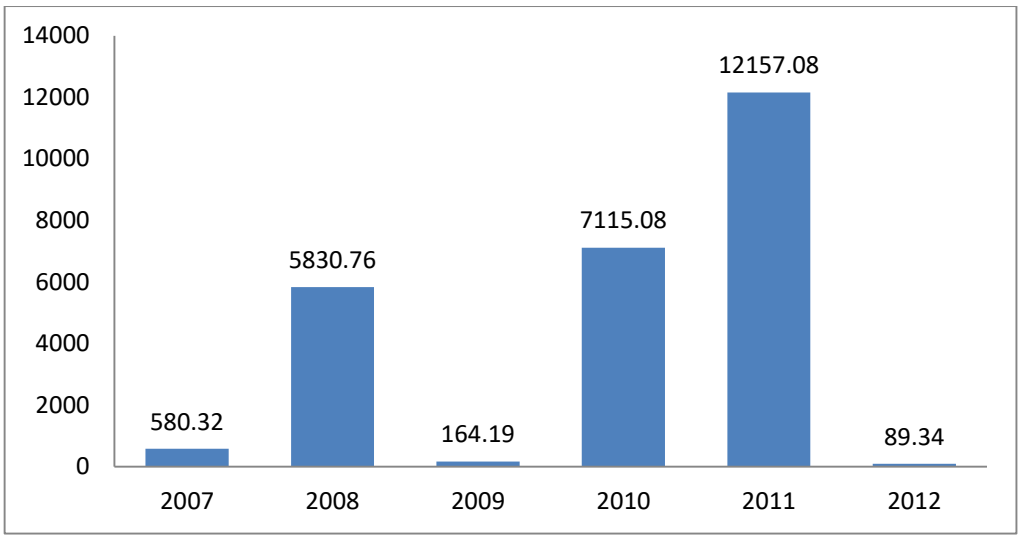


Figure 29. Forest area (ha) for conversion purpose for infrastructure development and non-agricultural and irrigation purposes 2007-2012

(Source: MARD, 2013)

According to the report of MARD (2016), from 2006 to 2016, there were 2,991 projects, with 386,290 ha of forest transferred to other purposes, of which: natural forest was 300,120 ha (accounting for 78.0%), and planted forest was 86,170 ha (accounting for 22.0%).

Table 23. The area of forest land converted to different uses for the period 2006-2016

No	Project	Forest area for conversion of use purpose (ha)	Ratio (%)
1	237 projects of hydropower	29,582	6.2
2	545 Projectes of mining	15,330	3.2
3	460 Projectes of rubber plantations	327,205	68.5
4	211 Projectes of agricultural production	61,964	13.0
5	57 projects of resettlement sites	5,244	1.1
6	99 projects of defense	4,228	0.9
7	73 projects of industrial parks and ports	3,895	0.8
8	122 projects of tourism infrastructure	4,603	1.0
9	80 projects of build irrigation and canals	5,100	1.1
10	1.107 projects of infrastructure in regional areas	19,190	4.0

(Source: MARD, 2016)

As of November 2016, the country had planted 37,578 ha of replacement forests, representing only 55% of the total area to be planted.

In term of the different types of land use purposes, many new roads have divided many national parks and protected areas, or created barriers to the distribution and movement of wildlife species, as well as created favorable conditions for illegal exploiters and traders of wild plants and animals to easily access forests causing great pressure on biodiversity. Regarding hydropower projects, the country currently has more than 1,020 hydropower projects (total installed capacity of 24,246 MW) planned, of which 138 projects are in the hydropower ladder planning on the main rivers, approved by the Ministry of Industry and

Trade. According to statistics, the hydropower system built on the Dong Nai River destroyed over 15,000 ha of natural forest in the basin (*FCPF, 2011*).

Many hydropower reservoirs fail to properly operate processes, such as flood discharge regimes ensuring environmental flow, causing human and economic damage, and strongly affecting ecosystems in downstream regions (*MONRE, 2019).*

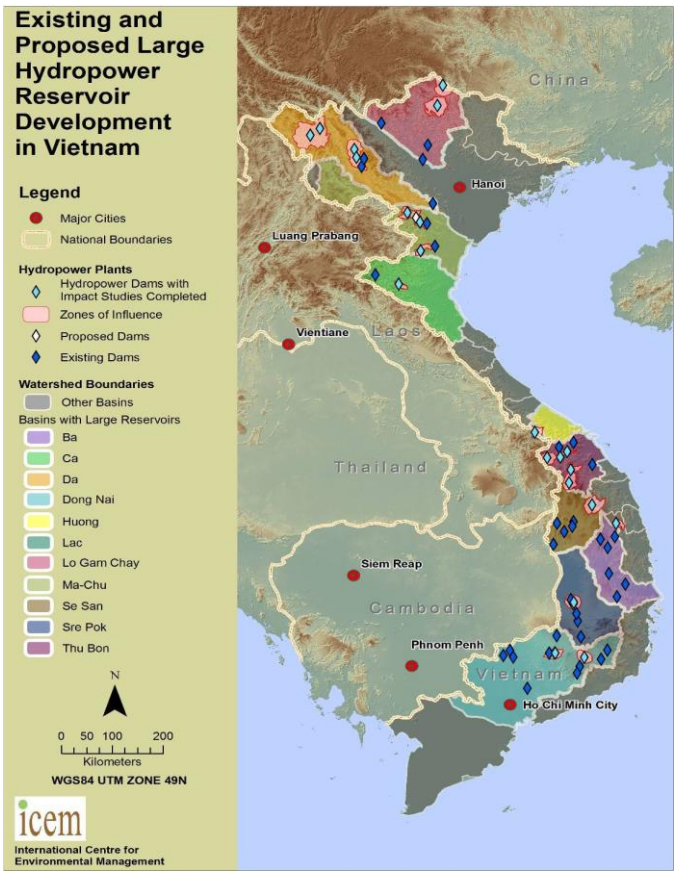


Figure 30. Distribution of some dams and hydropower reservoirs in major rivers of Vietnam

(*Source: ICEM, 2010*)

*Shifting cultivation i*s one of the direct threats to deforestation and forest degradation. Shifting cultivation has been determined to be correlated with forest degradation in some areas. However, there is also evidence in ethnic minority areas that shifting cultivation practices have not led to significant impacts on biodiversity.

Expanding agricultural production and intensification: Economic development and population growth has led to the expansion of intensive farming in many delta areas. In the Mekong River Delta region, for example especially in the Dong Thap Muoi and Long Xuyen quadrangles, most of the natural grasslands have been transformed into rice-growing areas that affect the habitat of some endangered species, at the same time some important wild genetic resources of Vietnam have been lost.

Shortcomings and limitations in regulating forest land conversion

Regulations on changing forest use purposes to non-forestry purposes are still generalized, as they do not yet require written opinions of higher specialized agencies, while developing environmental impact assessment reports requires the participation of forestry agencies and plans exist to compensate for forest clearance and to obtain consensus opinions of local population communities where forests are changed and approved by competent state agencies.

Slowly issuing documents specifying criteria and conditions for conversion of natural forests to other uses continues, while the maximum area allowed to change purposes and competent agencies to permit and convert land with natural forests for other purposes must have a plan to plant new forests.

Provisions on rubber plantation on forestry land have some unreasonable contents, such as poor timber forest with average standing volume of trees from 10-100 m^3/ha which is too broad, leading to easy exploitation for conversion; and it remains possible to cut the rich areas of inter-cropped forests with an area of less than 3 ha to create a seamless area that is not suitable for the sustainable rubber tree development solution proposed by the rubber industry that includes intercropping, planting of cover trees, and application of the agroforestry model.

Using forest land for purposes such as transportation, hydropower, and golf courses has not been carefully calculated; many localities also convert protective and special-use forest land for such purposes. The situation of forest land encroachment, self-transfer of non-planned land use purposes has not been detected and dealt with promptly.

In some localities, project owners are seriously negligent in observing regulations on replanting forests when changing land allocated for forest use to other purposes. The results of afforestation in the change of forest use allocation to other purposes are low.

2.1.2. Conversion of coastal wetlands

Many mangrove forests, lagoons and coastal tidal flats have been rapidly converted on a large scale into shrimp ponds, clam culture grounds and other marine products that have caused the primary mangrove forests to be almost completely lost in many provinces. From 1943 to 2005, at least 220,000 ha of mangroves disappeared initially due to the war, and then to the destruction and development of aquaculture (*MONRE, 2019*).

The leveling of tens of thousands of ha of natural tidal flats in the coastal area of Bac Bo to cultivate white clams (*Meretrix serata*) changes the mechanics of tidal soil and reduces the biodiversity of the tidal flats, exemplified in the gradual decrease in the population of indigenous clams (*Meretrix meretric*). High-density clam farming, as with other cases of high-density aquaculture, has led to environmental pollution from organic substances excreted from the cultured species to the outside environment (*MONRE, 2019*).

Coastal tidal flats are home to hundreds of economically valuable aquatic species and native or migratory waterbirds. Partial rehabilitation of tidal flats by planting mangroves in the Red River mouth area has seriously affected the habitat and favorite feeding habitats of many migratory birds such as the black-faced spoonbill (*Platalea minor*).

Mangroves in the buffer zone of Xuan Thuy NP are transformed into extensive shrimp and crab ponds

Tidal flats in the ecological rehabilitation zone of Xuan Thuy NP which has been converted into clam culture

Figure 31. Mangroves and tidal flats converted into shrimp ponds and clam culture

The opportunity to quickly reap massive profits has pressured most inshore and inland aquaculture activities to shift from extensive farming to less sustainable intensive farming, leading to depletion of mangroves, loss of habitats of many endangered species and environmental pollution. Surface coastal water, especially bays and lagoons used for cage culture of aquatic species, has polluted the water environment and bottom sediment, affecting coastal ecosystems, especially coral reefs and seagrass.

Photo: Nguyen Huy Yet, 2010

Photo: Nguyen Huy Yet, 2010

Figure 32. Aquaculture by cages in waters in Ha Long Bay, Bai Tu Long

2.2. Excessive and illegal exploitation of biological resources

Increasing demand for the use of biological resources leads to overexploitation of the supply capacity of ecosystems, the resilience of biomes, especially organisms of economic value that leads to degraded ecosystems, decline in biodiversity, and depleted biological resources.

2.2.1. Forest biological resources are excessively and illegally exploited

The need to use wildlife products for medicinal purposes such as: rhinoceros horn, tiger bone glue, and bear bile has been ingrained in the minds of many people in Vietnam and they are willing to pay high prices for these products. Many hunted species have had their population significantly reduced in Vietnam to the extent that traders have bought both wildlife and their products from other countries. For example, most pangolins have recently been imported illegally from Malaysia, Myanmar and Indonesia; while rhinoceros horn is transported from South Africa.

Forest ecosystems with high biodiversity are also the foundation for ecotourism which is becoming a popular service. In particular, protected areas have a significant value for their role in regulating the environment and climate, and promoting discovery and education to protect nature. On the other hand, they are also a source of benefits for local people when participating in ecotourism services. Overexploitation and illegal exploitation of wildlife resources, including wood from forests and wild animals, have served the needs for living and entertaining by commercially reducing biodiversity, pushing many species in Vietnam to the

brink of extinction in the wild and putting serious pressure on other populations, while simultaneously degrading the forest ecosystem.

Illegal exploitation of biological resources includes wild animals, timber, and even illegal logging within some national parks and protected areas. In many northern mountainous provinces, the eradication of precious medicinal plants for smuggling across borders is quite common. In Cao Bang, Chinese traders have set up many stations to buy and process local medicinal herbs such as white *Stephania glabra*, yellow *Stephania glabra*, *Gynostemma pentaphyllum*, arrowroot, *Sargentodoxa cuneata*, *Zoysia tenuifolia*, etc. Many medicinal plants whose economic value as well as therapeutic use remain unclear are illegally exported to China (*MONRE, 2019*).

Overexploitation of plant species not only affects biodiversity, but also affects the livelihoods of many households depending on forest products. Due to lack of data, the assessment of the importance of this threat is limited. The effect of overexploitation on many tree groups, for example for orchids, is very serious. High-value tree species are also often at high risk of overexploitation, most notably timber species. Vietnamese forests have provided a large number of commercially valuable timber species, including *Erythrophleum fordii*, *Dalbergia* spp., and other species of *Dipterocarpus* spp., *Shorea* spp., *Hopea* spp. and different conifers, such as *Fokienia hodginsii*. The population of most of these timber species has decreased significantly in recent decades, although the impact of this decline on the long-term viability of the populations of these species is not fully known. Other plant species of economic value threatened by overexploitation include *Aquilaria crassna* - a species for frankincense, and Ngoc Linh ginseng (*Panax vietnamensis),* used to produce tonics. In some cases, blatantly illegal exploitation by loggers flattened woodlands in the core zone of the national park. In 2017, tens of ha of protection forests were cut down in Binh Dinh and Quang Nam, causing acute distress to the society.

It is noteworthy that in areas with high forest cover such as in the Northeast, Northwest, Central and Central Highlands, there is a high incidence of poverty that easily leads to illegal and excessive resource exploitation of forests and biodiversity.

Precious timbers are illegelly logged in Phuoc Son, Quang Nam province

Excentrodendron tonkinensis timber is illegally logged in Bac Kan province

Figure 33. Forest protection force collects illegally exploited timber

(*Source: http://dantri.com.vn/, Quoc Do*; *website of Vietnam Law, Minh Anh*)

Illegal deforestation and degradation within protected areas

So far, the management of nature reserves is still ineffective, and some protected areas have been seriously violated by illegal wildlife and timber exploitation activities. Typically, the case of destroying 61 ha of forest in An Lao, Binh Dinh province in September 2017; hundreds of old trees were cut down, such as *Afzelia xylocarpa, Dalbergia cochinchinensis* and *Pterocarpus macrocarpus* in Yok Don National Park, Dak Lak province in January and February 2018. By April 2018, the Ministry of Public Security had directly investigated this incident and urgently arrested the "boss" of smuggled wood named Phuong Rau in Dak Lak. Especially prominent in recent years in Ba Be National Park, the phenomenon of logging in the core zone still occurs. Nhan Dan Newspaper and Thanh Hoa Newspaper (March 28, 2017) both regard this area as a hot spot for deforestation.

In the Chu Mom Ray NP, due to the pressure of the market economy inflating the demand for productive land, a part of the population has defied the law to invade the forest. In addition to hunting rare and precious animal species, illegal exploitation of many wild orchids in Chu Mom Ray NP is also a problem. Local people have eradicated a number of rare and precious forest orchids on the list of conservation.

The summary report of management tasks of Hoang Lien National Park in 2017 commented: the awareness of observing the Forest Law of the people is still low, the violators of the Law are becoming increasingly reckless and aggressive, moving from using ruses to committing acts of abuse of forest resources. People still have to rely on local sources of firewood, especially people in remote areas, as there is no substitute material to meet their minimum needs and, this is the direct source of difficulty in forest management and protection. Also during this time, there were other organized deforestation cases in Quang Nam, Phu Yen and Thanh Hoa provinces. In addition, in some protected areas, forests and forest land are also exchanged for projects of infrastructure development.

Kon Ka Kinh NP (Gia Lai province) was damaged

Afzelia xylocarpa of Yok Don NP (Dak Lak province) was cut down

Pterocarpus macrocarpus of Yok Don NP (Dak Lak province) was cut down

Old ebony tree was cut down in Phong Nha-Ke Bang NP (Quang Binh province)

Figure 34. Precious timber in some national parks illegally exploited

(Source: from Thanh Nien and Tien Phong electronic newspapers in 2017, 2018, 2019)

In particular, most recently, according to author Hoang Nam (Tien Phong newspaper on March 14, 2019), the dispatch on March 4, 2019 of the Management Board of Phong Nha - Ke Bang NP reported to the People's Committee of Quang Binh Province, regarding "Illegal logging in Phong Nha - Ke Bang NP" shows that: in the buffer zones 649 and 650, in the core zone of the National Park in Tan Trach commune, Bo Trach district, there were 66 large timber trees cut down, the scene left only the shell cover, the root, and the top branches. The amount of timber brought by loggers was estimated at about 70m^3. Through initial screening, 44 ebony trees belonging to group IA (endangered, precious and rare group, banned from exploitation) were cut down, the remainder were mainly *Vatica subglabra*. From the traces they left behind, the loggers were able to cut down and exploit timber resources between November and December 2018.

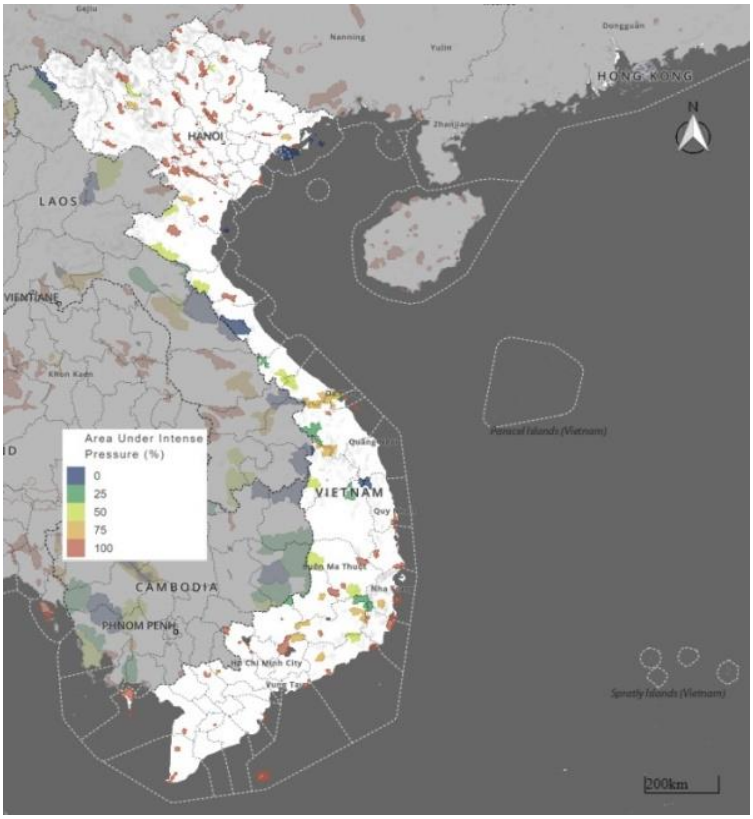


Figure 35. Human pressures on protected areas

(Source: UNBiodiversityLab, 2018)

2.2.2. Fishery resources in wetland and marine ecosystems are excessively and illegally exploited

Increasing consumption levels and ineffective fishing management are also leading to over-exploitation in many inland and marine waters, depleting aquatic resources. Many high-value aquatic species are severely reduced in term of population, such as pompano, lager fish, small fry, lobster, abalone, and scallops. Illegal and destructive exploitation techniques such as using explosives, poisons and electric shocks in capture fisheries is spreading, in both inland and sea waters, and is a substantial threat to ecosystems with high levels of biodiversity such as rivers and streams in mountain areas, lakes and reservoirs, coastal lagoons, sea grass beds and coral reefs.

Data from the subprojects 9I and 9II under Project 47 of the Research Institute for Marine Fisheries, Hai Phong of 2011-2015, for example showed that a situation of overexploitation of aquatic products as follows:

- Exploitation rates in some species (mainly in ocean areas) were pretty high, which reflected the over-exploitation of marine wildlife populations. Many marine species were being over-exploited in areas such as: the Gulf of Tonkin (e.g. *Evynnis cardinalis, Saurida tumbil, Saurida undosquamis*); the Central Coastal area (Chinese squid, Indian squid, *Priacanthus macracanthus*, Goatfish, Round scad); the South East (tuna, silver fish, Round scad, *Saurida tumbil)*; and the South West (*Saurida umeyoshii*).
- The sizes of fish species that were exploited, which dominated production volumes in mostly coastal regions of Vietnam were relatively small, not reaching sexual maturity. The proportion of sexual non-maturity was about 58% in the Gulf of Tonkin; 64% in the Central coast, 40% in the Southeast and 44% in the Southwest. This showed that in the marine biome, there was a decline in long-lived species, those of larger size or species that have not yet matured and have been exploited continuously with high intensity.
- Over 70% of the marine fishing boats in Vietnam were operating mainly in coastal waters, accounting for about 35% of the total seafood exploitation. However, the coastal waters only occupied about 11% of the exclusive economic zone and this is the traditional fishing area of Vietnam, so these areas are always overexploited and the pressure of exploitation is increasing. The number of fishing boats is too large, and the freedom of fishing of small vessels and uncontrolled increase in the number of boats results in an imbalance between exploitation capacity and ability of resources. Therefore, the economic efficiency of exploitation activities is gradually decreasing. Although the total production of marine products has been increasing continuously, the average yield (ton/year) shows a declining trend.
- Surveys and studies of marine resources in Vietnam's coastal waters (from a depth of 30m to the shore) have also shown some similarities: coastal fish stocks are depleted due to over-fishing and illegal exploitation; there are exploitation practices that destroy marine fisheries such as bottom trawling with small mesh netting; and using explosives and cyanide when fishing in coral reef regions.
- Destructive fishing techniques such as use of explosives, toxins, and electric shocks are rampant and uncontrolled in both inland and offshore waters, posing a serious threat to natural ecosystems of high biodiversity such as rivers, streams, lakes, seagrass beds and coral reefs in coastal waters of Vietnam.

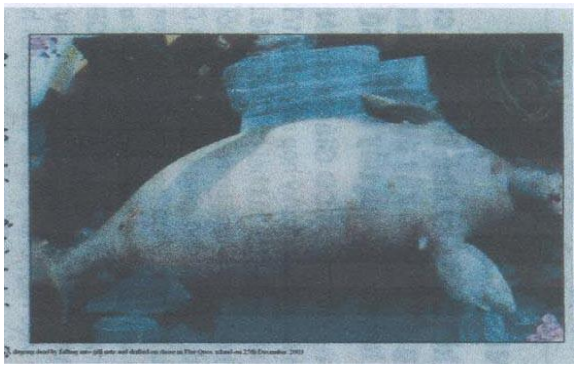
According to a survey by WWF in 2003, Phu Quoc and Con Dao are two small areas of Vietnam with a dugong population of no more than 100 animals. According to information from Mr. Phong, director of Phu Quoc MPA (2016), dugong has not appeared in the seagrass area of the MPA. The dugong population in Phu Quoc has a close relationship with the

dugong population living in neighboring waters of Cambodia. Perhaps due to hunting and also the seagrass habitat of dugongs in Phu Quoc often being degraded, the remaining dugongs have moved to the waters of Cambodia.

Figure 36. Bottom trawling occupies all kinds of fish, including juveniles, immature

(*Source: CWPD Project*)

Using net to catch dugong (*photo by Nguyen Van Tien, 2006*)



A Dugong caught a net in Phu Quoc seagrass on December 25, 2003 *(photo by Nguyen Van Tien et al., 2006)*

Figure 37. Illegal catching of dugong in Phu Quoc MPA

2.2.3. Illegal wildlife trade continues to occur

There is an increasing trend in the wildlife trade and its products. The consumption of wild animals has become common place in restaurants and sold publicly in the market, in spite of being in violation of the law and threatening the extinction of many animals. According to WWF, Vietnam has become one of the world's hot spots for hunting, exploiting and trading in wild fauna and flora. Results from a number of recent studies show that the demand for wild species is concentrated in big cities like Ho Chi Minh City and Hanoi. Meanwhile, provinces such as Quang Tri, Thua Thien Hue, Quang Nam, Ha Tinh, Nghe An, Gia Lai, and Kon Tum are places where wild species are exploited. At the same time, Vietnam is also seen as a transshipment country for the transboundary and transnational wildlife trade (*MARD, 2018*).

It is estimated that in Vietnam, there are currently less than 30 tigers left in the wild and are in danger of extinction because they are living in fragmented and degraded forests, with a lack of prey, while low adaptability and a small population is leading to the phenomenon of inbreeding (*Le Xuan Canh, 2016*).

According to the report of the Department of Forest Protection, from 2010 to 2016, forest rangers nationwide discovered and handled more than 174,000 cases of violating the law on forest management, development, protection and forest product management. Among them,

there were 4,305 cases of violations of wildlife management regulations involving the confiscation of thousands of kilograms of wildlife products and more than 60,000 individual wild animals, of which 3,418 individuals were classified as endangered species. Particularly in 2016, customs agencies discovered and confiscated 26 shipments of ivory and ivory products totaling nearly five tons, along with tons of pangolins, pangolin scales, turtles, bear limbs, and rhino horns, etc. smuggled for consumption in Vietnam, or for transfer to a third country. According to the Department of Forest Protection (2020), in 2018 and 2019, the national forest protection force detected and handled 466 cases of violations of regulations governing the management and protection of endangered wildlife (in 2018 was 239 cases, in 2019 was 227).

According to the General Department of Customs (2017), there are many species of animals and products of foreign origin such as rhino horn and elephant horn from Africa, as well as big cats, bears, pangolins, freshwater turtles, snake and monitor lizards originating from other Asian countries that were being traded, consumed and transshipped through Vietnam.

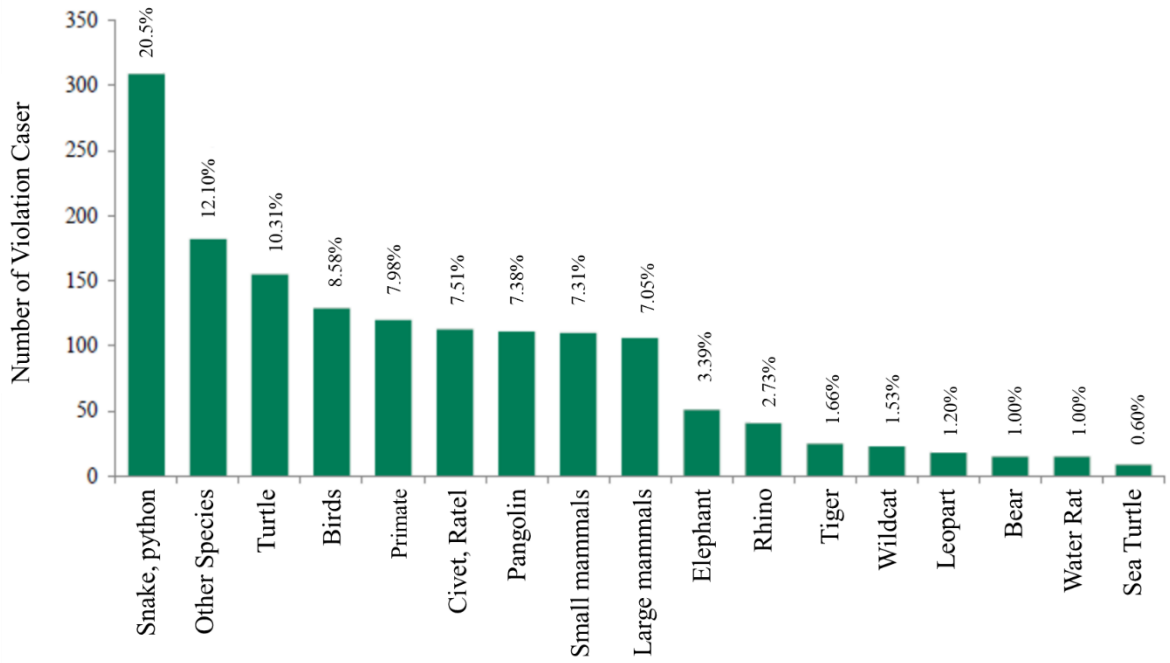


Figure 38. % of confiscated and handled cases of wildlife in 2013-2017

(Source: WCS, 2018)

2.3. Environmental pollution

The rapid urbanization and industrialization process has seriously affected air quality, land, inland water and coastal waters.

Air quality: According to Nguyen The Chinh (2017), air pollution in Vietnam has the following general features: at traffic points, intersections and construction sites, air pollution is showing signs of increasing, especially in big cities. In Ho Chi Minh City, the concentration of pollutants in the air along roads, mainly CO, increased by 1.44 times and PM10 dust increased by 1.07 times. In Hanoi, if there is no solution, the concentration of dust emissions can reach 200mg/m^3 in 2020, 10 times higher than the level recommended by the World Health Organization.

According to the National Report on Environmental Status (*MONRE, 2016*), in urban areas in Vietnam, the percentage of monitoring samples TSP exceeds the Vietnam standards of

national monitoring programs is always greater than 80% of the monitoring samples in year. In urban areas, NO_2, SO_2 and CO gases mainly come from transportation engines, while SO_2 arises from sources of sulfur and coal. Therefore, in urban areas, traffic precincts have the highest concentration of polluted gases. Ozone (O_3) is a secondary pollutant produced by the interaction between pollutants such as NOx, HC, VOC with solar ultraviolet radiation. At the automatic monitoring stations near the roads, O_3 concentration has exceeded the limit of Vietnam standards in many days of the year.

Water quality: Environmental pollution, especially water pollution has become increasingly serious in Vietnam. Surface water sources in some places are polluted, especially in urban areas, around industrial parks and craft villages. In river basins, pollution and water quality degradation are concentrated in the middle and downstream areas, many places are seriously polluted, such as in the basin of Nhue - Day river, Cau river, Dong Nai river system.

According to the National Report on Environmental Status (*MONRE, 2020*), surface water in urban rivers, lakes, canals and ditches in Vietnam has been mostly polluted by receiving waste from urban development, and with low self-cleaning capacity of waters, many lakes have become waste water storage waters of surrounding areas. Although efforts to improve have been made through projects to reduce surface water pollution in these areas, it is still a problem in most cities today. In addition, some river sections flow through urban areas in some provinces and cities that have been heavily polluted.

The research results showed that most lakes in Hanoi city have high nutritional levels, reflected by high concentration of phosphorus and nitrogen nutrient salts. Concentration of H_2S, CH_4, COD gas, BOD was also very high, causing eutrophication and blooming of microalgae. The algal bloom phenomenon occurred in West Lake with density of algae up to 249 million tb/l (*Duong Duc Tien, 1996*). In particular, the species of *Microcystis* genus (containing microcystins toxins - MCs) predominate (60-90% of the quantity) and contribute mainly to the algal bloom. The phenomenon of algal bloom also frequently takes place in Hoan Kiem Lake. Data on the algal bloom in Hoan Kiem Lake show that in the period of February to June there is a phenomenon of algal bloom of Cyanophyll *Microcystis* spp. with algae density of up to 200 million tb /l, forming floating dense algae on lakeside waters. In addition to algal bloom, eutrophication also reduces dissolved oxygen in water killing fish and shrimp in the lakes, and is especially the source of death of fish in West Lake, Hanoi in recent years.

Algal bloom of *Microcystis* spp.in Xuan Huong lake, Da Lat city

Sword Lake Turtle in the waters near Turtle Tower during the algal bloom of *Microcystis* spp. in the Hoan Kiem Lake, Hanoi city

Pollution killed many fish in the West Lake, Hanoi

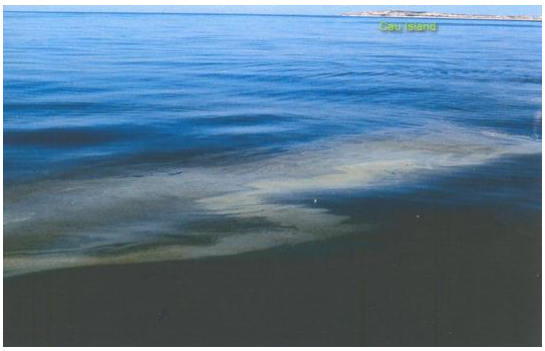
Algal bloom of *Microcystis* spp. in the Hoan Kiem Lake

Figure 39. Some pictures of organic pollution in some lakes

(Source: from various websites)

The coastal seawater environment in coastal urban areas is directly affected by socio-economic development activities such as seaport activities and tourism, coastal urban development and industrial zones. 70% to 80% of marine waste originates from inland sources, due to factories, industrial zones, and residential areas discharging waste water and solid waste without treatment to rivers and canals in coastal plains or directly into the sea.

Studies of toxic algae and red tides in coastal Vietnam show that some toxic microalgae bloom phenomena tend to thrive in the period from March to September, causing damage to aquaculture in water areas and coastal tidal areas. Some outbreaks of phenomena of harmful algal blooms, and red tides have been covered in published studies such as: the number of *Noctiluca scintillans* (sea sparkle) outbreaks in Van Phong - Ben Goi Bay in May and June 1995 that has caused damage to lobster farms for billions VND (*Nguyen Ngoc Lam et al., 1996*). The outbreak of Cyanophyta *Trichodesmium erythraeum* (sea sawdust) in Van Phong Bay (BinhThuan province) was recorded in March 1999 (*Nguyen Ngoc Lam, 1999*). The outbreak of fibrous algae *Phaecocystis globosa* that extended over 30 km along the coast in Phan Ri Bay, Binh Thuan in July and August 2002 destroyed all aquatic species in the area (*Sunday Youth Newspaper No. 31, 2002*). In April 2003, 82 people in the coastal village of Phu Hai (Phan Thiet-Binh Thuan) were hospitalized due to toxin infection of *Lyngbya majuscule* cyanobacteria (*Nguyen Ngoc Lam et al., 2004).*



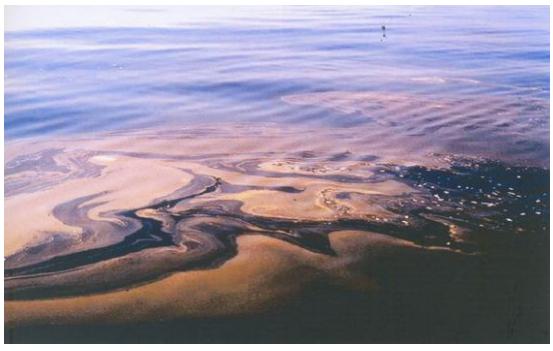


Figure 40. Algal bloom of *Trichodesmium erythraeum* cyanobacteria recorded March 26-27, 1999 in Phan Ri Bay, Binh Thuan province

(Photo: Nguyen Ngoc Lam, 1999)

In Vietnam, some oil spills from ships in river sections entering seaports or bays have seriously polluted coastal estuarine waters, which have very sensitive ecosystems, such as

mangroves, seagrass, tidal flats, and coral reefs with rich and diverse aquatic communities. According to statistics from 1995 to 2004, there were 35 oil spills in Vietnam's coastal sea with a total of 1,600 tons of oil spill (*National Report on Environmental Status, 2005*).

Soil quality:

In areas along big cities such as Hanoi, Ho Chi Minh City or areas with concentrated industrial and mining activities such as Thai Nguyen and Dong Nai, soil pollution caused by waste from industrial, construction and living activities is most clearly shown, with heavy metal content in the soil tending to increase. According to research institutes estimates, the level of soil pollution by 2020 will increase by 2-3 times compared to the current level, with indicators of pollution rising with the speed of industrial development and urbanization (*Nguyen The Chinh, 2017*).

Regarding locations of residues of plant protection chemicals (pesticides) causing serious and very serious environmental pollution, currently the whole country has 240 sites of pesticide residues in 15 provinces. In Dien Bien province, the results of monitoring in areas of pesticide depots in the province such as the area of the provincial Plant Protection Department, the storage of pesticides in Tuan Giao and the Tua Chua township in the period of 2011-2012, DDT content (mg / kg) in soil exceeded Vietnam standards (*QCVN 15: 2008/BTNMT*) from 1.34 to 3.86 times.

According to the "10-year report on implementation of the Stockholm Convention on persistent organic pollutants in Vietnam" (*MONRE, 2015*), by 2013, thousands of areas polluted by pesticides have been discovered in provinces and cities, with a focus on the northern and northern central regions. The concentration of pesticides in the soil at these points usually ranges from 10 to 50 ppm, however, some places can reach hundreds of ppm.

With the support of the GEF/WB Project - PCB in Vietnam, from 2012 to 2014, according to EVN by November 2014, the results of rapid analysis of chlorine in transformer oil showed that among more than 39,000 transformers there were 401 machines suspected of having PCBs in contaminated oil with a content exceeding the threshold of the Stockholm Convention (50 ppm), of which 112 have relatively high concentrations above 200 ppm. For the inventory of PCBs outside the electricity sector, the statistical results as of the end of 2014 showed that there were more than 35,712 devices suspected of being contaminated with PCBs and the project has conducted inventory of 9,000 machines and stored oil. Inventory results have detected a total of 930 tons of oil containing PCBs.

With expanding agricultural intensification, the use of various types of pesticides is becoming increasingly popular and uncontrolled in Vietnam, contributing to the degradation of ecosystems, reducing bird and insect populations in rural and suburban areas. Many useful birds specialized in killing harmful insects, along with many beneficial insects, have been destroyed, resulting in outbreaks of many diseases in the field.

2.4. Climate change

Climate change is impacting rapidly on species and ecosystems that are overexploited and losing habitats. Sea surface temperature and sea level rise due to thermal expansion of water and melting of continental glaciers are changing the behavior and demographic characteristics of marine species. Tropical storms and heavy rainfall have destroyed coral reefs, marine and coastal ecosystems. According to Doney et al. (2011), the impact of climate change on marine biodiversity has led to the loss or degradation of 50% of saline lagoons, 35% of mangroves, 30% of coral reefs and 20% of seagrass worldwide. Coral reefs are one of the most vulnerable ecosystems to the effects of climate change. Coral bleaching due to ocean acidification and unusually high seawater temperatures has become more frequent in recent times, killing corals and reducing coral cover, with coral reefs finding it hard to recover immediately. Cheung et al. (2009) (*cited in the IPCC Fifth Assessment Report*) forecasted the impact of climate

change on marine biodiversity by 2050 and predicts local extinctions, species invasion and turnover of more than 60% of current biodiversity due to ecological disorders capable of disrupting ESs.

Vietnam is one of the five countries most affected by global climate change. In this context, natural ecosystems that are already fragmented will inevitably adapt less to these changes and cannot avoid a very high rate of loss of species. According to climate change and sea level rise scenarios for Vietnam (*MONRE, 2016*), the following hazards and impacts are anticipated:

Risk of flooding with 100cm sea level rise:

- About 16.8% of the Red River Delta area, including 4.79% of Quang Ninh province are at risk of flooding;
- About 1.47% of the land area of the central coastal provinces from Thanh Hoa to Binh Thuan provinces is in danger of being inundated. In particular, Thua Thien - Hue Province has the highest risk (7.69% of the area);
- About 17.8% of Ho Chi Minh City's area, about 4.79% of Ba Ria - Vung Tau area is in danger of being inundated;
- The Mekong River Delta is a high-risk area (with 38.9% of the area);
- The highest risk islands are the Van Don island cluster, Con Dao and Phu Quoc island groups. The risk of flooding for the islands of the Spratly Islands is not great. Hoang Sa archipelago is at greater risk of flooding, especially for some islands such as Crescent Island and Tri Ton Island.

In Viet Nam, the Red River Delta, Ho Chi Minh city and the Mekong River Delta and other coastal areas are most severely affected by climate change.

Climate change affecting all ecosystems in Vietnam:

With such a sea level rise scenario, 78 out of 286 "critical habitats" (equivalent to 27%), 46 protected areas (equivalent to 33%), 9 biodiversity areas of national and international value (23%) and 23 other biodiversity areas in Vietnam would be severely affected.

Climate change is characterized by main factors such as rising temperatures, sea level rise, precipitation, and natural disasters. These factors subject all ecosystems and living things to climate change impacts. Many wild plants and animals will suffer increasing pressure due to changes in habitat, food sources and natural disasters such as floods, droughts and storms. Some species of plants and vertebrates may be at risk of extinction in the next century due to climate change effects. However, there has been limited knowledge of impacts of climate change on biodiversity in Vietnam.

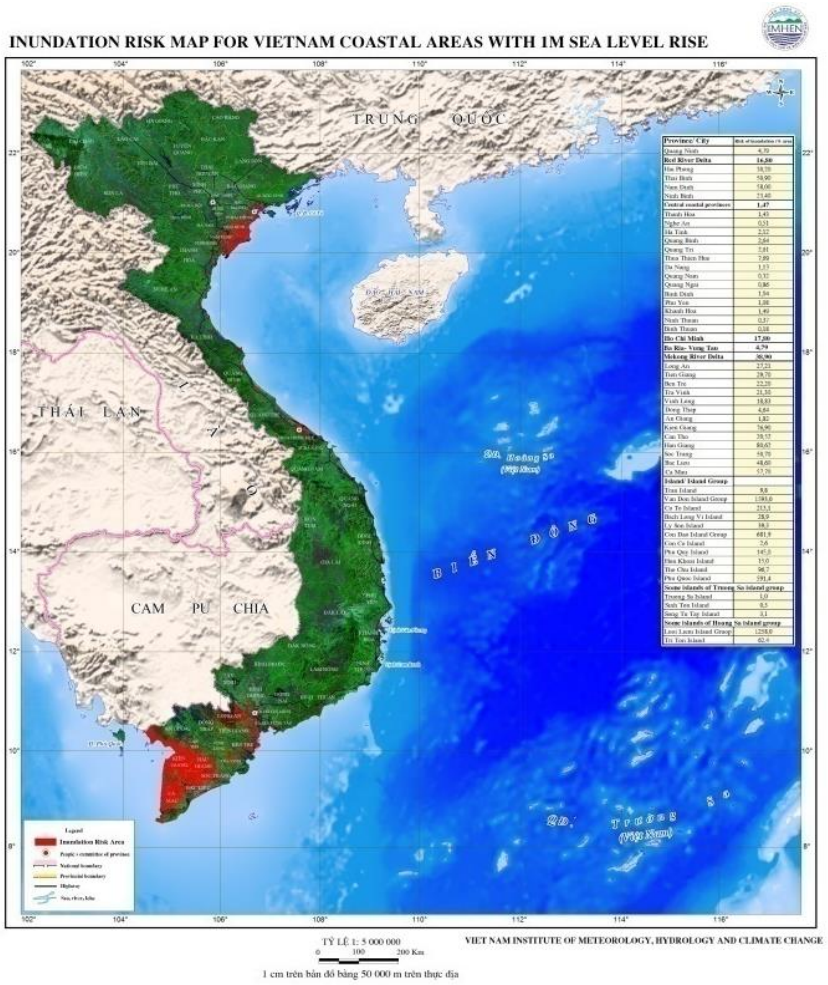


Figure 41. Inundation risk map for Vietnam coastal areas with 1m sea level rise

(Source: MONRE, 2016)

Figure 42. Inundation risk map for Red River Delta and Quang Ninh province with 1m sea level rise

(Source: MONRE, 2016)

Figure 43. Inundation risk map for Mekong River Delta with 1m sea level rise

(Source: MONRE, 2016)

Coral reef ecosystems are most severely affected by climate change

In coastal waters, coral reef ecosystems are considered to be most vulnerable to climate change. Research results on coral reefs in Vietnam showed that coral reef bleaching in 2010 led to mass die-offs, which could be traced to rising sea temperatures. If the sea temperature is rises above 29^{o}C for a long time, coral will lose its symbionts leading to bleaching and dying (*Vo Si Tuan, Nguyen Huy Yet and Nguyen Van Long, 2005*). After Hurricane Linda and coral bleaching in 1998, the area of coral reefs that remained alive in Con Dao and Phu Quoc seas sharply declined, even some coral reefs in Con Dao were severely degraded with coral cover at almost 0% (*Vo Si Tuan, Nguyen Huy Yet and Nguyen Van Long, 2005*).

According to data from Du Van Toan (2011), the degree of calcification of coral reefs is directly proportional to the concentration of CO_2 in seawater. If the concentration of CO_2 in 2050 is 560 ppm, the coral reef will be destroyed, only 40% compared to 1950. From global information on the scenario of the impact of CO_2 emissions to the ocean, the South China Sea will be strongly impacted. Many regions in these areas, pH will decrease by 0.3, meaning that the seawater here is directed towards high acidification in the world's oceans.

Table 24. Coral growth (%) in the South China Sea and CO_2 emissions

Year	1950	2000	2030	2050	2100
CO_2 (ppm)	280	380	450	560	750
Coral reef (%)	100	80	60	40	20

(Source: Du Van Toan, 2011)

2.5. The introduction of invasive alien species

Experts say that invasive species are at risk of biological pollution because by nature these species occupy a wide ecological spectrum, so have the innate ability to grow and develop strongly in different geographical areas. When introduced, invasive alien species populations will develop quickly, overwhelming native species by depriving them of food and habitat, and even eroding native genetic resources due to hybridization. Concerns about the risk of harm of invasive alien species to biodiversity, human health and the economy are increasing, especially after yellow snails (*Pomacea canaliculata* and *P. insunarum*) were introduced into South Vietnam in the late 80s and now spread nationwide. As of 1997, yellow snails harmed 132,000 ha of rice fields, causing millions USD in losses each year due to reduced rice production.

According to statistics, there are now 94 alien plant species imported into Vietnam, including 42 invasive species and 12 types of fast-growing invasive species such as *Mimosa pigra* and Japanese duckweed (*Eichhornia crassipes*). Among these, mimosa was first discovered in Tram Chim National Park (Dong Thap province) in 1995, and has since spread almost everywhere and has become a major risk in many wetlands throughout the country.

In 2009, MARD announced a list of 48 alien aquatic animals that have invaded Vietnam through many ways, of which 14 species are considered to have harmful effects on aquatic biodiversity. Moreover, yellow snails, red-eared turtles, and freshwater lobsters, are also internationally recognized as dangerous invasive species, negatively impacting biodiversity, economic sectors and peoples' health, but continue to be imported into Vietnam. Specifically, in 2010, Can Tho Seafood Import Joint Stock Company imported 40 tons of red-eared turtles from the US to breed at Can Tho Aquaculture Breeding Center in Mai Dam hamlet, Phu Thanh commune, Tra On district, Vinh Long Province, while Phu Thanh Limited Company in Vinh Chau district (Soc Trang province) imported freshwater lobster from the US to be cultured in Tran De district. These species are capable of intense outbreaks and have serious consequences when they establish populations.

In 2013, MONRE and MARD issued a joint circular no.27/2013/TTLT-BTNMT-BNNPTNT providing criteria for identifying invasive alien species and promulgating the list of invasive alien species. Accordingly, with respect to the list of 25 invasive alien species and 15 potential invasive alien species that have already appeared in the country and 41 potential invasive alien species have not yet appeared in the territory of Vietnam.

Although there have been efforts in managing and controlling invasive alien species by MONRE and MARD but there are still problems in this area as follows:

- There is inconsistency in the management mechanism for invasive alien species and duplication in lists of invasive alien species among different legal documents on biodiversity.
- Due to shortage of financial resources, there has been no comprehensive investigation and assessment on the harm and losses caused by invasive alien species in Vietnam in order to have measures to control, eliminate and minimize negative impacts of invasive species.
- Current efforts to control the eradication of invasive alien species are sporadic and inconsistent, mainly in places where invasive alien species have significantly impacted on livelihoods, production, and some national parks and protected areas.
- The assignment, decentralization and responsibility among management agencies in control of invasive alien species are unclear and overlapping. There has been no consistency in management and licensing of invasive alien species imported into Vietnam.

- Capacity to assess vulnerability and capacity to control invasive alien species remains limited.
- Provincial specialized agencies designated for the management of invasive alien species are Departments of Natural Resources and Environment (DONRE), but they have no full-time staff to carry out this task.

III. IMPACTS OF CHANGES IN ECOSYSTEM SERVICES ON THE SOCIO-ECONOMY

3.1. Interaction between ecosystem services and the socio-economy

According to Silvis H.J. and C.M. van der Heide (2013), the term ecosystem services - the economic and societal benefits derived from nature and the landscape - emerged in recent policy papers such as the UN Millennium Ecosystem Assessment in 2005 and the European Union project entitled The Economics of Ecosystem services and Biodiversity (TEEB) in 2010. It is advocated mainly by conservationists as a concept to underline the importance of nature as a source of welfare and well-being for mankind, apart from and in addition to its intrinsic value.

Economists tend to think of nature rather in terms of natural resources, and this has far more often been the subject of economic thought during the last few centuries than most people realize. Concerns about the effective allocation of human resources and human capital stem from the period of industrialization to the end of the twentieth century. However, before that period and in recent decades, the exploitation of natural resources has always been the focus of economies. 40% of the global economy is estimated to be based on biological products and processes (*WEHAB, 2002*). Costanza et al. (2014) estimated the global value of ecosystem services at an average of trillion USD/year in 1995 and 46 trillion USD/year in 2007. These authors estimated the total value of global ecosystem services in 2011 were 125-145 trillion USD. This shows that the economic value of ecosystem services can be measured in monetary terms.

3.2. Impacts of changes in ecosystem services on the socio-economy

Regarding the economic values of ecosystem services, MA classifies ecosystem services into four classes as mentioned before.

In the case of Vietnam, all of these interactions between ecosystem services with economic and social sectors are relevant, as shown in the table below.

Table 25. Framework for determining the interrelationship between ecosystem services and socio-economic sector

Ecosystem services	Products and services	Related economic and social sectors
Provisioning services		
Timber and products from timber Non-timber forest products (NTFPs) Fishery Other natural products	Timber for construction, veneers and flooring; wood chip for board, pulp for paper; timber products for woodfuel, including stumps and roots, and harvesting residue. Products such as food derived from plants, fungi, wildlife; materials (e.g. bamboo); medicines; plants for fatty oil ... Aquatic species exploited naturally: fish, crustaceans, molluscs, echinoderms, seaweed, sea grass etc.; aquatic species of economic value from farming; products with bioactive substances ... Sand, pearls, minerals	Agriculture (including forestry and fisheries) Industry and trade Health Construction

Water sources	Inland water: the provision of water through the interception of rain, mist and fog, which is then transferred to the soil and into a watercourse and groundwater (forest and wetland ecosystems). Sea water: provision for industrial use of sea water	Resources-Environment Agriculture Industry and trade
Biodiversity and Genetic resources	Protected areas (in-situ) and Conservation units (ex-situ) for storage of genetic resources (precious, rare, endemic, economic value).	Resources-Environment Science and technology Industry and trade Culture, tourism Educations, training Information, Communication
Regulating services		
Climate regulation	Carbon storage and capture (sequestration); temperature, wind, ultra-violet light regulation (e.g. by forest).	Resources-Environment Health
Regulation of natural disasters	Protecting and controlling soil erosion and precipitation, preventing flood regulation by delaying and attenuating peak river flows; protecting the shoreline from storms, coastal erosion, and sea - level rise (mangroves, seagrass carpets, etc.)	Resources-Environment Agriculture
Environmental regulation (including noise)	Trees can minimize pollution, including diffuse pollution from soil, water and atmosphere, improve the quality of environment, and reduce noise. Water purification and waste treatment.	Resources-Environment
Disease and pest regulation	Regulating diseases, and pests reduces the harmful effects of some pests and pathogens.	Agriculture Health
Pollination	Trees, woodlands and forests provide habitat for pollinator species.	Agriculture
Cultural services		
Health	Physical health benefits such as places for sightseeing, entertainment and relaxation; mental wellbeing and recovery; leisure activities	Health Culture, tourism
Nature/landscape connections and social development	Connect with both landscapes and wildlife, including biodiversity and human ecology with social welfare. Strengthen existing social relationships, create opportunities for new relationships, including those involved in nature discovery volunteer groups.	Culture, tourism Educations, training Information, Communication
Education and training	Ecosystems as basis for extra-curricular education for students from primary school to university and postgraduate levels. Studies show the importance of educating children and young people with nature.	Educations, training Information, Communication
Economy	Contribute to local livelihoods through job creation, support for forestry, fisheries, entertainment, tourism and resort industries.	Agriculture Industry and trade and tourism
Symbolic, cultural and spiritual significance	Includes use and non-use values e.g. contribution to culture, history, religion, aesthetic values, social relations, connections to historical or folk figures, and/or legends.	Culture, tourism Educations, training Information, Communication

Supporting services		
Primary productivity	The fixation of carbon dioxide by photosynthesis produces organic matter, leading to plant growth and oxygen production.	Resources-Environment Agriculture
Soil formation	The breakdown of the underlying geology by roots and microbial fauna (mineral weathering) and the accumulation of organic matter from leaf litter within the soil layer.	Resources-Environment Agriculture
Nutrition cycle	Enhance the nutrient cycle in water and sediment environments, providing essential nutrients such as nitrogen and phosphorus needed for the feed cycle of the ecosystem.	Resources-Environment Agriculture
Water cycling	Plays an important role in providing water in the hydrological cycle, and the ability to prevent moisture and evaporate water.	Resources-Environment Agriculture
Biodiversity	Biodiversity and the associated genetic variation within locally adapted species and provenances can support flora and fauna that contributes to woodland dynamics, including providing habitats for pollinators and below-ground flora and fauna that maintain the decomposition processes underpinning soil formation and nutrient cycling.	Resources-Environment Agriculture

In Vietnam, although not yet officially recognized, the use of ecosystem services has contributed significantly to the national economy, especially in the agricultural, forestry, fisheries, tourism and health sectors. According to the Statistical Yearbook (2021), the agriculture, forestry and fishery sectors contributed significantly to the gross domestic product (GDP), their export value increased from 19 billion USD in 2010 to 41.250 billion USD in 2020, accounting for 14.6% of the country's export turnover and 14.85% of GDP in 2020, and 12.36% of GDP in 2021. If calculating the products from the resources of agro-forestry, agricultural and marine ecosystem services, the gross domestic product at current prices in 2018 of agriculture and forestry sectors, aquatic products and minerals was 1,221,952 billion VND (equivalent to 55.54 billion USD), accounting for 22.04% of GDP. This shows the significant economic significance and value derived from forest, wetlands, and coastal and marine ecosystem services in Vietnam (direct use values). In addition, the values of indirect use, selection and non-use of ecosystem services have not been evaluated and statistics fully analyzed.

Thus, it can be seen that the values (use and non-use) of ecosystem services through products and services have made important contributions to the socio-economic situation of Vietnam in related industries such as environment, agriculture (including forestry and fisheries), industry and trade, health, science and technology, education and training, culture-tourism, and communication.

The above analysis, especially from the ecosystem services and socio-economic model under the DPSIR framework, shows the drivers and pressures on different scenarios affecting ecosystem services (provisioning capacity of ecosystem services), and changes in ecosystem services all have certain impacts on the socio-economy in Vietnam.

However, over recent decades, it is also necessary to see that in the drivers and pressures affecting ecosystem services, there are effects that denote "positive" impacts registered as continuously increasing output, quantity or revenue of a number of economic sectors such as agriculture, fisheries, industry and trade, and tourism meeting the increasing needs of people.

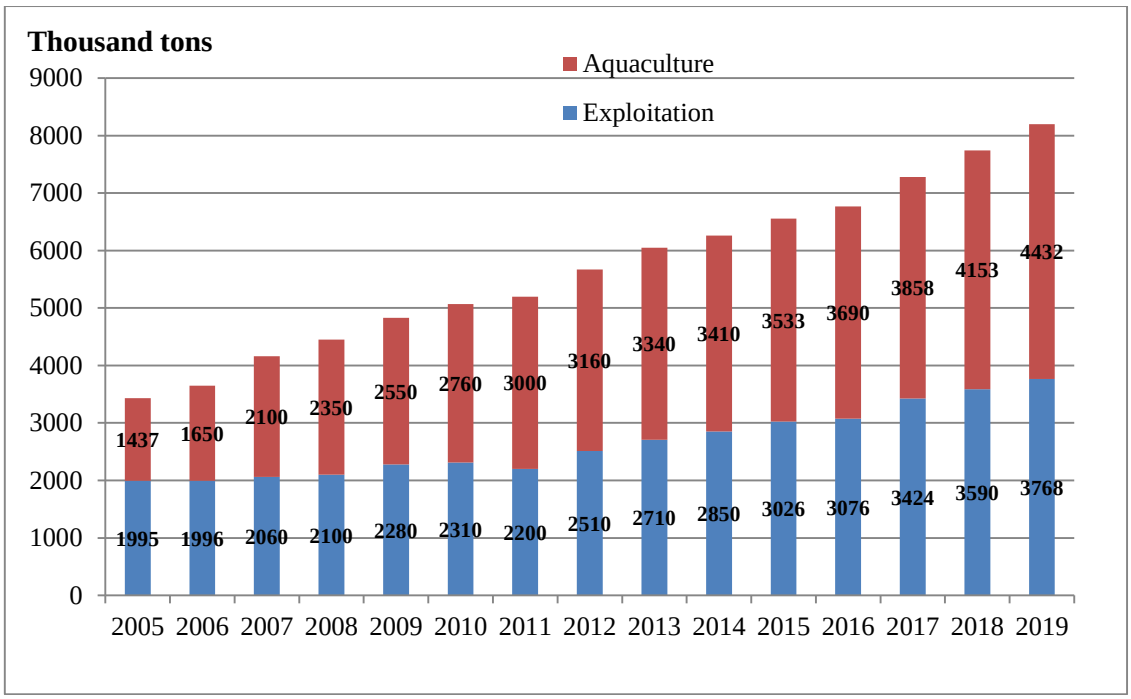


Figure 44. Growth of Vietnam's Fisheries Sector

(*Source: Directorate of Fisheries, 2020*)

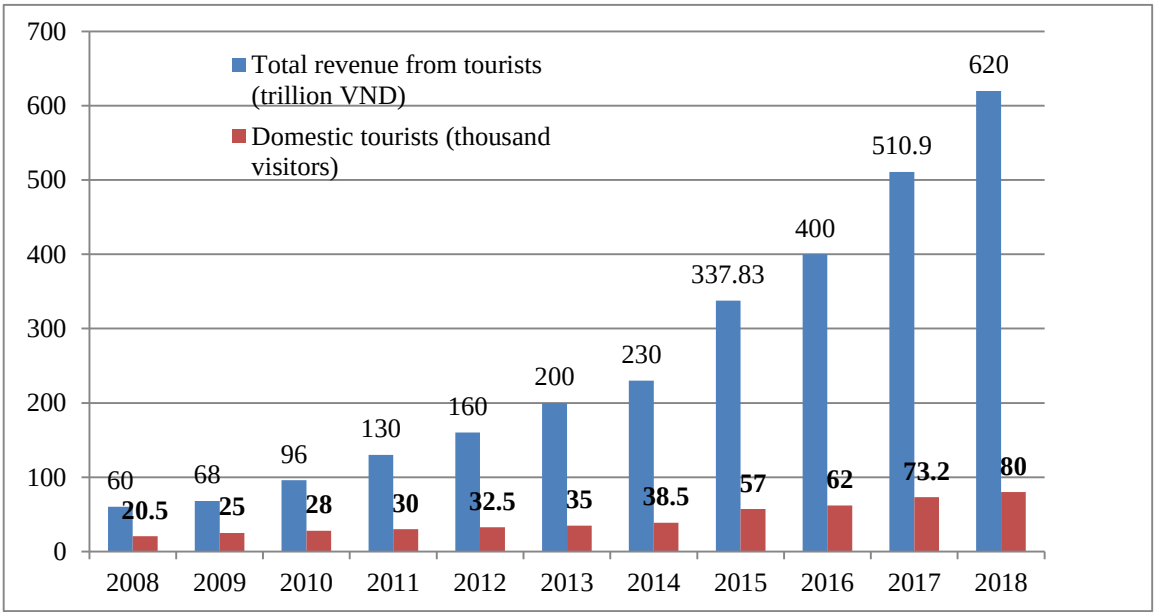


Figure 45. Growth of Vietnam's tourism industry

(Source: Vietnam Administration of Tourism, 2019)

According to MA (2005), there have been many changes in biodiversity and ecosystems implemented in order to increase the productivity of specific ecosystem services such as production of food exports. But only 4 of the 24 ecosystem services examined in this evaluation report had shown growth: cultivation, livestock, aquaculture and (in recent decades) carbon sequestration, while 15 other services were degraded.

According to the 2019 IPBES report, since 1970, trends in agricultural production, fish harvest, bioenergy production and harvest of materials have increased, but 14 of the 18 categories of contributions of nature that were assessed, mostly regulating and non-material contributions, have declined.

The downside of achieving these significant economic development numbers has been the trade-off of ecosystem degradation and biodiversity loss and consequently, ecosystem services degradation. Due to dynamics and pressures such as exploitation and use of products and services, this degradation is tending to increase, exceeding the supply capacity of ecosystem services, resulting in: reduced natural forest area; reduced seagrass beds area; lower coral reef coverage; reduced number of endangered species individuals; increased number of endangered species; critical levels of natural marine catch; increased environmental pollution from economic development:

Natural forest area is reduced: according to the report of the Government in 2018 on the results of three years of implementing the Program for sustainable forestry development in the period of 2016-2020, in the 3 years 2016-2018, the area of damaged forest averages 2,430 ha/year. Statistics from MARD, from 2010 to 2017 showed the natural forest area was tending to decrease, while the area of planted forests was increasing. However, plantation forests are usually monocultures, so the diversity of animal groups in the forest is much less diverse than that of natural forests, which are evergreen vegetation.

Area of seagrass beds is reduced: Nguyen Thi Thu, Cao Van Luong and others (2011) reported that in 10 years an average of 40-50% of coastal seagrass has been lost.

Coral reefs with lower coverage: Under the framework of the project "Preventing the trend of environmental degradation in the East Sea and Gulf of Thailand, UNEP/GEF/SCS" chaired by the Institute of Oceanography, a survey was conducted over 200 points of Vietnam's coastal sea, showing that only about 1% of coral reefs have a high coverage while the number of reefs with low coverage accounts for over 31%, the number of coral reefs with average or slight coverage were 41% and 26% respectively. Low coral reef coverage is causing the community of living reef animals to decline in the number of individuals and in species composition. Their role is being the source of spread of marine animal resources from coral reefs to neighboring seas has also gradually decreased.

Endangered species with reduced number of individuals: monitoring results for many years in some important bird areas show the number of rare and precious species, especially the globally endangered migratory birds in the PAs is decreasing, with some species having not been seen for years.

The number of endangered species is increasing: in 2014-2017, a proposal to include in the Vietnam Red Book in the next period, 1,211 newly ranked species, including: 600 species of plants and mushrooms and 611 animals. Thus, compared to the Red Book of Vietnam 2007 (the total number of threatened species is listed as 882 species, consisting of 418 animal species and 464 plant species), the number of species proposed for the Red Book of Vietnam in this new period has been considerably enlarged.

The yield of natural seafood exploitation is critical: according to the Voluntary Review Report on implementing the sustainable development goals (*VCR, 2018*), there are too many fishing boats, and the situation of allowing free participation in fishing of small vessels, and the uncontrolled increase in the number of boats has caused an imbalance between exploitation capacity and resources. Therefore, the economic efficiency of exploitation activities is gradually decreasing. Although the total output of natural seafood exploitation increases continuously, the average yield (ton/year) shows a downward trend. On the other hand, natural seafood production in Vietnam may have reached the threshold of exploitation capacity.

Exploitation rates of some species, mainly in ocean areas, are high, signalling over-exploitation. Sizes of fish species that dominate production volumes in mostly coastal regions of Vietnam are relatively small, with animals not reaching sexual maturity. The proportion of

sexual immaturity about 58%in the Gulf of Tonkin, 64% in the Central Coastal, 40% in the South-East and 44% in the South-West.

Socio-economic development in coastal areas has increased the pollution of coastal waters, affecting marine ecosystems, and affecting people's lives. The amount of marine plastic waste from land-based sources is increasing, and Vietnam is one of the countries with the largest amount of plastic discharged to the sea. Air pollution, especially PM 2.5 fine dust, as measured by the air quality index (AQI) is continuously high for many days, with very poor air quality, especially in big cities like Hanoi and Ho Chi Minh City as well as many other places in the Northern Delta.

Environmental pollution, together with the unhealthy eating habits of a part of the population, have led to dangerous epidemics for humans at global level such as the SARS, respiratory syndrome epidemic in 2002-2003 and Covid-19 in 2019 to now.

In addition to reducing or losing the ability to provide products, degraded ecosystems and decreased biodiversity will no longer be able to provide other services such as environmental regulation, culture and support that have not yet been properly accorded a monetary value by researchers.

PART V. FUTURE SCENARIOS FOR THE ECOSYSTEMS AND THEIR SERVICES

Key Findings

1. The first future plausible scenarios for ecosystems and their services were developed in Vietnam, examining the potential effects of changes in drivers and pressures

Four various plausible scenarios have been developed through the NEA and applied to better understand likely future pathways for ecosystems and their services in Vietnam such as: (i) development as usual scenario; (ii) feasible base scenario; (iii) higher growth scenario; and (iv) sustainable development scenario associated with conservation.

In the four scenarios above, the sustainable development scenario associated with conservation is considered the most positive trend, as the goals of the Government's 2030 Agenda Implementation Plan can be achieved, which include: sustainable economic growth with respect to social justice, and protection of the ecological environment, effective management and use of natural resources, proactive response to climate change; ensuring that all people are promoted to their full potential, participate and equally enjoy the fruits of development; building a peaceful, prosperous, inclusive, democratic, equitable, civilized and sustainable Vietnam society.

2. The movement of drivers and pressures according to the scenarios developed under Vietnam's NEA shows that some factors (such as population growth) will become less important while others (such as population distribution) will be more important

In the four plausible future scenarios, the drivers and pressures affecting the ecosystem are predicted to be basically the same as in the past, but the relative importance of the different drivers and pressures is different. Some factors (such as population growth) tend to decrease in importance in some scenarios, while others (population distribution, environment, climate change, and land/water use change, etc.) will more important.

3. The scenarios developed by Vietnam's NEA predict changes in the quality of ecosystems and their services due to clear changes between the scenarios in provisioning and regulating services

In the four scenarios above, predicted changes in the quality of provisioning services and regulating services shows clear changes between the scenarios. The scenario of *sustainable development associated with conservation* is considered to show a positive trend, with an important goal of harmonizing conservation and development, not trading off economic development at all costs and harming the environment and biodiversity. This scenario would also help Vietnam to meet the Aichi biodiversity targets and the Sustainable Development Goals.

4. Seven sets of measures proposed in Vietnam's NEA show ways to improve proactive management of ecosystems and their services

For active management of ecosystems and sustainable use of their services, based on the lessons learned from the scenarios, some solutions are proposed as follows: (i) complete the legal framework (revise, amend the Biodiversity Law to be consistent in some regulations to accord with the current situation); (ii) improve effective decision-making processes (tools as facilitating transparency, stakeholder engagement, developing plans; data collection and feedback, etc.); (iii) institutional and governance changes; (iv) integrate the conservation and sustainable use of biodiversity and the contribution of nature to people into sectoral policies, plans, programs and strategies (integrated approaches across sectors); (v) economics and incentives for regulating the use of ecosystem's goods and services; (vi) other necessary responses (social and customary responses, modern technology development, knowledge and awareness raising, strengthening biodiversity conservation management capacity); and (vii) develop and apply sustainable livelihood models to communities in agriculture, forestry and

fishery areas, especially in the buffer zones of nature reserves (ecotourism development in association with biodiversity conservation, combined model of agriculture-forestry-fishery, integrated model of climate change adaptation solutions based on ecosystems, community-based conservation, etc.).

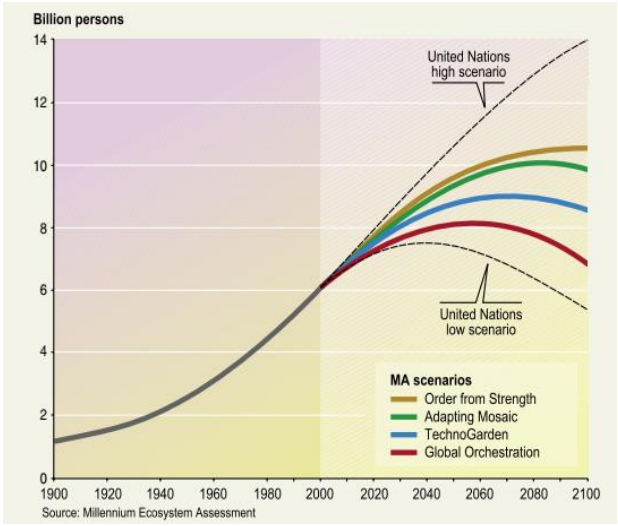
I. CONTEXT AND BACKGROUND

1.1. An overview on scenarios related to biodiversity and ecosystem services

1.1.1. Scenarios on ecosystems and their services in the MA report

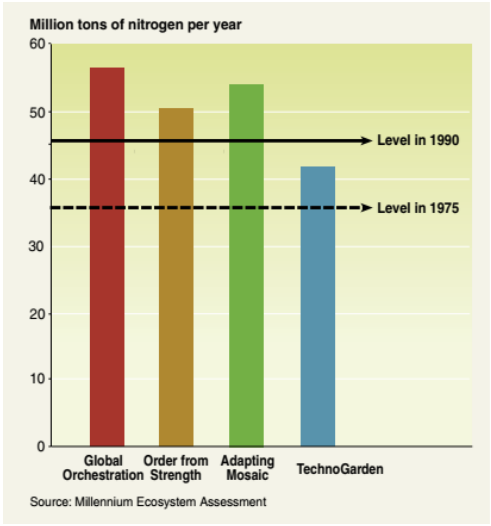
Experts have shown that ecosystems importantly impact on the socio-economy and human modified ecosystems. One of the goals of MA was to develop the first global set of scenarios to explore the importance of ecosystems and ecological change to human well-being while maintaining awareness of the importance of social and economic change. MA (2005) has developed four global scenarios to explore a plausible future for ecosystems and human well-being. The scenarios were developed with conditions up to 2050, although they included some information until the end of the century. Experts studied two global developments as part of this process: the increasingly globalized and increasingly regionalized world; and two different approaches to ecosystem management, reactive management of ecosystems with problems are only resolved after they have been clearly identified, and proactive management with policies in place to maintain ecosystem services in the long term. The four scenarios of MA are:

1. **Global Orchestration**: This scenario describes a globally connected society focused on global trade and economic liberalization and takes a reactive approach to ecosystem problems. However, it also takes strong steps to reduce poverty and inequality and invest in public goods such as infrastructure and education. Economic growth is the highest of the four scenarios, while this scenario is assumed to have the lowest population by 2050.
2. **Order from Strength**: This scenario represents a regionalized and fragmented world that is concerned with security and protection, emphasizes primarily regional markets, pays little attention to public goods, and takes a reactive approach to ecosystem problems. Economic growth rates are the lowest of the scenarios (particularly low in developing countries) and decrease with time, while population growth is the highest.
3. **Adapting Mosaic**: In this scenario, regional watershed-scale ecosystems are the focus of political and economic activity. Local institutions are strengthened and local ecosystem management strategies are common; societies develop a strongly proactive approach to the management of ecosystems. Economic growth rates are somewhat low initially but increase with time, and the population in 2050 is nearly as high as in *Order from Strength*.
4. **Techno-Garden**: This scenario depicts a globally connected world relying strongly on environmentally sound technology, using highly managed, often engineered, ecosystems to deliver ecosystem services, and taking a proactive approach to the management of ecosystems in an effort to avoid problems. Economic growth is relatively high and accelerates, while population in 2050 is in the mid-range of the scenarios.

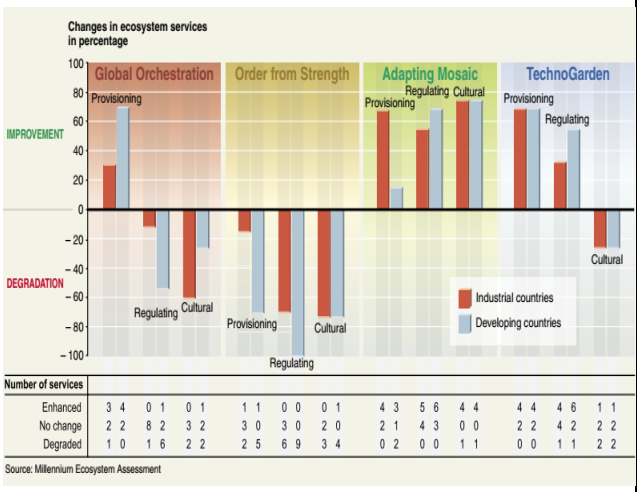


MA world population scenarios

Population is projected to grow to 8.1-9.6 billion in 2050 (medium to high certainty) and to 6.8-10.5 billion in 2100, depending on the scenario

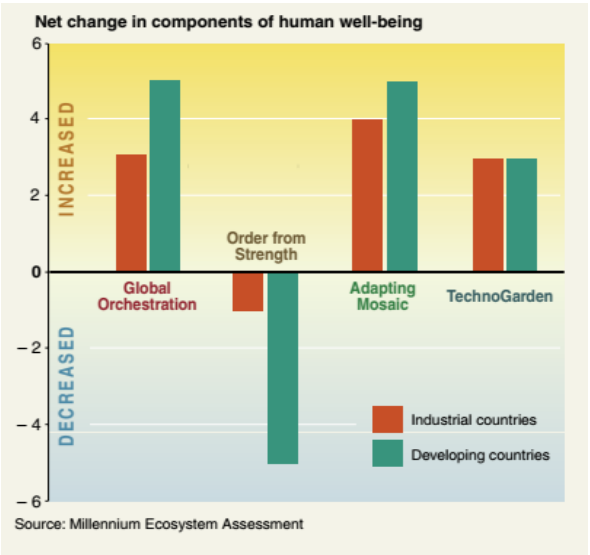


Comparison of global river nitrogen export from natural ecosystems, agricultural systems, and sewage effluents, 1975 and 1990, with model results for the MA scenarios in 2030



Number of ecosystem services enhanced or degraded by 2050 in the four MA scenarios

The Figure shows the net change in the number of ecosystem services enhanced or degraded in the MA scenarios in each category of services for industrial and developing countries expressed as a percentage of the total number of services evaluated in that category. Thus, 100% degradation means that all the services in the category were degraded in 2050 compared with 2000, while 50% improvement could mean that three out of six services were enhanced and the rest were unchanged or that four out of six were enhanced and one was degraded. The total number of services evaluated for each category was six provisioning services, nine regulating services, and five cultural services.



Net change in components of human well-being

The Figure shows the number of components of human well-being enhanced minus the number degraded for each scenario between 2000 and 2050 for industrial and developing countries. This qualitative assessment of status examined five components of human well-being: material well-being, health, security, good social relations, and freedom of choice and action.

Figure 46. MA scenarios
(*Source: MA, 2005*)

1.1.2. Scenarios on the 2050 vision for biodiversity of the CBD

The secretariat of the Convention on Biological Diversity (CBD) in 2017 published document on ‘Scenarios for the 2050 vision on Biodiversity’. Of them, the "business as usual scenarios"

for 2050 shows unsustainable results, with biodiversity continuing to be lost. An overview on the scenarios and their role in informing decision making on biodiversity is also provided. Some general conclusions of this document are:

- *The 2050 Vision of the Strategic Plan remains relevant and should be considered in any follow up to the Strategic Plan for Biodiversity 2011-2020*. The 2050 vision contains elements that could be translated into a long-term goal for biodiversity and provide context for discussions on possible biodiversity targets for 2030 as part of the post-2020 global biodiversity framework;
- *Current trends*, or "*business as usual scenarios", predictions in 2050 show unsustainable results, and further loss of biodiversity*: increased demand for fertile land from agriculture and bioenergy, resulting in increased pressure on natural terrestrial habitats and large declines in biodiversity; collapse of many wild fisheries, and their replacement by aquaculture, with potential consequent increased pollution, demand for high protein feed and further competition for land; climate change leading to biodiversity loss, ecosystem change and disruption of food production systems; and increased water scarcity in many regions, resulting in reduced water flow for vulnerable freshwater ecosystems. At local levels, declines in biodiversity could undermine agricultural productivity. At regional scales, combinations of drivers could push some ecosystems beyond tipping points, with serious implications for human well-being.
- *Scenarios of future socioeconomic development demonstrate that there is a wide range of plausible futures* with respect to population growth, education, urbanization, economic growth, technological development and approaches to international trade, among other factors, leading to varying levels of climate change, land-use change and other drivers of biodiversity change. This range of plausible futures provides space for developing policy measures to achieve the 2050 vision and other global goals;
- *A coherent approach is needed on biodiversity and climate change* to ensure that impacts on biodiversity of climate change are reduced, that biodiversity and ecosystems can contribute solutions to climate adaption and mitigation, and that climate mitigation measures do not negatively impact biodiversity through land-use change.

1.1.3. Scenarios in reports of the IPBES

In 2016, at the 6th Plenary Meeting, the IPBES Assessment Report described four different types of scenarios, each playing an important role in relation to the main phases of the policy cycle: (i) “exploratory scenarios” that can support agenda setting; (ii) “target - seeking scenarios” that can support policy design; (iii) "policy-screening scenarios" to support the implementation; and (iv) “retrospective policy evaluation” that can support policy review.

By 2019, at the 7th plenary meeting, the IPBES Assessment Report described three scenarios:

1. **The** "**global sustainability**" scenario combines proactive environmental policy and sustainable production and consumption with low greenhouse gas emissions;
2. **The** "**regional competition**" scenario combines strong trade and other barriers and a growing gap between rich and poor with high emissions; and
3. **The** "**economic optimism**" scenario combines rapid economic growth and low environmental regulation with very high greenhouse gas emissions.

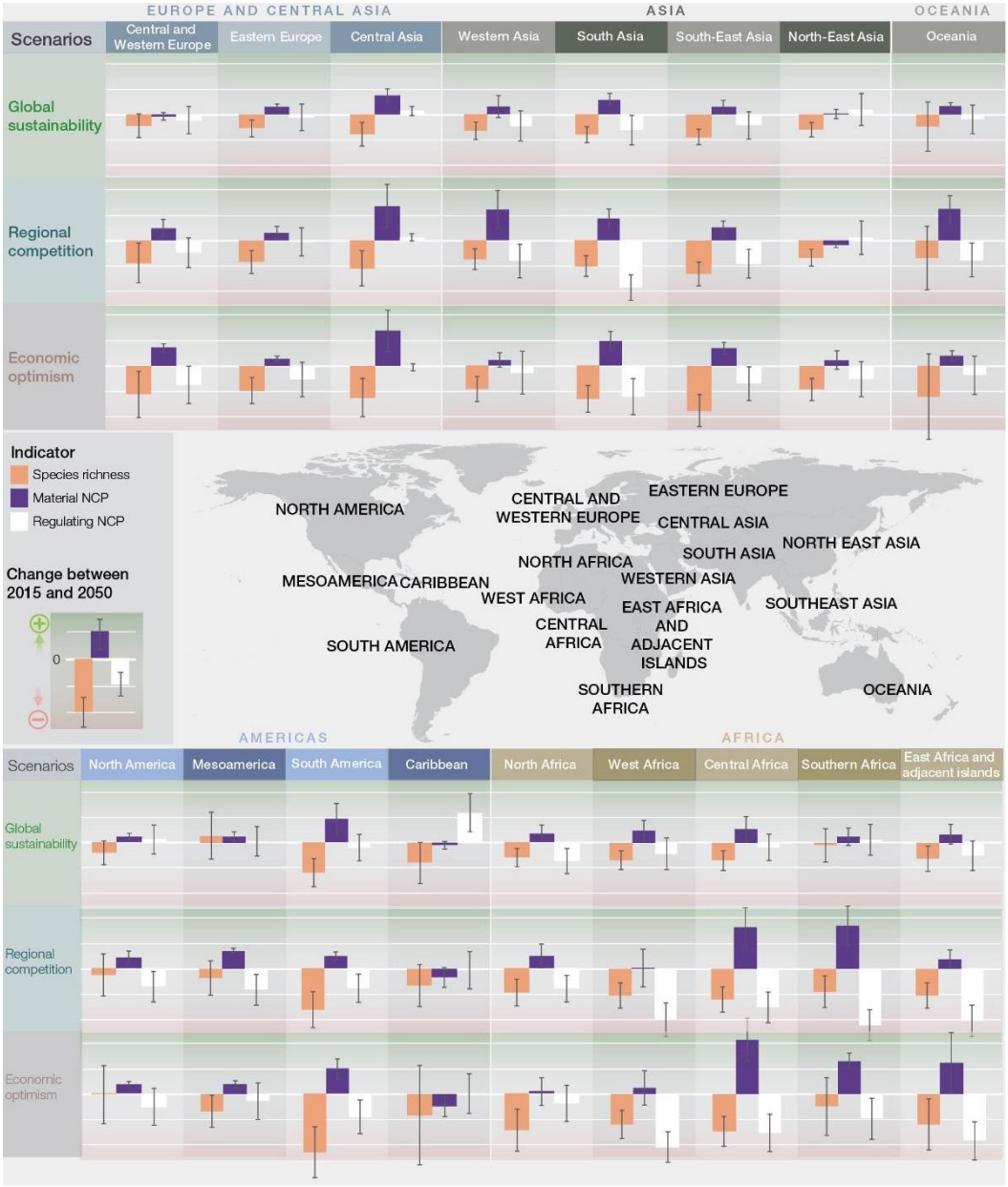


Figure 47. Projections of impacts of land use and climate change on biodiversity and nature's material and regulating contributions to people between 2015 and 2050

(*Source: IPBES, 2019*)

This figure illustrates three main messages: (i) impacts on biodiversity and regulating nature's contributions to people (NCP) are the lowest in the global sustainability scenario in nearly all sub-regions;(ii) regional differences in impacts are high in the regional competition and economic optimism scenario; and (iii) material nature's contributions to people increase the most in the regional competition and economic optimism scenarios, but this comes at the expense of biodiversity and regulating nature's contributions to people. Projected impacts are based on a subset of the Shared Socio-economic Pathway (SSP) scenarios and greenhouse gas emissions trajectories developed in support of Intergovernmental Panel on Climate Change assessments.

1.1.4. Scenarios in regional assessment reports on biodiversity and ecosystem services for Europe and Central Asia

In the summary of regional assessment report on biodiversity and ecosystem services for Europe and Central Asia under IPBES (2018), *a reasonable future version for Europe and Central Asia involving six plausible scenarios has been developed as* follows:

1. **Business-as-usual** assumes the continuation of past and current trends in indirect and direct drivers.
2. **Economic optimism** assumes global developments steered by economic growth, resulting in a strong dominance of international markets with a small degree of regulation.
3. **Regional competition** assumes an increasingly fragmented world with a growing gap between rich and poor; increasing problems with crime, violence and terrorism; and strong trade barriers.
4. **Regional sustainability** assumes a shift towards local and regional decision-making that is strongly influenced by environmentally aware citizens. A proactive attitude to environmental management prevails, but poor international collaboration obstructs coordination to solve global environmental issues.
5. **Global sustainable development** assumes an increasingly proactive attitude by policymakers and the public towards environmental issues, a high level of international cooperation and strong regulation.
6. **Inequality** assumes increasing economic, political and social inequalities with power concentrated in the relatively small political and business elite who invest in green technology.

Discussion

From the literature on the development of future scenarios related to biodiversity and ecosystem services, as shown above, it is found that the scenarios themselves are not only prediction; they are also designed to explore unpredictable and uncontrollable characteristics of changes on biodiversity in ecosystems as well as ecosystem services and a number of socio-economic factors.

Scenarios and models are developed and used with the main purpose of informing policy making and discussing policy impacts on issues related to environment, climate change, and biodiversity and human well-being. Future scenarios may promote options for appropriate policies and mechanisms or effective management of ecosystem services and biodiversity.

Three of the four MA scenarios show that significant changes in policies, institutions, and practices can mitigate many of the negative consequences of increasing pressure on the ecosystem.

1.2. An overview on Vietnam's policies related to biodiversity and ecosystem services

1.2.1. The laws

Many important laws in the field of natural resource management have been issued such as the Law on Environmental Protection (2020) the Law on Forestry (2017); the Fisheries Law (2017); the Planning Law (2017); the Law on Natural Resources and Environment of Sea and Islands (2015); the Land Law (2013); the Law on Water Resources (2012); and the Biodiversity Law (2008).

1.2.2. Strategies

In order to implement the laws, a series of strategies for development, management, conservation, and use of resources have been developed and approved and promulgated by the Government of Vietnam. Among national strategies, a number of strategies related to

biodiversity and ecosystem services have been developed continuously in stages, as shown in the table below.

Table 26. The strategies related to conservation and sustainable use of biodiversity and ecosystems in Vietnam

No	Strategy	Targets/basic indicators
1.	Socio-economic development strategy for the period of 2011-2020 (2011)	Average GDP 7%-8% /year; forest coverage rate reaches 45%; over 80% of existing production and business establishments meet environmental standards; 95% of ordinary solid waste, 85% of hazardous waste and 100% of medical wastes are treated up to standard.
2.	Vietnam sustainable development strategy for the period 2011 – 2020 (2012)	Converting to a growth model that broadens and deepens harmonious development; gradually implement green growth, develop low carbon economy; minimize the negative impact of economic activity on the environment; rational exploitation and effective use of natural resources, especially non-renewable resources; pollution prevention, control and remediation.
3.	National strategy on climate change (2011)	Guarantee food security, energy security, water security, poverty reduction, gender equality, social security, public health, and better livelihood as well as protect natural resources in the context of climate change; and low carbon economy and green growth becomes the key trends in sustainable development; mitigating greenhouse gas emissions and increasing the absorption of greenhouse gases gradually become a mandatory target.
4.	Vietnam forestry development strategy 2021-2030, with a vision to 2050 (2021)	By 2030: planted production forest with about 340,000 ha/year; planted protection and special-use forests at an average of 4,000-6,000 ha/year; restoration of protection and special-use forests on average of 15,000 ha/year; the total PFES collection increasing by of 5%/year on average; and the national forest coverage rate is stable at 42%-43%.
5.	Strategy for management of special-use forests, marine protected areas and inland water protected areas in Vietnam up to 2020, with a vision toward 2030 (2014)	By 2020: the area of special-use forests, marine protected areas and inland water protected areas will reach 9% of the territorial area and 0.24% of Vietnam's territorial waters.
6.	Strategy for Vietnam fisheries development to 2030, with a vision to 2045 (2021)	By 2030: an increase in the production value of the fishery industry from 3%-4% /year; seafood export turnover will reach 14-16 billion USD; the total production of aquatic products reaches 9.8 million tons, of which aquaculture accounts for 7.0 million tons of the total production.
7.	Strategy for sustainable agricultural and rural development in the period of 2010-2020, with a vision to 2050 (2022)	By 2030: the forest cover remains stable at 42%; the forest area with sustainable management certificate to be reached over 1 million ha; the area of marine and coastal PAs conserved to be reached 3%-5% of the state sea area; the GDP growth rate of agricultural, forestry and fishery will reach an average of 2.5%-3%/year; the productivity growth rate of agricultural, forestry and fishery workers will reach an average of 5.5%-6 %/year.
8.	Science and technology development strategy for the 2011-2020 period (2012)	The value of hi-tech products and hi-tech applied products is about 45% of GDP.
9.	Vietnam industrial development strategy	By 2025: the value of hi-tech products and hi-tech applied products reaches 45% of GDP, after 2025 reaching over 50%; The rate of

	to 2025, with a vision to 2035 (2014)	industrial greenhouse gas emissions increased by an average of 4%-4.5%/year.
10.	National strategy of green growth in the period 2021-2030 and with a vision to 2050 (2021)	By 2030: the greenhouse gas emissions intensity per unit of GDP reduces at least by 15% compared to 2014; the primary energy consumption per unit of GDP reduces by 1.0%-1.5% annually on average for the 2021-2030 period; the proportion of renewable energy in the total primary energy supply reaches 15%-20%; the digital economy accounts for 30% of GDP; the forest cover remains stable at 42%; in at least 30% of the total irrigable dryland crop area; the rate of municipal solid waste that is collected and treated in compliance with the regulated standards reaches 95%; the proportion of municipal solid waste that is treated with the direct burial method accounts for only 10% of the waste collected; the rate of municipal wastewater collected and treated in compliance with the regulated standards reaches more than 50% for class II or higher urban areas, and 20% for other types of urban areas.
11.	Strategy of using clean technology in the period to 2020, with a vision to 2030 (2013)	By 2030: completing the system of legal documents, standards and technical regulations on clean technology; 100% of facilities for the whole industry must apply standards and technical regulations on clean technology.
12.	National environmental protection strategy to 2030, with a vision to 2050 (2022)	By 2030: the area of nature PAs reaches three million ha; the area of marine and coastal PAs conserved to be reached 3%-5% of the state sea area; 15 Ramsar sites are established; forest cover is to reach 42%-43.
13.	Strategy for sustainable exploitation and use of natural resources and protection of the marine environment until 2020, with a vision to 2030 (2013)	By 2020: mitigate the level of degradation, depletion of natural resources and curb the rate of increasing environmental pollution in coastal areas, coastal areas and on islands; improving climate change adaptation, maintaining ecological functions and biological productivity of marine ecosystems to protect marine biodiversity and marine resources.
14.	Strategy for sustainable development of Vietnam's marine economy to 2030, with a vision to 2045 (2018)	By 2030: the area of MPAs and coastal areas will reach at least 6% of the natural area of the sea area; the purely marine economic sectors contribute about 10% of the national GDP; the economy of 28 coastal provinces and cities is estimated to reach 65-70% of the national GDP; in coastal provinces and cities, 100% of hazardous waste and daily-life solid waste are collected and treated up to environmental standards; 100% of economic zones, industrial parks and coastal urban areas are planned and built in the direction of sustainability, ecology, intelligence, adapting to climate change, sea level rise, having water treatment system concentrated waste, meeting environmental regulations and standards.
15.	Integrated management strategy of Vietnam's coastal zone to 2020, with a vision to 2030 (2014)	Support the implementation of co-management of coastal resources, environmental protection, livelihood improvement, and climate change adaptation.
16.	National strategy for biodiversity up to 2030, with a vision to 2050 (2022)	By 2030: the area of terrestrial PAs reaches 9% of the territory; the area of marine and coastal PAs conserved to be reached 3%-5% of the state sea area; forest cover is to reach 42%-43%; at least 20% of the degraded natural ecosystems area is restored; 15 Ramsar sites, 14 global biosphere reserves, and 15 ASEAN heritage parks are established.

Most development strategies have a 10-year period and a vision of 10 years or longer. The specific objectives, contents and tasks of each strategy provide quantitative targets to be achieved. The objectives and targets of a number of these important strategies related to the development of future scenarios for ecosystems and their services are described in more detail below:

(1) The Socio-economic development strategy for the period of 2011-2020 (2011), key targets include: striving to achieve the average growth rate of GDP of 7-8%/year; the proportion of industry and service accounts for about 85% of GDP; forest coverage rate reaches 45%; over 80% of existing production and business establishments meet environmental standards; 95% of ordinary solid waste, 85% of hazardous waste and 100% of medical wastes are treated up to standard.

Recently, the Ministry of Planning and Investment held a seminar with the title: *towards high-quality growth in the period 2021-2030*: policy priority orientation to discuss the development of Vietnam's socio-economic development strategy for the period 2021-2030. Some of the guiding ideas in this period's development strategy include: focusing on contents such as rapid growth to combat the risk of falling behind; quality growth to ensure sustainability (efficient growth, green growth, inclusive growth); socially sustainable development and without affecting the environment; building a full, modern and integrated market economy institution; efficiently exploit natural capital, ensure green growth to achieve the goals of growth and sustainable growth; addressing climate change issues; identifying science, technology and innovation with special significance are the main drivers of the new growth model.

In 2019, the National Center for Socio-Economic Information and Forecast (NCIF) formulated two scenarios of economic growth for the period 2021-2025:

1. **Feasible base scenario** is that Vietnam's GDP growth would reach about 7%. With this scenario, the macro-economy is basically stable, inflation is at 3.5%-4.5%/year; labor productivity improved with an increase of about 6.3% /year; By 2025, Vietnam's GDP per capita will reach about 4,688 USD, making Vietnam join the group of high middle-income countries.
2. **Higher growth scenario**: if Vietnam can take advantage of Industry 4.0 technology and attract investment to improve quality, develop the current economic base, expect GDP growth 7.5%/year. “However, if Vietnam does not have breakthroughs in investment, it will be difficult to go beyond the current scale to advance to a higher growth step and achieve true quality of growth" according to NCIF experts.

"*Vietnam Digital Economic Future Report: looking forward to 2030, 2045*" was published in Hanoi within the framework *of the conference of science, technology and innovation - a pillar for economic development social - economic survey of Vietnam* on May 15, 2019, in Hanoi. In this report, Australia’s Commonwealth Scientific and Industrial Research Organisation (CSIRO) has collaborated with the research team of the Ministry of Science and Technology to develop four future scenarios for the digital economy of Vietnam. These scenarios have outlined a panorama to help policy makers to formulate plans for Vietnam's digital economy in the period of 2021-2045:

1. **Traditional scenario**: according to the report, until 2045, digital technology is expected to contribute 196 billion USD to GDP at comparative prices in 2020 and at purchasing power parity (61 billion USD at current prices). Compared to 2005 and average exchange rate. Low digital transformation, the information and communication technology (ICT) industry is growing slowly.
2. **Digital export scenario**: Until 2045, digital technology is expected to contribute 217 billion USD to GDP at 2020 prices and at PPP purchasing power parity (67 billion USD at 2005 constant prices and average exchange rate). The ICT industry is rapidly

developing mainly based on export processing and limited number of applications in industries.

3. **Digital consumption scenario**: until 2045, digital technology is expected to contribute 331 billion USD to GDP at 2020 prices and at PPP purchasing power parity (103 billion USD at 2005 constant prices and average exchange rate). Strong digital transformation in domestic industries but mainly using other country's ICT products and services, domestic ICT industry has been slowly developing.
4. **Digital conversion scenario**: Until 2045, digital technology is expected to contribute 544 billion USD to GDP at 2020 prices and at PPP purchasing power parity (169 billion USD at 2005 constant prices and average exchange rate). Application of digital technology in the entire economy and the ICT industry has grown sharply.

From the above four scenarios, the Ministry of Information and Communications has selected the digital conversion scenario and will start to implement policies to work towards this scenario from 2020.

(2) The National strategy on climate change (2011), MONRE has developed several versions of Vietnam's climate change scenarios. Most recently, the climate change and sea level rise scenarios for Vietnam (2016 version) were published by MONRE in March 2017 with two scenarios based on the RCP4.5 scenario (low average greenhouse gas concentration scenario) and the RCP8.5 scenario (high greenhouse gas concentration scenario).

1. According to the **RCP4.5 scenario**, the national average annual temperature at the beginning of the century is a common increase from 0.6÷0.8^{o}C; by the middle of the century, there is a projected increase of 1.3÷1.7^{o}C, by the end of the century there is an increase of 1.9÷2.4^{o}C in the North and 1.7÷1.9^{o}C in the South; annual rainfall at the beginning of the century tends to increase in most of the country, generally from 5÷10%; by the middle of the century, it will increase by 5÷15%; the average sea level rise for the whole coastal area of Vietnam to 2050 is 22 cm (14 cm÷32 cm); in 2100 it is 53 cm (32 cm÷76 cm).
2. According to the **RCP8.5 scenario**, the average annual temperature nationwide at the beginning of the century is a common increase from 0.8÷1.1^{o}C, in the middle of the century there is an increase of 1.8÷2.3^{o}C, including an increase of 2.0÷2.3^{o}C in the North and 1.8÷1.9^{o}C in the South. By the end of the century, there will be an increase of 3.3÷4.0^{o}C in the North and 3.0÷3.5^{o}C in the South; annual rainfall tends to increase similar to the RCP4.5 scenario. The average sea level rise for the whole coastal area of Vietnam until 2050 is 25 cm (17 cm÷35 cm); and to 2100 it is 73 cm (49 cm÷103 cm).

(3) The Clean technology utilization strategy to 2020, with a vision to 2030, targets to 2020 include: 100% of new investment projects in sectors that use a lot of energy and are likely to cause serious pollution to environment like dyeing; production of fertilizers and pesticides; steel refining; mining and processing of minerals; thermal; paper production; cement production; and sugarcane production must meet standards and technical regulations on clean technology; 60%-70% of production facilities will complete the technological innovation roadmap towards using clean technologies.

By 2030: completing the system of legal documents, standards and technical regulations on clean technology; 100% of facilities for the whole industry must apply standards and technical regulations on clean technology.

(4) The National strategy on biodiversity to 2030, with a vision to 2050 (2022), there are targets: by 2030, the area of terrestrial PAs reaches 9% of the territory (this target is also the target of the strategy for management of special-use forests, marine protected areas and inland water protected areas in Vietnam by 2020, with a vision to 2030); the area of marine and coastal PAs conserved to be reached 3%-5% of the state sea area (this target is also the target of the national environmental protection strategy to 2030, with a vision to 2050; and the

strategy for sustainable agricultural and rural development in the period of 2010-2020, with a vision to 2050); forest cover is to reach 42%-43% (this target is also the target of the national environmental protection strategy to 2030, with a vision to 2050; the Vietnam forestry development strategy 2021-2030, with a vision to 2050; the national strategy of green growth in the period 2021-2030 and with a vision to 2050; and the strategy for sustainable agricultural and rural development in the period of 2010-2020, with a vision to 2050); at least 20% of the degraded natural ecosystems area is restored; 15 Ramsar sites, 14 global biosphere reserves, and 15 ASEAN heritage parks are established.

The 6th National Report on the status of Vietnam's biodiversity in 2019 assessed the progress of the strategy's objectives and tasks such as: two targets, including the area of terrestrial PAs to be reached 9% of the territory and the area of marine and coastal PAs reaches 0.24% of the state sea area by 2020 were not reached, the remaining targets are achieved, even exceeding the target of 15% of the natural ecosystem area critical degradation is restored.

(5) Resolution no.24-NQ/TW (2013) on Proactively responding to climate change, strengthening natural resource management and environmental protection with targets for 2020: reduce levels of greenhouse gas emissions per unit of GDP from 8-10% compared with 2010; not to generate and to thoroughly handle facilities causing serious environmental pollution; 70% of wastewater discharged into the environment of river basins is treated; destroy and treat over 85% of hazardous wastes and 100% of medical wastes; reuse or recycle over 65% of domestic waste; strive to have 95% of urban population and 90% of rural population use clean and hygienic water; ensure safety controls and environmental pollution treatment as a result of American/Vietnam war; improving the quality of air in urban areas and densely populated areas; clearly improve the environment of 'trade villages' and rural areas; to rationally manage and exploit, and soon end the exploitation of natural forests, raising the area of nature conservation zones to over 3 million ha; and raising the forest cover to over 45%.

(6) Resolution no.36-NQ/TW(2018) on the Strategy for sustainable development of Vietnam's marine economy to 2030, with a vision to 2045 with targets: to 2030, increase the area of marine and coastal PAs to at least 6% of the national natural area of the sea; the pure marine economic sectors contribute about 10% of the national GDP; the economy of 28 coastal provinces and cities is estimated to reach 65%-70% of the national GDP; in coastal provinces and cities, 100% of hazardous waste and daily-life solid waste are collected and treated up to environmental standards; 100% of economic zones, industrial parks and coastal urban areas are planned and built in the direction of sustainability, ecology, intelligence, adapting to climate change and sea level rise, having centralized wastewater treatment system, and meeting environmental regulations and standards.

1.2.3. Master plans and plans

In the Vietnamese context, the development of plans and planning is the next activity to implement the objectives, contents and solutions of the proposed strategies. Most plans are developed for a 5-year period.

A number of plans and plans related to biodiversity and ecosystem services have been developed and approved by the Government such as:

1. *Planning the system of Vietnam's marine protected areas till 2020* with the target of establishing 16 marine protected areas. By 2020, 12 MPAs with a total area of 213,400 ha have been established and put into operation. A detailed planning for the four remaining MPAs has been completed (*Directorate of Fisheries, 2021*).
2. *Planning the national special-use forest system to 2020, with a vision to 2030* with the objectives by 2020 of bringing the area of the current special-use forest system from 2.2 million ha to 2.4 million ha.

3. *National master plan on biodiversity conservation to 2020, with a vision to 2030* with the following contents: proposals to gradually establish and put into operation 46 new PAs, bringing the total the number of existing and newly established PAs nationwide to 219 PAs with a total area of 3,067,000 ha; review and upgrade the system of 38 biodiversity conservation facilities; and review and establish 21 biodiversity corridors; etc.
4. *The national action plan to implement the 2030 Agenda for Sustainable Development* has a general goal: maintain sustainable economic growth towards progressive implementation, social justice and protection of the ecological environment, effective management and use of resources, proactively coping with climate change; ensure that all people are promoted to their full potential, participate and equally enjoy the fruits of development; and building a peaceful, prosperous, inclusive, democratic, equitable, civilized and sustainable Vietnamese society. Among its specific targets, Goal 14 is to conserve and sustainably use the oceans, seas and marine resources for sustainable development and Goal 15 is to protect and develop sustainable forests, conserve biodiversity, develop ecosystem services, combat desertification, prevent degradation and restore land resources. National sustainable development goals are set in line with the international goals (i.e. SDGs).

In addition, there are master plans for development of medicinal materials up to 2020 and orientations to 2030; plan to implement national strategy on environmental protection until 2020, with a vision to 2030; emergency action plan for the conservation of primates of Vietnam up to 2025, with a vision to 2030; and other relevant plans.

In addition to the above strategies, plans and plannings, the Prime Minister also ratified and issued many decrees and decisions related to Vietnam's biodiversity conservation.

Discussion

In Vietnam, except for the climate change scenarios, only future scenarios for the socio-economic sector have been developed, while there are no future scenarios developed for ecosystems and their services. Therefore, within the framework of the national ecosystem assessment report, plausible future scenarios for ecosystems and their services are developed to inform issues related to socio-economic development with the environment, climate change, biodiversity and human well-being, while serving as a basis for national authorities to develop appropriate institutions, policies and effective management of ecosystems and sustainable use of ecosystem services in Vietnam.

II. DEVELOPMENT OF PLAUSIBLE FUTURE SCENARIOS FOR ECOSYSTEMS AND THEIR SERVICES

2.1. Four plausible future scenarios proposed

Applying the CBD's experience in developing future scenarios for biodiversity and ecosystem services (2017) and IPBES global assessment report (2019), and based on the future scenarios of Vietnam’s socio-economic development and the conferences of the Ministry of Planning and Investment and the Seminar held by the Prime Minister on the orientation of the Strategy for socio-economic development in the 2021-2030 period, as well as strategies and plans related to Vietnam's biodiversity, four plausible future scenarios are proposed for ecosystems and their services in Vietnam, as follows:

1. **Development as usual scenario** or maintenance of trends: with a forecasted growth rate of 6.76% to about 7%, inflation of 3.2%, continued loss of biodiversity and change in land use, leading to pressures on terrestrial natural habitats.
2. **Feasible base scenario**: Vietnam's GDP growth will reach about 7%. With this scenario, the macro-economy is basically stable, inflation is at 3.5%-4.5%/year; labor productivity is improved with an increase of about 6.3%/year; by 2025, Vietnam's

GDP per capita will reach about 4,688 USD, allowing Vietnam to join the group of high middle-income countries.

3. **Higher growth scenario:** expecting GDP growth of 7.5%/year. Economic growth is the highest of the four scenarios. It is necessary to take advantage of Industry 4.0 and attract investment to improve the socio-economic quality and develop the current economic foundation.
4. **Sustainable development scenario associated with conservation**: GDP growth is about 7%/year or more; there is efficient use of natural capital, ensuring green growth to achieve the goals of sustainable growth; climate change issues are addressed; there is combined proactive environmental policy and sustainable production and consumption with low greenhouse gas emissions; harmony is sought between development and conservation.

2.2. Description of four plausible future scenario's characters

2.2.1. The development as usual scenario

The "*development as usual scenario*" assumes trends that have occurred in the past and present under the effects of driver and pressure factors will continue unchanged. With this scenario, the economy has a growth rate of 6.76% to about 7%, and inflation is 3.2%.

Under this scenario, important ecosystems continue to be degraded, especially coral reefs and seagrass beds. Biodiversity continues to decline, with the number of individuals of many endangered species being reduced, as is already evident in species of globally threatened migratory birds such as the Black faced-spoonbill (*Platalea minor),* the Chinese white stork (*Egretta eulophotes),* red-necked cranes (*Grus antigone*), as well as sea dugongs (*Dugong dugon*). There is no solution to control invasive alien species.

Provisioning services of ecosystems are heavily exploited, even excessively or illegally. The downside of achieving meaningful figures on economic development in sectors such as agriculture, forestry, fisheries, tourism, etc. must be a trade-off with ecosystem degradation, biodiversity loss and thereby degradation of ecosystem services. Coral reefs have lower coverage, and the seagrass area is reduced.

The wild capture fishing industry has reached the threshold and efforts to replace this protein through developing coastal aquaculture results in increased pollution and increasing competition for coastal land.

The process of land-use conversion still takes place to build infrastructure and economic zones, increasing the pressure on terrestrial natural habitats, including inland and coastal wetlands and biodiversity loss. Environmental pollution and climate change continues to lead to the loss of biodiversity and degradation of important ecosystems, while increasing extreme weather patterns, give rise to increased saline intrusion, and scarcity of freshwater in the Mekong River Delta, resulting in reduced water flows for the vulnerable freshwater ecosystems in this region. Environmental incidents and epidemics affect a large number of people.

2.2.2. The feasible base scenario

Vietnam's GDP growth will reach about 7%. With this scenario, the macro-economy is basically stable, with inflation is at 3.5-4.5%/year; labor productivity is improved, with an increase of about 6.3%/year; by 2025, Vietnam's GDP per capita will be about 4,688 USD, lifting Vietnam into the group of high middle-income countries; science and innovation are especially significant in being the main driving force of the new growth model and provide strategic breakthroughs, increasingly playing an important role in socio-economic development, and contributing to strengthening enterprise competitiveness and national

competitiveness. Economic growth is relatively high, while the population in 2050 is within the average range of scenarios.

Increased income levels bring changes in consumption patterns, driving demand for ecosystem services, including agro-forestry products such as timber, meat, fish and vegetables. The increase in provisioning services leads to a decline in other services. With trade barriers removed, along with a major highlight is poverty reduction.

Under this scenario, ecosystems continue to decline with a loss of biodiversity. Increased land use conversion leads to pressures on natural terrestrial land, underwater and marine habitats and biodiversity degradation.

2.2.3. The higher growth scenario

"*The higher growth scenario*" expecting GDP growth to be 7.5%/year. Economic growth is the highest in the four scenarios. Science and innovation are increasingly playing an important role in socio-economic development, contributing to increasing the competitiveness of enterprises as well as national competitiveness; science and innovation have special significance as the main driving force of the new growth model, providing strategic breakthroughs. It is necessary to take advantage of Industry 4.0 technology and attract investment to improve socio-economic quality and develop the current economic foundation.

Increased income levels bring changes in consumption patterns, driving demand for ecosystem services, including agro-forestry products such as timber, meat, fish and vegetables in major urban centers in the Red River and Mekong river regions. The increasing demand for these services leads to a decline in other services. Rapid economic growth requires large amounts of energy and raw materials, along with low environmental regulation with high greenhouse gas emissions (the trend is that of the RCP8.5 scenario - i.e. high concentration of greenhouse gases). The high level of economic development combined with climate change has led to an increase in extreme forms of weather, especially increased saline intrusion and increased scarcity of fresh water in the Mekong River Delta, even in the Central and Northern regions, resulting in reduced water flows for freshwater ecosystems and the agro-ecological systems in these vulnerable areas.

The provision of ecosystem services as a component of economic growth, coupled with the enhancement of high technology due to rising income levels, brings many poor people into the middle class. Human well-being factors are related to the decline in social relations in this scenario due to the loss of local culture and customs as well as traditional knowledge and the weakening of civil - social organizations when the interaction rate is increasing on the Internet.

Dependence on technological solutions sometimes creates new problems and gaps. In some cases, new problems seem to appear faster than solutions. Environmental management costs are constantly increasing. Environmental incidents and epidemics affecting large numbers of people become more common. Trade barriers are removed, along with a major highlight is poverty reduction.

Under the high growth scenario, there is continued loss of biodiversity and increased land use conversion, resulting in pressures on natural, terrestrial and marine natural habitats and declining biodiversity, increasing the use of provisioning ecosystem services while reducing regulating services of the ecosystem. Agriculture, fisheries and forestry are important sectors for socio-economic development, contributing significantly to GDP. However, products from these industries come at an increasing cost in the form of a decline in many other ecosystem services.

2.2.4. The sustainable development scenario associated with conservation

This scenario is similar to the feasible baseline scenario, in that GDP growth is about 7%/year or more. However, in this scenario, the perspective of sustainable development associated with conservation is mentioned as a key factor, involving: quality growth to ensure

sustainability (efficient growth, green growth, inclusive growth); efficient use of natural capital, ensuring green growth to achieve the goals of growth and sustainable growth; addressing climate change issues; combining proactive environmental policy and sustainable production and consumption with low greenhouse gas emissions; and seeking harmony between development and conservation.

Under this scenario, the goals of the Government's 2030 Agenda Implementation Plan must be achieved including: sustainable economic growth with respect to progress, social justice and protection of the ecological environment, effective management and use of resources, proactively responding to climate change; ensuring all people are promoted to their full potential, and can participate and equally enjoy the fruits of development; and building a peaceful, prosperous, inclusive, democratic, equitable, civilized and sustainable Vietnamese society. Accordingly, significant progress has been made in developing modern, environmentally friendly technologies to increase production of services, to create alternative products and to reduce harmful trade-offs, and combining proactive management policies and sustainable production and consumption with low greenhouse gas emissions (the trend is that of the RCP4.5 scenario - i.e. low average greenhouse gas concentration).

The most important aspect of this scenario is that to implement sustainable development associated with conservation, the system of legal mechanisms and policies related to biodiversity conservation should be prioritized for renovation and improvement, in accordance with the actual conditions, and especially they are effectively enforced to harmonize development with environmental protection and biodiversity conservation. Resources for biodiversity conservation, both from the Government as well as from international organisations and NGOs, are guaranteed; an active management and ecosystem adaptation approach is applied with the consent of stakeholders from central and local levels, businesses and the community; many livelihood models for the community based on the exploitation and sustainable use of natural resources are developed and popularized; and modern environmentally friendly technologies are developed.

These conditions mentioned above can lead to higher resilience of ecosystems, with increasing levels of biodiversity and growing number of individuals of endangered species populations, and improved quality of ecosystem services due to proactive management of ecosystems and sustainable use.

III. THE MOVEMENT OF DRIVERS AND PRESSURES ACCORDING TO THE SCENARIOS

In the four plausible future scenarios, the drivers and pressures affecting the ecosystem are predicted to be basically the same as in the past, but the relative importance of the different drivers and pressures will change across the scenarios. Some factors (such as population growth) tend to decrease in importance while others (population distribution, environment, climate change, and land / water use change, etc.) will become more important.

Table 27. Assumptions on the evolution of driver and pressure factors according to the scenarios

	Development as usual scenario	**Feasible base scenario**	**Higher growth scenario**	**Sustainable development scenario associated with conservation**
Drivers				
Demographics / Population	Average fertility; population with average fertility option: 102. 321	Average fertility; population with average fertility option: 102. 321	Low fertility; population with low fertility options: 101. 152	Average fertility; population with average fertility option: 102. 321

	million people (2029); migration at a high level leads to population distribution in the plains	million people (2029); migration at a high level leads to high population distribution in the plains	million people (2029); migration at a high level leads to high population distribution in the plains	million people (2029); migration at a moderate level
Demand for resources	Similar to nowadays	High	High	High
Energy demand	Similar to nowadays	High	High	High
Energy supply	The current energy structure	Changing energy structure; recycled energy; changing modern technology	Changing energy structure; recycled energy; changing modern technology	Changing energy structure; recycled energy; changing modern technology friendly to the environment
GDP growth	6.8-7%	About 7%	7.5%	About 7%; Green growth
Science, Technology	Medium	High	High	High Environmentally friendly technology; modern and effective environmental treatment technology
Legal mechanisms and policies on biodiversity conservation	Similar to nowadays	Similar to nowadays	Similar to nowadays	Innovation, more complete and more feasible
Conservation management	Similar to nowadays	Similar to nowadays	Similar to nowadays	Proactive management and adaptation of ecosystems; effective management of the PA
Conservation resources	Not guaranteed	Not guaranteed	Not guaranteed	Guaranteed
Approach to sustainable development	Similar to nowadays	Approach to sustainable development	Approach to sustainable development	Green technology; ecological efficiency; approach to sustainable development
Pressures				
Land / waters use conversion	High level of conversion; area of natural forest decreased; planted area increased slightly	Planted area increased slightly	Planted area increased slightly	Increasing forest area; increase forest cover
Environmental	Environmental	There is still	High risk of	Reduced pollution

pollution	pollution	environmental pollution	environmental pollution	levels
Climate changes	Greenhouse gas emissions as today; saline intrusion increases; RCP8.5 scenario trend	Average greenhouse gas emissions; saline intrusion increases; trends in RCP4.5-RCP8.5 scenarios	High greenhouse gas emissions; saline intrusion increases; RCP8.5 scenario trend	Lower greenhouse gas emissions; saline intrusion is under control; trends in RCP4.5 scenario
Invasive alien species	Uncontrolled	Uncontrolled	Uncontrolled	Proceed to control

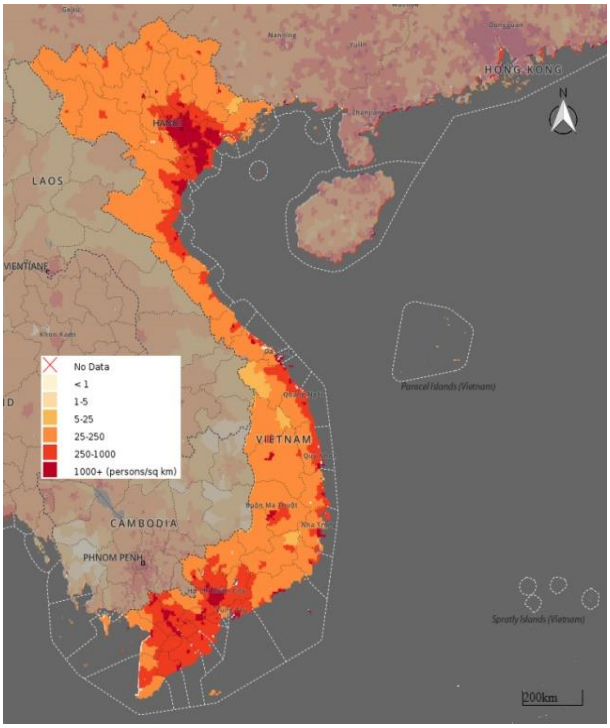


Figure 48. Population density change of Vietnam in 2020

(*Source: UNBiodiversityLab, 2018)*

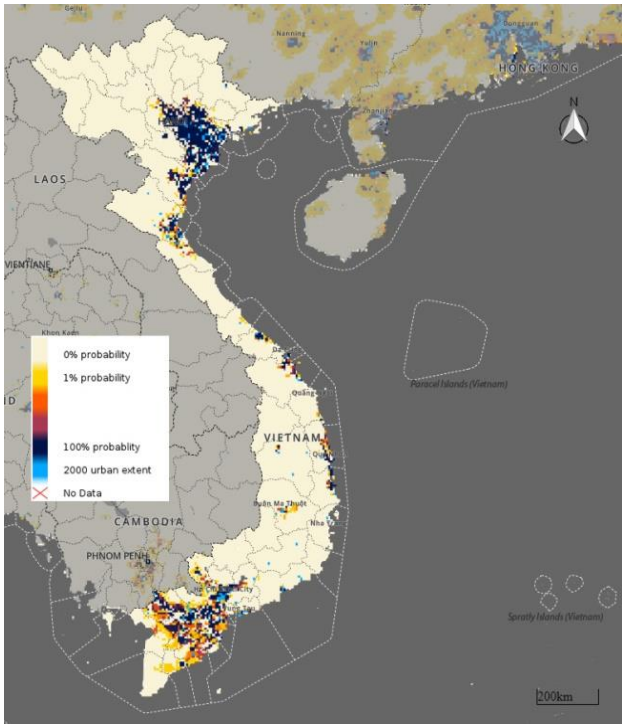


Figure 49. The ability to expand the urban network to 2030

(Source: UNBiodiversityLab, 2018)

IV. PREDICTED CHANGES IN THE QUALITY OF ECOSYSTEMS AND THEIR SERVICES

The change of ecosystems and the provision of basic ecosystem services according to the four plausible future scenarios developed for this assessment are shown in the tables below

4.1. Predicted changes in the quality of ecosystems

Predicted changes in the quality of three key ecosystems under the plausible future scenarios with different development characteristics can be described below.

The decrease in ecosystems is reflected in the indicators of reduced area (primary/natural forests; coral reefs; seagrass beds); live coral cover; reduction of wildlife community indicators (forest ecosystems); animal community living in coral reefs, seagrass beds); the flow of fresh water and sediments across rivers and estuaries are reduced; pollution level (rivers, lakes, reservoirs); reduced peat layer thickness (peat swamp); hydrological regime, impact of land use conversion (seasonal wetlands).

The increase is shown when the above indicators assume a positive increase or a decrease in pollution levels due to controlled environment. The continental slope and the deep sea area are undetermined because there are no comprehensive research data.

Table 28. Predicted changes in the quality of ecosystems according to the scenarios

Ecosystems	Development as usual scenario	Feasible base scenario	Higher growth scenario	Sustainable development scenario associated with conservation
Forest ecosystems				
Area of natural forest	↓	↓	↓	↔
New planted forest area	↑	↑	↔	↑
Forest ecosystem (wildlife community)	↓	↔	↓	↑
Inland wetland ecosystems				
Rivers and streams (water flow, water quality)	↓	↔	↓	↑
Estuarine areas (freshwater flow, sediment flowing through, salinity intrusion)	↓	↔	↓	↑
Natural lakes, reservoirs (water reserves, water quality, water regulation	↓	↔	↓	↑
Swamp, peat swamp (reduced peat layer thickness)	↓	↓	↓	↔
Costal and marine ecosystems				
Quality of tidal flats (due to pollution, clam aquaculture)	↓	↓	↓	↑
Area of mangroves (natural forest, regenerated forest, new planted forest)	↑	↑	↓	↑
Lagoon, gulf (pollution)	↓	↔	↓	↑
Area and coverage of coral reefs (animal communities in the reef)	↓	↓	↓	↑
Area of seagrass beds (animal communities in grass)	↓	↓	↓	↑
Offshore island waters	↓	↔	↓	↑
Continental slope and deep sea	●	●	●	↑

increase ↑ decrease ↓ as before 2020 ↔ Not determined ●

4.2. Predicted changes in the quality of ecosystem services

For provisioning services, determining increases means increasing service output through changes in the area in which the service is provided (for example, agricultural expansion) or increasing output product per unit area. The rating goes down if the current use of biological resources exceeds sustainability. For regulating services, the increase refers to changes in services that result in greater benefits for everyone (e.g. disease correction services can be improved by deleting a vector known to spread the disease to everyone). Regression of

regulating services means reducing the benefits gained from services, through service changes (for example, loss of mangroves reduces storm protection benefits of ecosystems) or pressure of humans for services that exceed its limits (e.g. excessive pollution beyond the ability of ecosystems to maintain water quality). For cultural services, degradation refers to a change in ecosystem features that reduce the cultural benefits (recreational, aesthetic, spiritual, etc.) provided by the ecosystem, while the increase refers to a change that increases them. For supporting services, increased assessment means increased primary productivity and ensured the balance of nutrient cycles in ecosystems. Ecosystem degradation leads to reduced primary productivity and imbalance in nutrient cycles or food webs in ecosystems.

Table 29. Predicted changes in the quality of ecosystem services according to the scenarios

Ecosystem services	Development as usual scenario	feasible base scenario	Higher growth scenario	Sustainable development scenario associated with conservation
Provisioning services				
Products made from wood and non-wood for materials, fuel and food	⇔	⇔	⇔	↑
Fishery products for food	↓	⇔	⇔	↑
Biologically active products and pharmaceuticals	↑	↑	↑	↑
Products are jewelry, decoration	↑	↑	↑	↑
Fresh water resource	↓	↓	↓	↑
Genetic resources and bio-diversity	↓	⇔	⇔	↑
Regulating services				
Regulating water source	↓	⇔	↓	↑
Climate regulation, carbon sequestration & storage	↓	↓	↓	↑
Control erosion, protect coastlines, reduce storm damage	↓	↓	↓	↑
Disease control: human	↓	⇔	⇔	↑
Pest control	↓	⇔	⇔	↑
Cultural services				
Cultural and historical values	↑	⇔	↓	↑
Tourism, relaxation, sports	↑	↑	↑	↑
Educations, training	↑	↑	↑	↑
Supporting services				
Land formation	↓	⇔	↓	↑
Nutrition cycle of ecosystems; Primary productivity	↓	⇔	↓	↑

increase ↑ disease ↓ As before 2020 ⇔

In the four scenarios above, provisioning service and regulating services have clear changes between the scenarios. The scenario of sustainable development associated with conservation

is considered the most positive trend, with an important goal of harmonizing conservation and development, without the trade-off of development at all costs, which harms the environment and biological resources. This scenario also reflects Vietnam's determination to implement the Aichi Biodiversity Goals and the Sustainable Development Goals.

V. PROACTIVE MANAGEMENT OF ECOSYSTEMS: BENEFITS AND MEASURES

5.1. Benefits of proactive management

According to MA (2005), proactive or anticipatory management of ecosystems is generally advantageous in the MA scenarios, but it is particularly beneficial under conditions of changing or novel conditions (e.g. biological and environmental factors). The scenarios "techno-garden" and "adapting mosaic" show the least biodiversity loss because they assume a proactive approach to environmental and ecosystem management. Ecological surprises are inevitable because of the complexity of the interactions and because of limitations in current understanding of the dynamic properties of ecosystems (material and energy exchange processes in the ecosystem). For example, the ability of pests to evolve resistance to biocides; eutrophication increases the vulnerability of the ecosystem, etc.

In general, proactive action to manage systems sustainably and to build resilience into systems will be advantageous, particularly when conditions are changing rapidly, when surprise events are likely, or when uncertainty is high. This approach is beneficial largely because it involves prevention, and the restoration of ecosystems or ecosystem services following their degradation or collapse is generally more costly and time-consuming than preventing degradation, if that is possible at all. However, the costs and benefits of both proactive and reactive management approaches to ecosystems must be taken into account.

Table 30. Costs and benefits of proactive as contrasted with reactive ecosystem management as revealed in the MA scenarios

	Proactive management	Reactive management
Payoffs	Benefit from lower risk of unexpected losses of ecosystem services, achieved through investment in more efficient use of resources (water, energy, fertilizer, etc.); more innovation of green technology; capacity to absorb unexpected fluctuations in ecosystem services; adaptable management systems; and ecosystems that are resilient and self-maintaining	Avoid paying for monitoring effort
	Do well under changing or novel conditions	Do well under smoothly or incrementally changing conditions
	Build natural, social, and human capital	Build manufactured, social, and human capital
Costs	Technological solutions can create new problems	Expensive unexpected events
	Costs of unsuccessful experiments	Persistent ignorance (repeating the same mistakes)
	Costs of monitoring	Lost option values
	Some short-term benefits are traded for long-term benefits	Inertia of less flexible and adaptable management of infrastructure and ecosystems
		Loss of natural capital

(Sources: MA, 2005)

5.2. Proposed measures for proactive management of Vietnam's ecosystems and their services

Ecosystems and their services can be preserved, restored and used sustainably in order to meet national goals through coordinated activities that promote transformation as well as social

goals such as, meeting human needs for food, water, energy, health and happiness. Climate change mitigation and adaptation, conservation and sustainable use of natural resources - can be achieved in the process of sustainable development through the implementation and improvement of existing policy tools and new management approaches that help take advantage of stakeholder engagement for transformational change. In order to proactively manage the ecosystem and sustainably use its services under the sustainable development scenario associated with conservation, some measures are recommended to be implemented in the coming period as follows:

5.2.1. Improvement of the legal framework on conservation and sustainable use of biodiversity and ecosystems

Make amendments to the Biodiversity Law and related laws in accordance with the current Vietnam context. In terms of biodiversity conservation, environmental protection and sustainable use of natural resources, in addition to specialized laws such as the Law on Forestry, the Fisheries Law, etc., the key laws such as the Biodiversity Law and the Law on Environment Protection have important implications for legislating key issues to protect the environment and biodiversity conservation in recent years. However, the reality of state management of biodiversity, ecosystem services and environmental protection has changed substantially in recent years, some of the contents of the Biodiversity Law and the Law on Environment Protection is not suitable to current reality and need to be updated and adjusted.

5.2.2. Effective improvement of decision-making processes

Legal decisions affecting ecosystems and their services can be improved by changing the processes used to make appropriate decisions.

A range of tools (facilitating transparency and stakeholder engagement), gathering information (mainly focused on data collection and feedback), and tools for developing plans (often used to evaluate optional potential policies) can support decision making regarding ecosystems and their services.

A number of frameworks and methods can be used to make better decisions in the face of data uncertainty, prediction, context and scale.

5.2.3. Changes in institutions and governance

Institutional and governance changes within the framework of environmental governance and facilitates effective and proactive management of ecosystems. Effective management of biodiversity and nature's contributions to people will benefit from well-integrated, contextual policy tools. A number of shortcomings that limit the effectiveness of current policies are law enforcement. There are stated reasons such as lack of human resources, institutional capacity and financial resources or corruption. Necessary interventions include:

- Integrating ecosystem management objectives in other sectors and within the broader development planning framework. Promote a comprehensive governance approach through participation of stakeholders including also local communities to ensure fairness of participation.
- Increase transparency and accountability of the Government and the private sector in decisions affecting ecosystems and their services, including greater involvement of stakeholders in decision-making.
- Build institutions that assign responsibility (or centralisation) decision-making to meet management needs while ensuring effective coordination at central and local levels.
- Build institutions to regulate the interaction between markets and ecosystems and their services.
- Develop institutional frameworks that promote a shift from a sectoral resource management approach to an interdisciplinary integrated approach.

- Economic values from ecosystems services need to be included in the national accounting system.
- Eliminate subsidies that promote excessive use of ecosystem services (and, if possible, transfer these subsidies to payments for non-market ecosystem services).

5.2.4. Integration of biodiversity and ecosystem services into sectoral policies, strategies, plans and programs

Policy makers and organizations develop integrated interdisciplinary approaches will allow for a more systematic review of biodiversity and nature's contributions to people. Especially, integrate biodiversity and ecosystem services into strategic environmental assessment and environmental impact assessment.

5.2.5. Economy and incentives

Economic and financial interventions provide powerful tools to regulate the use of ecosystem's goods and services such as eliminating subsidies harmful to biodiversity including economic incentives; economic reform towards sustainable development and green growth. However, market mechanisms can only work if there are support organizations, and therefore institutional capacity needs to be built to allow wider use of them and to improve the sustainability of the economic and financial system.

5.2.6. Other necessary responses for proactive management

Social responses: social responses, including population policy; public education; empowering communities, women, and youth; and civil society actions, which can be instrumental in coping with ecosystem and their services degradation to build a sense of sustainable and civilized production and consumption of natural resources, and increase energy efficiency.

Modern technology development: due to the increasing demand for ecosystem services and other increasing pressure on ecosystems, the development and dissemination of modern technology friendly to the environment to increase resource efficiency or reduce the impact of pressures such as climate change and environmental pollution.

Knowledge and awareness raising: effective management of ecosystems is limited due to the lack of knowledge and information related to different aspects of ecosystems and the inadequate use of existing information to support management decisions. Therefore, it is necessary to strengthen communication, education, training and awareness raising for environmental protection, biodiversity conservation and sustainable use of natural resources for stakeholders, especially the local community.

Strengthening biodiversity conservation management capacity: developing programs and capacities for surveying, inventory, monitoring and reporting on biodiversity and conservation, and strengthen the national database on biodiversity, as set out in the 2020-2030 plan and beyond.

Increasing resources for biodiversity conservation: promote the full and effective participation of local people and segments of society in decision-making regarding biodiversity conservation and sustainable use of ecosystem services.

Development and application of sustainable livelihood models to the community in agriculture, forestry and fishery areas, especially in buffer zones of protected areas such as model of ecotourism development associated with biodiversity conservation; combined model of agriculture-forestry-fishery; integrated model of climate change adaptation solutions based on ecosystem; community-based conservation model; model of coral reef restoration, mangrove planting; model of organic agriculture; sustainable aquaculture model.

5.2.7. Development and application of sustainable community livelihood models

Developing and replicating livelihood models for communities in agriculture, forestry and fishery areas, especially in buffer zones of protected areas, will also contribute to proactive management of biodiversity, ecosystems and their services. Models must be suitable for the natural conditions as well as the practices of each different ecological region, and may include:

- Model of eco-tourism development in association with biodiversity conservation
- Combined model of agriculture-forestry-fishery
- Integrated model of climate change adaptation solutions based on ecosystems
- Community-based conservation model
- Model of coral reef restoration and mangrove planting
- Organic farming model
- Sustainable aquaculture model

PART VI. LEGAL AND INSTITUTIONAL FRAMEWORK ON CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY AND ECOSYSTEMS - IMPACTS, GAPS AND RECOMMENDATIONS TO ENHANCE ECOSYSTEMS

Key Findings

1. The legal framework on conservation and sustainable use of biodiversity and ecosystems is gradually being improved in Vietnam but it is still inconsistent or conflictive resulting in obstacles or difficulties in implementation

The three key specialized laws on conservation and sustainable use of biodiversity and ecosystems have been issued and gradually improved such as: the Law on Forestry (2017); the Fisheries Law (2017); and the Biodiversity Law (2008) are to create a legal corridor for overall comprehensive management of biodiversity and ecosystems in Vietnam. The Government and ministries and agencies have issued more than 193 policy documents guiding the implementation of these laws. However, the concept of ecosystem services has not been mentioned and institutionalized in the laws on biodiversity in Vietnam. Ecosystem services have only been regulated in some limited policy documents and there is lack of policies with regulations on ecosystem assessment. Besides, the percentage of policy documents for marine and wetland ecosystems is very limited, account for only 17.8% and 4.5% respectively of the total of policy documents on biodiversity conservation, while these ecosystems play an important role in supporting on socio-economic wellbeing in Vietnam. In addition, the quality of some policies is not high, some regulations are not in accordance with the practical situation due to these policies haven't been developed on the basis of science-policy-practice interface, resulting in difficulties to apply and enforce the laws and documents under laws on biodiversity and ecosystem conservation.

Though many policies have been issued, numerous regulations stemming from these policy documents are inconsistent or conflictive resulting in obstacles or difficulties in implementation. The biggest challenge to management and conservation of biodiversity and ecosystems is the inadequate coordination between MONRE and MARD in developing and issuing policies. This existence stems from the inconsistency between the three key laws in promulgating regulations on biodiversity conservation in Vietnam.

According to the Law on Forestry (2017), forests are classified into five categories: (i) national park; (ii) nature reserve; (iii) species - habitat reserve; (iv) landscape protection forest; and (v) scientific research or experiment forest, while the Biodiversity Law classified PA system into four categories: (i) national park; (ii) nature reserve; (iii) species/habitat PA); and (iv) landscape PA.

Due to the inconsistency in names, classifications, criteria and standards of PA system between the two these laws, leading to overlap and contradiction in rankings system of PAs. In addition, there is inconsistency in functional sub-zones and buffer zones of PAs and shortcomings in the management of PAs with mixed ecosystems, e.g. the PAs have all forest, wetland and marine ecosystems, resulting in degradation of biodiversity, ecosystems and their services.

2. The institutional framework on management of biodiversity and ecosystems in Vietnam has been reorganized, there are still overlaps in functions and missions

The Government performs unified state management of biodiversity; the Ministry of Natural Resources and Environment is responsible to the Government for performing state management of biodiversity; Ministries and ministerial-level agencies shall, within the scope of their tasks and powers, perform the state management of biodiversity according to the Government's assignment; People's Committees at all levels shall, within the scope of their tasks and powers, perform the state management of biodiversity according to the Government's decentralization.

Though the Government has made every effort to restructure the organization of biodiversity management at central and local levels, the system is still very unwieldy with many focal agencies resulting in some shortcomings and overlaps in function and missions. Besides, interdisciplinary coordination in management is not strict and still limited due to passivity and lack of continuity, resulting in low biodiversity management efficiency.

The assignment of state management responsibility for biodiversity is unclear between MONRE and MARD as well as between local management agencies leading to overlap and conflict. Human resources for local conservation are still inadequate and have not been trained in professional skills in biodiversity conservation. In particular, at most local DONREs, there are no functional units and specialized officials for biodiversity and ecosystem conservation.

Overlapping functions of state management on biodiversity and different ecosystems can negatively affect the use and sustainable exploitation of ecosystem services while reducing the provisioning services of the ecosystems.

3. Policy documents have had significant impacts on Vietnam's conservation and sustainable use of biodiversity and ecosystems

Though some policies are inconsistent or conflicting, however, the results of the implementation of policies and laws are to reduce drivers and pressures affecting biodiversity and ecosystems. Each group of key drivers and pressures affecting biodiversity and ecosystem services in Vietnam has corresponding policy documents developed and promulgated. These are feedbacks to effectively manage biodiversity and ecosystem services in order to minimize the impact of motivational and pressure groups. There have been basic results when implementing those legal bases.

4. Existing policy measures have made significant contributions to maintain and enhance ecosystems and their services

There are two basic groups of policies related to forest protection and benefit sharing from forest ecosystem services: (i) forest protection and development policy and; (ii) policy on payment for forest environmental services with many incentive measures to mobilize the communities to participate in forest protection.

After 10 years of implementation, the PFES policy has achieved many successes in the fields of economy, society, and environment and was recognized as one of the ten greatest achievements of the forestry sector in the period 2011-2015 (*MARD, 2017*). Thanks to this policy, many jobs have been created and a positive change in the awareness and responsibility of stakeholders for forest management and protection has been created. Therefore, in the three years of 2016-2018 implementation of the *target program for sustainable forestry development for the period of 2016-2020*, a number of targets have been achieved or exceeded (*Government Report, 2018*).

A first basis on a policy on payment for wetland ecosystem services has been initially institutionalized in the Decree no.66/2019/ND-CP dated July 29, 2019. However, the provisions on the payment price of the entities used for each type of service have not been mentioned. Therefore, it is necessary to have separate policy documents to implement the policy of payment for wetland ecosystem services.

Regarding activities of payment for marine ecosystem services, until now, payments have been done from a spontaneous perspective as collection of fees from tourist services in Ha Long Bay, some NPs and PAs, etc. Thus, it is necessary to have a legal basis for a policy on payment for wetland and marine ecosystems services.

5. Specific recommendations to maintain and enhance ecosystem services are proposed by the national ecosystem assessment

The legal framework on biodiversity and ecosystem still has certain shortcomings and overlappings; the existing laws as the Biodiversity Law, the Law on Forestry and the Fisheries Law that are inconsistent in some regulations or still lacks a number of regulations or is incomplete. Therefore, it is necessary to revise, adjust and supplement some regulations to complete the legal framework in accordance with the current situation such as (i) unifying the concepts, classifications, criteria and functional sub-zones and buffer zones of PAs between the Law on Forestry and the Biodiversity Law; (ii) introduction of contents of ecosystem services into the revising of the Biodiversity Law to create a legal basis for developing policies, guidelines on ecosystem services, ecosystem assessment, evaluation of ecosystem services; (iii) Development of a pilot policy on payments for wetland, marine and coastal ecosystem services; and (iv) review and revise the Decree no.147/2016/ND-CP dated 2 November 2016 on PFES for a higher implementation efficiency.

I. LEGAL AND INSTITUTIONAL FRAMEWORK ON CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY AND ECOSYSTEMS

1.1. Legal framework on conservation and sustainable use of biodiversity and ecosystems

At the highest level, the need for biodiversity conservation in Vietnam has been identified in the Constitution (passed by the National Assembly on November 21, 2013): *The State has a policy to protect the environment, conserve nature and biodiversity. Strict handling, remediation and compensation measures are applied to organizations and individuals that pollute the environment, deplete natural resources and reduce biodiversity* (Article 63).

Many important laws in the field of natural resource management were issued and gradually completed, in chronological order such as: the Law on Forest Protection and Development (1991, amended and supplemented in 2004, and amended and changed into the Law on Forestry 2017); the Land Law (1993; amended and supplemented in 1998, 2003 and 2013); the Law on Environment Protection (1993; amended and supplemented in 2005, 2014 and 2020); the Law on Water Resources (1998, amended and supplemented in 2012); the Law on Natural Resources and Environment of Sea and Islands 2015; the Fisheries Law (2003, amended and supplemented in 2017); the Planning Law 2017. In particular, the Biodiversity Law, passed by the National Assembly in 2008 and came into effect in 2009, has marked a turning point for biodiversity conservation. This is the legal framework with the highest legal effect in the field of state management of biodiversity in Vietnam today. After about 13 years of implementation, the Biodiversity Law has shown the superiority, synthesis, comprehensiveness, science, integration and practicality of a specialized law on management, conservation and development of biodiversity in Vietnam. The Biodiversity Law stipulates principles and tasks of biodiversity conservation at national, ministerial and local levels, creating a legal basis for local communities to participate in conserving natural resources through new benefit-sharing mechanisms.

Up to now, in order to create a legal corridor for overall comprehensive management of biodiversity issues, the Government and ministries and agencies have issued more than 193 policy documents guiding the implementation of the Biodiversity Law or other laws related to biodiversity conservation. These policy documents include decrees, decisions (approving strategies, master plans, plans, etc.), directives, circulars, official letters, technical guidelines, etc. (Annex 3). However, ecosystem services have only been regulated in some limited policy documents and there is lack of policies with regulations on ecosystem assessment. Besides, the percentage of policy documents for marine and wetland ecosystems is very limited, account for only 17.8% and 4.5% respectively of the total number of policy documents on biodiversity conservation (figure 51), while these ecosystems play an important role in

supporting on socio-economy in Vietnam. In addition, the quality of some policies is not high, some regulations are not in accordance with the practical situation due to these policies haven't been developed on the basis of science-policy-practice interface, resulting in difficulties to apply and enforce the laws and documents under laws on biodiversity and ecosystem conservation.

1.1.1. Policy documents on conservation and sustainable use of biodiversity and ecosystems

Central policy documents: Since the promulgation of the Biodiversity Law (2008), to create a legal framework for conservation and sustainable use of biodiversity and ecosystems. The central authorities and ministries have developed and issued policy documents related to biodiversity conservation activities such as finance, benefit sharing mechanisms in some special-use forests, integrating biodiversity into land use planning, invasive alien species, etc.

The policy documents are developed according to the system of the three specialized laws: (i) the Biodiversity Law (2008); (ii) the Law on Forest Protection and Development (1991, 2004) revised to the Law on Forestry (2017); and (iii) the Law on Fisheries (2003) revised to the Fisheries Law (2017). These laws have some inconsistent or conflictive contents, e.g. according to the Law on Forestry (2017), forests are classified into five categories: (i) national park; (ii) nature reserves; (iii) species - habitat reserves; (iv) landscape protection forest; and (v) scientific research or experiment forest, while the Biodiversity Law classified PA system into four categories: (i) national park; (ii) nature reserve; (iii) species/habitat PA); and (iv) landscape PA. Due to the inconsistency in names, classifications, criteria and standards of PA system between the two these laws, leading to overlap and contradiction in rankings system of PAs. In addition, there is inconsistency on functional sub-zones and buffer zones of PAs and shortcomings in the management of PAs with mixed ecosystems, e.g. the PAs have forest, wetland and marine ecosystems, resulting in degradation of biodiversity, ecosystems and their services.

Therefore, there has overlap and heterogeneity related to the management of biodiversity from the decrees guiding the implementation of these laws to the next set of policy documents, leading to difficulties and shortcomings in implementing biodiversity conservation management, especially in localities. From the inconsistency between the system of major policy documents on biodiversity between the two sectors of natural resources, environment and agriculture, rural development, it has led to overlap in the management system of biodiversity conservation by central and local authorities making it difficult to apply and enforce the laws on biodiversity and ecosystem conservation.

Local policy documents: People's Committees of provinces and cities under central authority (collectively referred to as provincial level) have issued according to their competence specific documents to implement the laws and other policy documents issued by central agencies, focusing on issues such as making, approving and organizing the implementation of provincial biodiversity plans, provincial biodiversity action plans, forest protection and development planning and development of fisheries. Some localities have developed documents of traditional conventions and customs of the locality to preserve biodiversity and related indigenous knowledge.

Policies and mechanisms related to biodiversity conservation: on the basis of policy documents and mechanisms have been promulgated to effectively implement conservation activities such as: integrating biodiversity and ecosystems into the interdisciplinary policies and programs; research activities on breeding, growth, salvage, artificial propagation of endangered, precious and rare species; implementing the sustainable forestry development program; developing organic agriculture; development of agricultural production processes according to GAP; development of aquaculture facilities certified as sustainable seafood (ASC); deploying cleaner production strategy in industry; development and application of tourism models associated with biodiversity conservation; development of renewable energy

sources and increasing energy efficiency; payment for forest environmental services; socialization of conservation: mobilization of funds from different sources to support conservation; national strategy on green growth; and the national action program on sustainable production and consumption.

Though there is the inconsistency between the three key laws related to biodiversity and ecosystems conservation, however, through assessments of ministries, sectors at the central and local levels as well as of experts on the implementation of these laws in recent years, some positive comments can be drawn. The general definition is as follows:

- The Biodiversity Law has identified principles and priorities for biodiversity conservation at all levels, from national, ministerial, and local levels; creating a legal basis for local communities to participate in conservation of natural resources through new mechanisms for co-management and benefit sharing;
- Awareness of biodiversity conservation has been gradually raised in social strata, especially at local levels and communities in areas with high biodiversity;
- Enhancement of biodiversity conservation and development is carried out at both levels of ecosystems, species and genetic resources, in both terrestrial, aquatic, inland and marine environments;
- The benefits from biodiversity conservation and ecosystem services have initially been exploited and used for socio-economic development and reasonably shared to improve people's lives (such as ecotourism activities, conservation, exploitation and use of species and genetic resources for livestock development, cultivation, health, scientific research, and payment for forest environmental services).

Development of strategies on biodiversity conservation: some strategies directly related to biodiversity and ecosystems have been issued and implemented such as: the national strategy on biodiversity to 2030, with a vision to 2050 (2022); the strategy for Vietnam forestry development in 2021-2030, with a vision to 2050 (2021); the strategy for management of special-use forests, marine protected areas and inland water protected areas in Vietnam up to 2020, with a vision toward 2030 (2014); the strategy for sustainable exploitation and use of natural resources and protection of the marine environment until 2020, with a vision to 2030 (2013); and the strategy for Vietnam fisheries development to 2030, with a vision to 2045 (2021); etc. Some key information on the strategies has been presented in table 26, Part V.

Development of biodiversity conservation plannings: In Decision no.1479/QD-TTg dated October 13, 2008, the Government approved "Planning of inland water protected area system by 2020" with 45 zones, located in almost all geographical regions, including typical inland water bodies such as rivers, underground rivers in mountains, reservoirs, natural lakes, lagoons, marshes, estuaries and coastal waters that currently hold aquatic biodiversity values with scientific and economic significance. This can be considered as the first planning of protected areas related to biodiversity. Of these 45 inland water conservation zones, there were 16 areas that coincide with the list of 68 wetlands of importance proposed by MONRE.

On May 26, 2010, the Prime Minister issued Decision no.742/QD-TTg approving "Planning the system of Vietnam marine protected areas to 2020", in which for the period 2010-2015 there were set out 16 MPAs.

In 2014, the Prime Minister signed and issued a Decision no.45/QD-TTg dated January 8, 2014 approving the National Master Plan on Biodiversity Conservation to 2020, with a vision to 2030.

The National Master Plan on Biodiversity Conservation is very important for biodiversity conservation in Vietnam. With the nature of planning in Vietnam, it is necessary to define the objects/scope of planing, according to 8 inland geographic regions (Northwest; Northeast; Red River Delta; North Central; South Central; Central Highlands; Southeast and the Mekong

River Delta). In this Plan, the system of existing protected areas was arranged and proposed to step by step establish and operate 46 new PAs, bringing the total number of PAs nationwide, both existing and planned to be newly established, to a total of 219 areas with a total area of about 3,067,000 ha, distributed evenly across the country. The system of 38 biodiversity conservation facilities (ex-situ conservation) was reviewed and upgraded, along with the review and development of 21 biodiversity corridors. The National Master Plan also proposed implementation solutions.

The Prime Minister signed and issued Decision no.1976/QD-TTg dated October 30, 2014 approving the Planning on the national special-use forest system till 2020, with a vision 2030. The objectives of this Planning were to by 2020, to bring the existing system of special-use forests from 2.2 million ha to 2.4 million ha; completing boundary identification, landmarks of functional zones and buffer zones of special-use forests; and clearly delineate planned land for purposes other than the planned area for the special-use forest system. In the planning of the special-use forest system, a list of national planning for special-use forest has been proposed to 2020, with a vision to 2030 totalling 176 special-use forests, including: 34 NPs, 58 NRs, 14 species PAs, 61 landscape protection forest and 09 empirical science study forest.

In the National Assembly's Resolution no.134/2016/QH13 dated April 9, 2016 on the adjustment of land use planning to 2020 and the national end-stage (2016-2020) land use plan, to the year 2020, there are 16,245,250 ha of forest land, of which protection forest land is 4,618,440 ha; special-use forest land is 2,358,870 ha and production forest land is 9,267,940 ha.

Thus, it can be seen that at the central level there are plans related to biodiversity conservation in different ministries. In localities, there are also similar plans according to different guidelines from the central government.

To overcome this situation, the Planning Law (2017), effective from 2019, in Appendix III, only includes the national master plan on biodiversity conservation (sectoral planning), and abolishes the provincial master plan on biodiversity conservation directly under the Central Government, and integrate this plan as a component within the provincial master plan on socio-economic development.

1.1.2. Implementation of policy documents on biodiversity is not effective

From the data presented in the previous section, it can be seen that the Government of Vietnam has paid attention to developing quite a number of policy documents to effectively manage biodiversity, sustainable exploitation and use and equitable sharing of benefits from ecosystem services. Though many policies have been issued, however, the quality of some policies is not high, numerous regulations stemming from these policy documents are inconsistent or conflicting or not in accordance with the practical situation resulting in obstacles or difficulties in implementation. Therefore, the policy implementation is not as expected.

1.1.2.1. Protected area management is inadequate

Protected area management activities in Vietnam are developed in the management plan and approved by competent authorities, with basic contents as follows:

- Protecting and restoring specific and important ecosystems and endangered, precious and rare species prioritized for protection;
- Scientific research and biodiversity monitoring;
- Public education campaigns, training and awareness raising for environmental protection and biodiversity conservation for stakeholders, especially local communities;
- Developing ecotourism services and livelihood models to improve living standards for

buffer zone communities;
- Improving management capacity and strengthening conservation powers.

Some additional mechanisms and policies have also been developed and implemented to facilitate the management of special-use forest such as:

- Current policy documents on management of special-use forests have contributed to stabilizing the special-use forest system in the whole country;
- Decree no.117/2010/ND-CP, dated December 24, 2010 on the organization of management of special-use forest system is the most complete decree to be developed, which is an important policy, contributing to increasing investment in the management of special-use forests;
- Decision no.24/2012/QD-TTg dated June 1, 2012 of the Prime Minister on the policy of investment in special-use forests in the period of 2011-2020 which has arranged, renovated, developed and improved operational efficiency of Management Boards and economic sectors involved;
- Co-management of special-use forests is considered to be an effective policy for the management and protection of special-use forests in order to link the interests and responsibilities of stakeholders, especially local communities.

Inadequacies in policy documents on protected area management:

In the reports on the results of the implementation of the management plan for protected areas in Vietnam, it is clear that although achievements have been made, there are still issues to address within the legal framework, mainly:

- The inconsistency in names, classifications, criteria and standards of protected areas categories between the three key specialized laws as mentioned in above item;
- The effectiveness of interdisciplinary coordination in the management and protection of the PA is still limited due to passivity, lack of continuity and inadequate coordination;
- There are many shortcomings in mechanisms and policies to involve communities in the management of special-use forests;
- Many protected areas have too small areas, do not protect the objects that need to be protected, especially protecting large animals capable of moving widely such as in Yok Don NP, Cat Tien NP, and Vu Quang NP;
- Although the system of protected wetlands has been mentioned in the National Master Plan on biodiversity conservation (2014), it has progressed very slowly, so far only 4 wetland PAs were established according to the regulations of the Biodiversity Law.
- There are no regulations on criteria of functional sub-zones of PAs, especially strict protection sub-zones and ecological restoration sub-zones;
- Resources including funds, equipment and forces for management and conservation of special-use forests are still limited in terms of quantity and professional work;
- Most protected areas have not yet effectively managed biodiversity values as desired.

1.1.2.2. Management of natural ecosystems is not effective

The management of natural ecosystems, especially on terrestrial forest ecosystems is not effective, so in many localities, forest destruction and illegal logging activities are still taking place in protection forests, buffer zones of PAs, and corridors between protected areas. Quality of forests have declined, with areas of primary and natural forests having high quality and high levels of biodiversity continuing to decrease year by year while plantation areas are increasing.

The management of wetland ecosystems as well as marine ecosystems also has many problems. Illegal exploitation or over-exploitation of aquatic resources often takes place

making aquatic resources in coastal areas severely reduced. In some coastal waters, along large nearshore islands, there is a conflict between development and conservation (as seen in developing industrial zones on reclaimed land in the Red River Delta; waste problems from industrial factories such as Formosa Ha Tinh and Vinh Tan 1 Thermal Power Plant in Ninh Thuan Province, over-developed aquaculture using cages in lagoons and bays), causing environmental pollution and affecting coastal wetland ecosystems and coastal waters.

1.2. Institutional framework on management of biodiversity and ecosystems

Article 6 of the Biodiversity Law (2008) stipulates: The Government unifies the state management of biodiversity; the Ministry of Natural Resources and Environment (MONRE) is responsible to the Government for the implementation of the state management of biodiversity; Ministries and ministerial-level agencies shall, within the scope of their respective tasks and powers, perform the state management of biodiversity as assigned by the Government such as the Ministry of Agriculture and Rural Development (MARD), the Ministry of Science and Technology (MOST), the Ministry of Health (MOH); Provincial People's Committees (PPC) within the scope of their duties and powers are to perform the state management of biodiversity as decentralized by the Government.

The agencies are responsible for direct management of biodiversity in Vietnam are presented in figure 50. The management of special-use forests, marine protected areas under the authority of MARD. Management of wetland protected areas, including wetlands listed under the Ramsar Convention, is covered by responsibility of the MONRE. The provincial agencies are responsible for the implementation of national biodiversity policies, laws and plans.

To date, management of the protected areas has been decentralized to local responsibilities at appropriate levels (Provincial and District People's Committees). Currently, there are six national parks directly managed by VNFOREST under MARD, and the rest of the PAs at the provincial level are managed by PPCs. The assignment and decentralization of the management of the PAs has revealed overlaps and shortcomings, so it is necessary to establish a unified management agency for the PA system in Vietnam.

In terms of genetic resources conservation, there are many ministries involved in genetic resources management: MONRE is assigned to be the focal point for management of genetic resources and biosafety. However, in reality, MARD is being assigned to preside over the conservation of genetic resources of plants, animals and fisheries, while the assigned MOST is the focal point to carry out the tasks of the gene fund and traditional knowledge copyright on genetic resources. In addition, the implementation of the task of managing genetic resources also includes the Ministry of Industry and Trade and the Ministry of Health.

A list of above acronyms is explained in below table.

The Ministry of Natural Resources and Environment (MONRE)	
Vietnam Environment Administration	VEA
Nature and Biodiversity Conservation Agency	BCA
Vietnam Administration of Seas and Islands	VASI
The Ministry of Agriculture and Rural Development (MARD)	
Department of Science, Technology & Environment	DSTE
Vietnam Administration of Forestry	VNFOREST
Department of Forest Development	DFD
Department of Forest Protection	DFP
Department of Special Use and Protection Forests Management	DSUPFM
National Parks	NPs
Fisheries Resources Surveillance	FRS
Department of Capture Fisheries	DCF
Department of Aquatic Resource Conservation and Development	DARCD
Department of Crop Production	DCP

Department of Livestock Husbandry	DLH
The Ministry of Science and Technology (MOST)	
The Ministry of Health (MOH)	
Provincial People's Committees (PPC)	
Department of Natural Resources and Environment	DONRE
Department of Agriculture and Rural Development	DARD
Department of Science and Technology	DOST
Department of Health	DOH

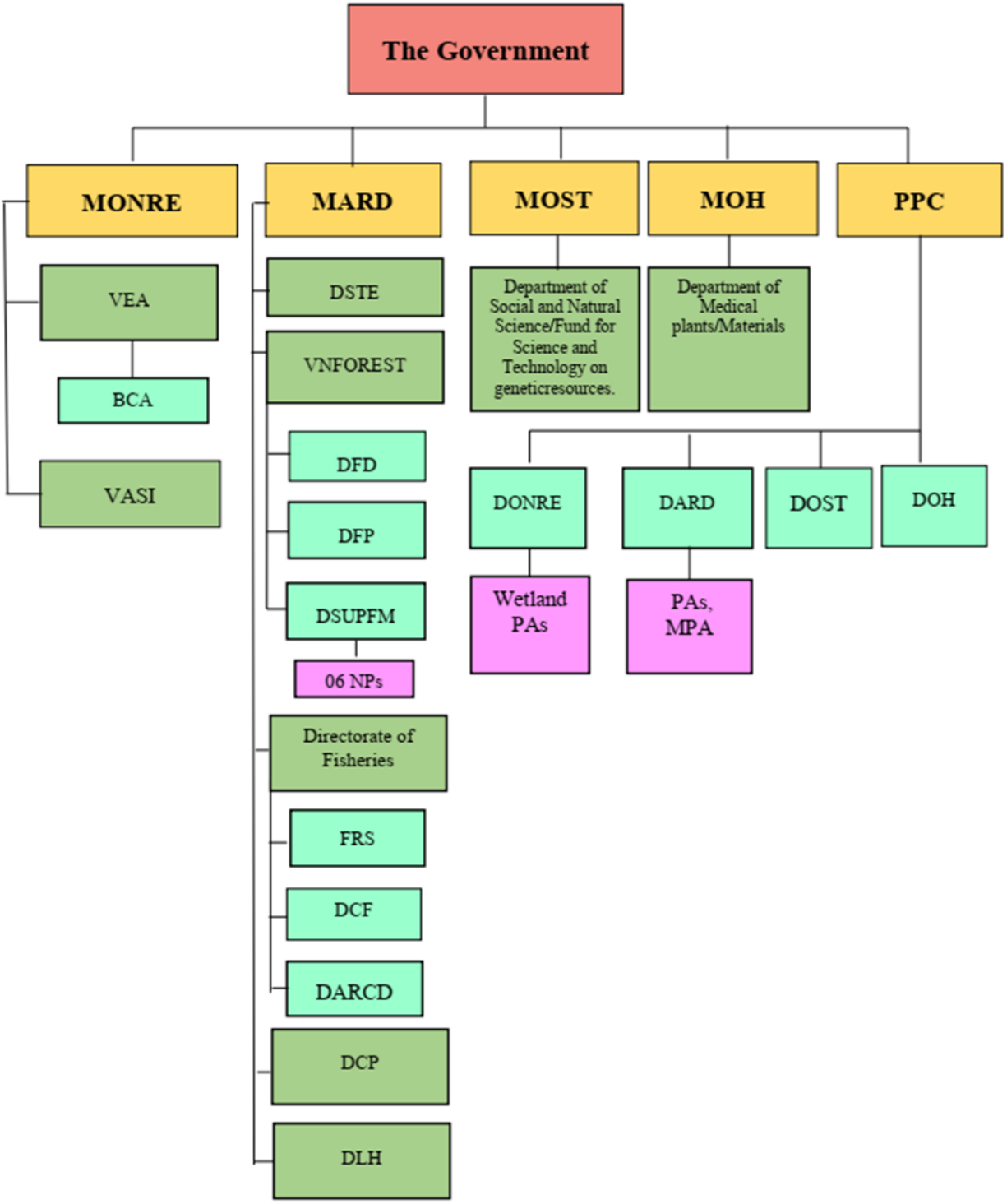


Figure 50. Diagram of the institutional framework on biodiversity in Vietnam

In addition to the state management role, many national and international non-governmental organizations and development organizations are also actively involved in biodiversity conservation, such as the Vietnam Association for Conservation of Nature and Environment (VACNE), the Vietnam Forestry Association (VIFA), the Research Institute of Resources and Environment (CRES), the Center for Biodiversity Conservation (CBC), the Education for Nature-Vietnam (ENV), the Center for People and Nature (PanNature), the Centre for Marine Life Conservation and Community Development (MCD), IUCN, BirdLife International, WWF, Winrock International, Wildlife Conservation Society (WCS), Fauna & Flora International (FFI), GIZ, USAID, Asian Turtle Conservation Program (ATP), and People Resources Conservation Foundation (PRCF).

Though the Government has made every effort to restructure the organization of biodiversity management at central and local levels, the system is still very unwieldy with many focal agencies, the assignment of state management responsibility for biodiversity is unclear between MONRE and MARD as well as between local management agencies leading to overlaps and conflicts in function and missions. Besides, interdisciplinary coordination in management is not strict and still limited due to passivity and lack of continuity. Human resources for local conservation are still inadequate and have not been trained in professional skills in biodiversity conservation. In particular, at most local DONREs, there are no functional units and specialized officials for biodiversity conservation, etc. leading to low biodiversity management efficiency.

Overlapping functions of state management on biodiversity and different ecosystems can negatively affect the use and sustainable exploitation of ecosystem services while reducing the provisioning services of the ecosystem.

II. IMPACTS OF LEGAL FRAMEWORK ON BIODIVERSITY AND ECOSYSTEM SERVICES

2.1. Impacts of policies on biodiversity and ecosystem services

The legal and institutional framework on biodiversity in Vietnam mentioned in the preceding sections are intended to address the drivers and pressures affecting biodiversity and ecosystem services such as those analyzed in Part IV.

Each identified group of key drivers and pressures having impacts on biodiversity and ecosystem services in Vietnam have respective policy documents developed and issued. These are feedback actions by regulators and policy makers to effectively manage biodiversity and ecosystem services. Some basic results of the implementation of policies related to biodiversity conservation and ecosystem services are presented in Annex 2.

2.2. Impact of the policy on payment for forest environmental services on sustainable development

In 2008, the Prime Minister has issued Decision no.380/2008/QD-TTg approving the Policy on PFES. Accordingly, this policy was piloted in two provinces of Son La and Lam Dong. After the pilot, the Policy on PFES was institutionalized through Decree no.99/2010/ND-CP on the PFES in Vietnam. Then in 2016, the Government again issued Decree no.147/2016/ND-CP dated November 2, 2016 amending and supplementing a number of articles of Decree no.99/2010/ND-CP dated September 24, 2010. Thus, the policy on PFES has been continuously adjusted by the Government by 03 policy documents to suit the actual conditions.

This policy can be considered as a mechanism for the sustainable use of forest ecosystems and the equitable sharing of benefits between providers and users of forest ecosystem services. This policy has been started from the regulation of Article 74 (environmental services related to biodiversity) of the Biodiversity Law (2008) and has been recorded in task 3 of the

National Strategy on Biodiversity to 2020 (2013), with a vision to 2030, which the Government has approved in Decision no.1250/2013 /QD-TTg.

Thanks to the actions taken in accordance with policy documents, especially the policy on PFES as mentioned above has created many jobs and a positive change in awareness and responsibility of stakeholders for forest management and protection. Therefore, in 03 years 2016-2018 in implementing the target program for sustainable forestry development for the period 2016-2020, according to the Government report (2018), a number of targets have been met exceeding the plan as follows:

- The number of cases of violating the Law on Forest Protection and Development (2004) was averaged 17,665 cases/year, an average decrease of 9,600 cases /year compared to the period 2011-2015. It is estimated that in the period 2016-2020, the number of violations will be reduced by 39% compared to the period 2011-2015.
- The damaged forest area has averaged 2,430 ha/year, a decrease of 270 ha/year, corresponding to a decrease of 10% compared to the period 2011-2015. It is estimated that in the period of 2016-2020 it will be reduced by 30% compared to the period 2011-2015.
- The forest area contracted to households, individuals and communities increases from 4,944 million ha/year in the period 2011-2015 to 6,143 million ha/year in 2016-2018.
- The concentrated afforestation was 675,000 ha, an average of 225,000 ha/year; planting production forests: 627,000 ha, an average of 209,000 ha/year; planting 47,400 ha of special-use and protection forests, an average of 15,800 ha/year.
- Regarding sustainable forest management: as of August 2018, the total forest area certified for sustainability under the FSC system is 229,281 ha (plantation forest 147,677 ha, natural forest 81,604 ha) in 17 provinces with 36 units certified, namely 04 households (Tuyen Quang, Yen Bai, Quang Tri and Quang Nam provinces) and 32 forestry companies. The output of exploited timber from certified planted forests is 2.0 million m^3, with certified timber having a selling price of 10-15% more than that of non-certified wood.

Significantly, so far, the policy on PFES in the Law on Forestry (2017) has been legalized. This is one of the important provisions that serves as the legal basis for forest development and protection in general, and in particular for the sustainable use and fair sharing of benefits from forest ecosystem services in the next stages. More information on the contributions of PFES policy can be found in item I of Part III.

III. EXISTING POLICY MEASURES HAVE MADE SIGNIFICANT CONTRUTIONS TO MAINTAIN AND ENHANCE ECOSYSTEMS AND THEIR SERVICES

3.1. Policy measures to maintain and enhance forest ecosystems and their services

Vietnam joined the Convention on Biological Diversity in 1994. Since 2008, many Government's policies have been issued to guide the implementation of the old Law on Forest Protection and Development (1991; amended and supplemented in 2004) as well as the recent Law on Forestry 2017, including the Prime Minister's Decree and Decisions. In addition, there are dozens of Circulars and Joint Circulars issued by the Minister of MARD. There is the Directive 13/2017/CT-TW on strengthening the party's leadership role in forest management and protection.

Vietnam has also participated in the United Nations Sustainable Development Programs. The Prime Minister signed Decision no. 622/QD-TTg dated 10/5/2017 on the Promulgation of the National Action Plan to implement the 2030 Agenda for Sustainable Development, including Objective 15: to protect and develop forests sustainably, conserve biodiversity, develop ecosystem services, combat desertification, prevent degradation and restore land resources.

There are two basic groups of policies related to forest protection and benefit sharing from forest ecosystem services: (i) forest protection and development policy and; (ii) policy on payment for forest environmental services with many incentive measures to mobilize the communities to participate in forest protection.

3.1.1. Forest protection and development policy

It can be seen that forest ecosystems are very important and of great concern to the Government of Vietnam, which has promulgated policy documents on forest protection and development. Forest protection and development is considered a priority activity in the forestry sector. In addition to the formation of the special-use forest system, which started with the establishment of Cuc Phuong protected forest in 1960 (now Cuc Phuong National Park), is the policy of afforesting 5 million ha of forest, enacted in Decision no.661/QD-TTg of the Prime Minister signed on July 29, 1998 approving the objectives, tasks, policies and implementation of planting 5 million ha of forest. After more than 10 years of implementation, this project was reviewed by the Government and the National Assembly in October 2010, and evaluated as having achieved many important results. Some noteworthy figures are that forest coverage increased from 32% in 1998 to 39.5% in 2010. The whole country has allocated 9,999,892 ha out of the total 16.24 million ha planned for forestry land. By 2010, the country's timber reserve reached 935.3 million m^3, an increase of 24.4% compared to 1998. The Government also requested the National Assembly to approve and organize the implementation of the forest protection and development plan in the period 2011-2020 to ensure continuity in the implementation of forest protection and development tasks.

By 2012, the Prime Minister signed Decision no.57/QD-TTg dated in 01/2012 approving the National Plan for Forest Protection and Development for the period 2011-2020, in which there are the following objectives: (i) well protect the existing forest area; ensure efficient and sustainable use of forest resources and planned land funds; (ii) increase forest coverage to 42-43% by 2015 and 44-45% by 2020; increase productivity, quality and value of forests; restructure the industry in the direction of increasing added value; basically meeting the demand for wood and forest products for domestic consumption and export; (iii) create more jobs, increasing income for people with a life associated with forestry, contributing to hunger eradication, poverty reduction, security and defense. Subsequently, the forest cover target was adjusted in Decision no.886/QD-TTg, June 16, 2017 approving the national target program for sustainable forest development for the period 2016-2020. Accordingly, the target of the rate of forest cover only needs to reach 42% by 2020 to suit the reality. The results of the national target program on sustainable forest development were clear: by 2020, Vietnam had 14,677,215 ha of forest land, of which 10,279,165 ha was natural forest and 4,398,030 ha was planted forest. The area of forested land eligible to calculate the national coverage rate was 13,919,557 ha, the coverage rate was 42.01% (*MARD, 2021*).

On April 1st, 2021, the Prime Minister approved the Strategy for Vietnam forestry development for the period 2021-2030, with a vision to 2050 with specific goals: (i) afforestation, with about 340,000 ha/year by 2030; (ii) planting protection forests and special-use forests at an average of 4,000-6,000 ha/year; (iii) restoration of protection and special-use forests on average 15,000 ha/year; (iv) total PFES collection increasing by 5%/year on average; (v) the national forest coverage rate is stable at 42%-43%.

3.1.2. Policy on payment for forest environmental services

Policy on Payment for Forest Environmental Services (PFES) has already been presented in item II of this Part.

3.2. Policy measures to maintain and enhance wetland ecosystems

Vietnam has been a party to the Ramsar Convention since 1989. Due to the great role and significance of wetlands and the threats to the area, quality and value of wetlands, the

Government has issued Decree no.109/2003/ND-CP dated September 23, 2003 on the conservation and sustainable development of wetlands. Since then, the policy framework for the conservation and development of wetland ecosystems has been built. According to the Biodiversity Law (2008), Article 35 stipulates the sustainable development of natural ecosystems on natural wetlands. The Fisheries Law (2017) has Article 17 regulating the aquatic resource PAs.

In Decision no.1479/2008/QD-TTg dated October 13, 2008, the Government has approved "Planning system of inland water conservation zones up to 2020" with 45 zones. This can be considered as the first planning of wetland protected area.

Decision no.149/QD-TTg, dated 28/1/2022 approving the National Strategy on Biodiversity to 2030, with a vision to 2050, start implementing a plan for conservation and sustainable use of wetlands nationwide, with priority given to key river basins.

Decision no.45/QD-TTG, dated January 8, 2014 of the Prime Minister approved the national master plan on biodiversity conservation to 2020, with a vision to 2030, including 60 wetland protected areas and MPAs. Although the wetland PA system has been mentioned in the national master plan on biodiversity conservation (2014), it has progressed very slowly. Up to now, there have been only 4 wetland protected areas established in accordance with the Biodiversity Law such as: Dong Xuyen Bird Garden Species-Habitat Conservation Area (Bac Ninh Province); Phu My Species-Habitat Conservation Area (Kien Giang Province); Thai Thuy wetland protected area in 2019 (Thai Binh Province); and Tam Giang-Cau Hai wetland protected area in 2020 (Thua Thien-Hue province).

In addition, some NRs with high wetland biodiversity were recognized such as: 09 Ramsar sites; 06 inland and coastal wetland areas of 11 world Biosphere Reserves; 03 inland and coastal wetlands 0f 10 ASEAN Heritage sites that have been presented in item I of Part II.

In 2019, the Government issued Decree no.66/2019/ND-CP dated July 29, 2019 on the conservation and sustainable use of wetlands. This can be considered as the most complete policy document on the conservation, use and management of wetlands in Vietnam, especially important wetlands. The Decree stated that there be sharing of benefits from ecosystem services of important wetlands (outside the protected area), stakeholders are to share in benefits from important wetland ecosystem services including: (i) organizing the management of the wetland conservation area and important wetland areas outside the conservation area and the agency performing the state management of the wetland area; (ii) communities are allowed to participate in exploitation and use of important resources of wetlands in accordance with the Biodiversity Law; (iii) organizations and individuals are responsible for participating in conservation and protection of important wetlands according to the provisions of the Law; and (iv) People's Committees at all levels with an important wetland area and other relevant organizations and individuals.

Benefit-sharing activities on important wetlands under the Decree include: (i) direct exploitation and use of values and products from important wetlands, including activities of capture fisheries, aquaculture, exploitation of forest products, and exploitation of other natural resources; (ii) the exploitation and use of intangible values, including: ecotourism, scientific research and training, product promotion, images of important wetlands, and protected areas reserves of wetlands.

Thus, it can be seen that a first basis for a policy on payment for wetland ecosystem services has been initially institutionalized in the above provisions of the Decree 66. However, the provisions on the payment price of the entities used for each type of service have not been mentioned. Therefore, it is necessary to have separate policy documents to develop, pilot and implement the policy of payment for wetland ecosystem services in Vietnam.

On July 4, 2014, in Nha Trang, the VEA/MONRE organized a workshop to comment on the draft "Guidance on the application of payment for coastal wetland ecosystems in Vietnam". For mangrove forests - a type of coastal wetland, people participating in the protection of mangroves should be paid for forest protection with the agricultural sector's payment of 100,000 VND/ha /year through the People's Committee. The coastal districts have signed coastal mangrove allocation contracts. As this level of payment is too small, the Project of Reproducing the ecosystem adaptive mangrove model in the Mekong River Delta (MAM2 for short) was helping Ca Mau become the first of 28 coastal provinces in Vietnam to implement a policy of payment for mangrove ecosystem services. Through the support of the project, the People's Committee of Ca Mau province issued Decision no.111/QD-UBND dated January 22, 2016 on pilot regulations on shrimp-forest farming with international certification, with Article 8 piloting payments for forest environment services. The subjects paying for forest environment services are specified as fisheries enterprises and beneficiaries of money are households signing contracts on forest contracting and protection forest management boards. The payment level was 500,000 VND/ha/year for the household's forest area under a direct payment contract. Statistics from the Nhung Mien and Kien Vang Protection Forest Management Boards in Ca Mau showed that the total number of households involved in the piloting in Nhung Mien was 542 households with a total forest area of 1,157 ha. In the 3 years 2016-2018, the total payment for forest environmental services to households was 1.75 billion VND (equivalent to 76,292 USD). In Kien Vang protection forest, the total number of pilot households was 458 households, the total area of pilot forest was 1,661 ha, and the total payment for forest environmental services to households was 1.78 billion VND (equivalent to 77,521 USD). This showed that the payment rate of fisheries enterprises for mangroves has increased 5 times compared with the payment regulations of the agriculture sector, stimulating the spirit of protecting and developing mangroves in the locality.

3.3. Policy measures to maintain and enhance marine and coastal ecosystems

The vast marine waters of Vietnam have about 20 different ecosystems containing over 11,000 known marine species. As early as 2003, the first Fisheries Law and later the revised Fisheries Law in 2017, both contain provisions on marine protected areas and protected aquatic resources. In 2008, the Government of Vietnam issued Decree no.57/2008/ND-CP dated May 2, 2008 on the Regulation of management of MPAs of Vietnam with national and international importance. Then, in 2010, the Prime Minister issued Decision no.742/2010/QD-TTg approving the Master Plan on the system of marine protected areas of Vietnam to 2020, including 16 MPAs (accounting for 0.24% of the marine area). By 2020, 12 MPAs with a total area of 213,400 ha have been established and put into operation. A detailed planning for 04 remaining MPAs has been completed (*Directorate of Fisheries, 2021*).

In 2015, the National Assembly of Vietnam approved the Law on Natural Resources and Environment of Sea and Islands. This is an important law with chapters and many provisions regulating the management, investigation, research, exploitation, and planning of marine and island resources in the presence of marine biological resources in marine and coastal ecosystems.

Decision no.1570/2013/QD-TTg approved the Strategy for sustainable exploitation and use of natural resources and protection of marine environment to 2020, with a vision to 2030, including targets to adapt to climate change, maintain ecological functions and biological productivity of marine ecosystems in order to protect marine biodiversity and marine resources.

In particular, up to 2018, the Central Party Committee issued Resolution no.36-NQ/TW, October 22, 2018 of the Eighth Conference of the XII Central Executive Committee on the Strategy for Sustainable Marine Economic Development Vietnam to 2030, with a vision to 2045 with the general goal: to turn Vietnam into a strong sea nation; basic achievement of

criteria for sustainable development of marine economy; forming marine ecological culture; proactively adapting to climate change and sea level rise; prevent the rising trend in marine pollution, degradation of the marine environment, coastal erosion and sea erosion; and restore and preserve important marine ecosystems. New, advanced and modern scientific achievements have become a direct factor in promoting sustainable marine economic development. In the specific target group, there are objectives for well managing and protecting marine, coastal and island ecosystems; increasing the area of marine and coastal protected areas to at least 6% of the national marine area; and restoring the minimum area of coastal mangroves to the 2000 level.

The Decision no.622/2017/QD-TTg on promulgating the national action plan to implement the 2030 Agenda for sustainable development that seeks in Goal 14 to conserve and sustainably use oceans, seas and marine resources for sustainable development. According to Decision no.681/2019/QD-TTg on the Roadmap for the implementation of this sustainable development goal, by 2030, the area of marine and coastal protected areas will reach 3-5% of the national marine natural area, based on science and in accordance with national and international law.

Regarding a policy of payment for marine ecosystem services, until now, payments have been done from a spontaneous perspective. Typical examples are as follows:

- Collection of fees from tourist services in Nha Trang Bay MPA: currently, Nha Trang is applying two types of entrance fees applicable to tourists, including scenic fees applied to all tourist visitors by boat and conservation fees applied to visitors participating in activities in the core zone of the MPA such as scuba diving, snorkeling masks to see corals. According to Hoang Minh Ha et al. (2008), in 2006 alone, 150,000 USD were collected from conservation fees of which 115,000 USD were retained for conservation activities of the Management Board. The remaining amount was deducted from the provincial operating budget.
- Collection of fees from tourist activities in Ha Long Bay: on average, Ha Long Bay received 5.3 million USD a year from fees to visit the bay, and fees to visit caves in the bay and 45% was retained for bay management activities. However, there was no clarity and transparency in the use of entrance fees for investments in marine ecosystem conservation projects. These activities were based on provincial, state or other funding sources (*Bernard OC, 2008*).
- Collection of fees from tourist activities in Con Dao National Park: the most obvious difference of Con Dao National Park from other protected areas is the concentrated breeding ground of sea turtles, so it has the advantage of welcoming a large number of annual visitors. Funding for conservation is collected from a variety of sources such as accommodation fees, scenic fees, and scientific research fees. Besides, the National Park has piloted the establishment of a Marine Turtle Conservation Fund. This is a fund established from voluntary donations and donations from tourists and is only used for the purpose of protecting the sea turtle spawning grounds within Con Dao National Park.

The broader implementation of a policy of payment for ecosystem services as a sustainable financial mechanism is inevitable and should be prioritized for early implementation for all types of ecosystems, particularly highly resilient ecosystems such as wetland and marine ecosystems. For early implementation, it is necessary to have a legal basis and therefore the policy for payment for wetland and marine ecosystem services requires a Government Decree, as is the case with the policy on payment for forest environmental services.

Between the three forest, wetland and marine ecosystems, there are different laws and policies to manage biodiversity conservation and maintain ecosystem services. However, the percentage of policy documents for these 3 ecosystem groups is different.

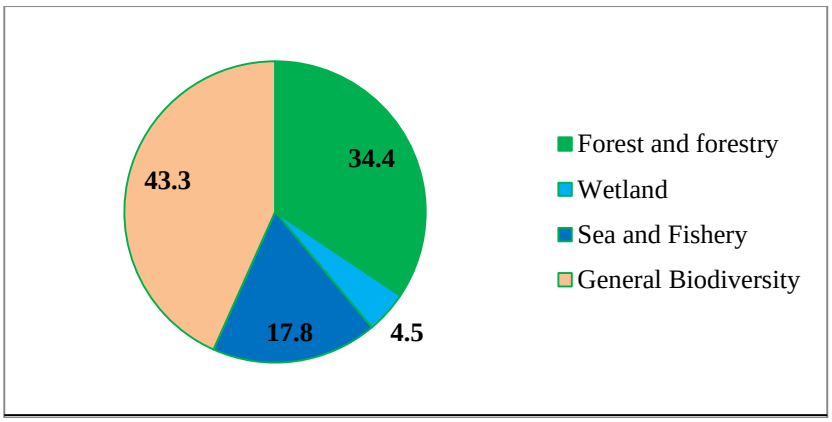


Figure 51. Percentage of Government policies on biodiversity conservation and forest, wetland and marine ecosystems

From the data in the above figure, in addition to the number of policy documents on biodiversity conservation in general accounts for 43.3%, forest ecosystems and the forestry sector account for 34.4%, while marine ecosystems and the fishery sector account for 17.8%. Wetland ecosystems and water resources account for only 4.5% of the total of policy documents.

IV. POLICY GAPS AND RECOMMENDATIONS TO MAINTAIN AND ENHANCE ECOSYSTEMS AND THEIR SERVICES

4.1. The legal framework on conservation and sustainable use of biodiversity and ecosystems still has certain shortcomings and overlaps

The current legal framework on conservation and sustainable use of biodiversity and ecosystems basically ensures a high level of intrinsic consistency of the legal documents of natural resources and environmental protection, serving the country's sustainable development. The Biodiversity Law stipulates the most general issues of conservation and sustainable development of biodiversity, while specific issues are still regulated in special specialized laws such as the Law on Forestry and the Fisheries Law approved in 2017. However, there are still some shortcomings and overlaps:

1. Inconsistency in the concepts, classifications, criteria and functional sub-zones of PAs. Even now, while the classification of marine protected areas of the Fisheries Law (2017) has been adjusted to be consistent with the PA classification of the Biodiversity Law (2008), special-use forest classification of the Law on Forestry (2017) and PA classification of the Biodiversity Law are still inconsistent.
2. For the management of genetic resources and biosafety, there are many ministries involved in management such as: MONRE, MARD, MOST, MOH and Ministry of Industry and Trade. Therefore, the reality of implementing biosafety management activities for genetically modified organisms, management of genetic resources, as well as the management of access to genetic resources in Vietnam is lacking in linkages sharing and exchange of information. The assignment, decentralization and regulations of responsibility among management agencies in controlling invasive alien organisms are unclear and overlapping. There has been no consensus about the management and licensing of alien species imported into Vietnam.
3. The concept of *ecosystem services* has not been mentioned and institutionalized in the laws on biodiversity in Vietnam. Ecosystem services have only been regulated in some limited policy documents and there is lack of policies with regulations on ecosystem assessment. When ecosystems are threatened by human activities, it is important to take into account the enduring ecosystem’s health and its role in facilitating human habitation and economic activity. It is in this context that the concept of ecosystem services was

introduced to assist in the assignment of economic values to the role of the ecosystems and to design sustainable development policies (*Silvis and van der Heide, 2013*).

4. Currently the policy on PFES is quite comprehensive, but it only applies to water supply services for hydropower plants, water companies and tourist companies. For other forest areas that do not benefit from PFES, it is necessary to consider other programs such as investments from the private sector and the community to improve the local landscape, providing revenue through sales and carbon sequestration credits.
5. At present, there is still no policy on payment for wetland ecosystem services and marine ecosystem services while these ecosystems have many important services provided to people such as food, fisheries, tourism, relaxation and environmental and climate regulation. To soon implement, it is necessary to have a mechanism and policy for the payment for wetland and marine ecosystem services in the form of a Government Decree as is available with payments for forest environmental services.
6. The Biodiversity Finance Report, Policy and Institutional Review (*UNDP, 2018*) emphasizes that PFES has the potential to become an important source of finance for forest development, including biodiversity conservation, but lacks a comprehensive and reliable enough monitoring system.
7. The process of operating reservoirs and inter-reservoirs has not been fully and effectively implemented (between the Ministries of Industry and Trade, MARD and MONRE).
8. The planning on the system of aquatic resource protection zones and areas where fishing is prohibited for a definite period has not been implemented under the Fisheries (Law 2017).

4.2. The Biodiversity Law lacks a number of regulations or is incomplete

The Biodiversity Law (2008), which took effect from July 1, 2009, is a turning point for biodiversity conservation. This is the legal document with the highest legal effect in the field of state management of biodiversity in Vietnam today. After about 13 years of implementation, the reality of state management on biodiversity has undergone many changes. In addition, in the context of Vietnam's strong socio-economic development and severity of global climate change already evident in Vietnam, many issues are related to biodiversity conservation and epidemics, ecosystem services and ecosystem assessment have not been clarified and legalized in the Biodiversity Law.

4.2.1. The sanctions are insufficient or not strong enough for the Biodiversity Law violations

Article 7 of the Biodiversity Law prohibits acts such as hunting, fishing and exploitation of wild species within a PA, except for exploitation for scientific research purposes. This also prohibits acts of illegally hunting, catching, exploiting body parts, killing, consuming, transporting, buying and selling species listed as endangered precious and rare species prioritized for protection. However, this law does not specify administrative or criminal remedies. The Law only stipulates that organizations or individuals causing biodiversity loss to compensate according to the provisions of the Law (Article 75), and should specifically refer to the Criminal Law.

4.2.2. There are no regulations on the role of communities, gender equality, stakeholders, and socialization in biodiversity conservation

In the Biodiversity Law, there are no regulations on the role of communities, gender equality and stakeholders in biodiversity conservation and development; and the role of communities, stakeholders in socializing biodiversity conservation, especially in protected area management by communities. In fact, there have been many models of community initiatives for biodiversity conservation such as bird sanctuaries in Bac Lieu province, storks in Thanh Mien, Hai Duong province, fish streams (Thanh Hoa province), sacred forests (Northern mountainous areas and Central region and Central Highlands), protection of coral reefs, and

co-management of mangrove forests in coastal sub-regions. The above conservation models and community initiatives and stakeholders have not been mentioned in the Biodiversity Law or related documents under the Law.

Women are a large force present in all activities related to biodiversity and ecosystem conservation. However, gender equality is only mentioned in general in the 2008 Biodiversity Law under the terms "collectives", "households", and "communities". Therefore, in the revision of the Biodiversity Law, gender equality should be integrated under the provisions of the Law on Promulgation of Legal Documents 2015, Articles 20 and 21 of the Law on Gender Equality, in the direction of ensuring fundamental gender rights and promoting gender role equality in participation in biodiversity and ecosystem conservation.

4.2.3. Some contents have not been regulated or not clearly specified in the Biodiversity Law

After more than 12 years of implementing the Biodiversity Law, the reality of state management on biodiversity has changed many times, some of the contents are no longer relevant to current reality and need to be updated and adjusted, while other contents have been clarified in legal documents. However, some issues related to biodiversity in the new situation need to be considered, adjusted and promptly supplemented in the revising Biodiversity Law such as:

1. Landscape approach in biodiversity conservation and landscape services in order to identify important natural landscapes, and areas with high biodiversity and important wetlands outside nature reserves;
2. Biodiversity and ecosystem services, ecosystem assessment in the context of climate change;
3. Gender equality should be integrated in the direction of ensuring basic gender rights and promoting gender role equality in participating in biodiversity conservation;
4. Development of economic tools in conservation work;
5. Specific regulations on biodiversity corridor management;
6. Regulations on biodiversity and ecosystem assessment, investigation, statistics, monitoring, reporting and development and management of a national database on biodiversity and mechanisms for providing, sharing and using information on biodiversity;
7. Biodiversity offsets must be legally regulated;
8. The amount of economic value of ecosystem services needs to be specified and must be recognized and included in national accounting, financial and economic systems;
9. Development of national targets on biodiversity;
10. Assessment of impacts of development activities on biodiversity;
11. Regulations on financial mechanisms for biodiversity and ecosystem conservation;
12. Regulations on public education to raise awareness about biodiversity and ecosystem services values;
13. Integration of biodiversity and ecosystem services into sectoral and interdisciplinary policies.
14. Specific regulations on payment for wetland, marine, coastal and rocky mountain ecosystem services (without forest vegetation) to maintain, restore and develop the services of these ecosystems, including: payment principle; monetary value of each service; users and providers of ecosystem services.
15. Socialization of conservation work (protected areas managed by communities).

4.3. Specific recommendations to improve the legal framework on conservation and sustainable use of biodiversity and ecosystems

The Biodiversity Law was passed in 2008 and took effect on July 1, 2009. Now, after more than 13 years of implementation, the Government has requested that the Law be evaluated, amended and supplemented to be consistent with relevant laws and suitable with current

conditions. Currently, the revision of the Biodiversity Law is being chaired by the Ministry of Natural Resources and Environment, and coordinated with other ministries and sectors to evaluate and to adjust, supplement and submit to the National Assembly for consideration in the next period. Therefore, the National Ecosystem Assessment Report only proposes some recommendations to adjust and supplement a number of provisions in the Biodiversity Law, and at the same time recommends the development and amendment of a number of mechanisms and policies related to forest, wetland, marine and coastal ecosystems in order to maintain and increase the quality of important ecosystem services.

4.3.1. Recommendations to improve the Biodiversity Law

Through many assessments by ministries and branches during the implementation of the Law, it is necessary to adjust and supplement a number of contents related to biodiversity and ecosystem conservation to be consistent with relevant laws and suited to the current situation:

1. Introduction of the concept of ESs into the revising of the Biodiversity Law;
2. Adopt a landscape and ecosystem-based approach to biodiversity conservation;
3. Conduct economic valuation and assessment of ecosystem services as a basis for harmonization between conservation and development, as currently economic values from ecosystem services have not been included in Vietnam's national accounting system;
4. Environmental products/services have not been fully assessed and accounted for in the current accounting system, leading to incorrect perception of growth. Currently, the United Nations has issued a unified green GDP calculation framework for worldwide application and implementation;
5. Ensure benefits from biodiversity and ecosystem services are shared fairly and reasonably among stakeholders with community participation and in particular, legislate different ecosystem service payment policies;
6. Investigate, inventory, monitor and report on biodiversity, especially for protected areas, areas of high biodiversity value (outside of PAs), and important wetlands;
7. Establish the national database system on biodiversity and the mechanism for managing and using information on biodiversity and ecosystem services;
8. Unifying names, classifications, criteria and standards of PA types between the revised Biodiversity Law and the Law on Forestry (2017); as well as on viewpoints and measures in the organization and management of NRs and PAs between ministries and branches at the central level, and between central and local governments and protected areas;
9. Develop and implement mechanisms to promote community participation in biodiversity and ecosystems conservation, especially in PAs;
10. Develop and implement mechanisms and policies for the socialization of conservation work of biodiversity and ecosystem services;
11. Mechanisms and policies to promote the conservation, restoration and development of biodiversity and ecosystems are implemented as an action to adapt to climate change;
12. Apply the provisions of the Law on Gender Equality 2006 and integration of the gender issues into biodiversity conservation;
13. Increase the ability of the Biodiversity Law to reference other relevant laws.

4.3.2. Recommendations to develop and improve some policies under the relevant laws

Some policy documents on biodiversity and ecosystems should also be reviewed, adjusted and supplemented or newly developed with contents and regulations to consist with the revising of the Biodiversity Law and suit to the current actual conditions in Vietnam.

4.3.2.1. Development of some new policies on ecosystems and their services

In order to maintain and increase the quality of important ecosystem services and to contribute many practical benefits to socio-economic development, it is necessary to develop a number of mechanisms, policies, and technical guidance for ensuring consistency among relevant laws, resolve conflicting and overlapping issues in the management and conservation of biodiversity and ecosystem services at the national level and implement international commitments to which Vietnam has joined. In order to ensure the quality of policies after promulgation, and ease and appropriateness in the implementation process, it is necessary to mobilize information and knowledge from the linkage between groups of scientists - policy makers - practitioners as well as consult with relevant partners in the process of formulating and perfecting mechanisms and policies. Some of the proposed policies to develop are as follows:

1. Pilot policy on payments for wetland, marine and coastal ecosystem services. In which, it is necessary to develop appropriate benefit-sharing mechanisms between service users and service providers; a support mechanism; and payment rates of users for each type of service. After the successful implementation of the pilot policy, it is recommended that the Government issue a higher legal document to mobilize organizations and individuals to participate in the conservation and sustainable development of ecosystems and their services through mechanisms and policies to pay for ecosystem services.
2. Coordination mechanism in the management of protected area systems. Currently, with the PAs established under the Law on Biodiversity (2008) and the Law on Fisheries (2017) and the PAs established under the Law on Forest Protection and Development (2004) and the Law on Forestry (2017) there have been many disagreements regarding the rating of the PA, functional zoning and buffer zones, criteria, etc. Therefore, a coordination mechanism is required to unify management in order to minimize the conflicts and differences that form the driving forces for biodiversity loss and the degradation of ecosystems and their services.
3. Technical guidance on ecosystem assessment and piloting in a PA or NP will then be scaled up at provincial, regional and national levels. In particular, attention should be paid to strengthening the capacity to evaluate and integrate ecosystem services into policies of relevant sectors through the activities of the phase 2 project implemented by MONRE and UNDP Viet Nam.
4. Coordination mechanism on genetic resource management and biosafety among the Ministries: MONRE, MARD, MOST and MOH aimed at unifying and clarifying the responsibilities of each ministry in managing these areas as well as enhancing coordination in the management of natural resources and ecosystem services.

4.3.2.2. Adjusting and supplementing some policies on ecosystems and their services

Some policy documents under laws such as the Biodiversity Law, the Law on Forest Protection and Development, now the Law on Forestry, and the Fisheries Law have remained unchanged for many years and are no longer suited to current conditions. They need to be adjusted and supplemented to be consistent, and synchronized as follows:

1. Strategy for management of the system of special-use forests, marine conservation zones, and inland water conservation zones in Vietnam to 2020, with a vision to 2030 (2014);
2. Strategy for exploitation and sustainable use of natural resources and marine environment protection up to 2020, with a vision to 2030 (2013);
3. Strategy for integrated coastal zone management of Vietnam to 2020, with a vision to 2030 (2014);

4. Master plan on Biodiversity conservation of the whole country to 2020, with a vision to 2030 (2014);
5. Decree No. 147/2016/ND-CP dated November 2, 2016 Amending and supplementing a number of articles of the Government's Decree No. 99/2010/ND-CP dated September 24, 2010 on spending policies payment for forest environmental services (2016).

4.3.2.3. Other recommendations to maintain and improve ecosystems and their services

In order to maintain and enhance ecosystems for improving the important ecosystem services contributing to the socio-economy, it is necessary to implement various measures at the same time to reduce drivers and pressures to change the status and trends of ecosystems and biological lifeforms in the context of global climate change such as:

1. The ecosystem approach has become very popular over the past decade as a harmonious way to conceptualize management issues related to natural ecosystems. The application of this approach to forest, wetland, marine and coastal ecosystems constitutes a comprehensive integrated management of human activities based on the best scientific knowledge of ecosystems and dynamics, in order to identify and take measures for sustainable exploitation and use of ecosystem services and maintenance of ecosystems.
2. Continue to promote research on the values of ecosystem services (especially for wetland ecosystems and marine and coastal ecosystems) that include provisioning services, regulating services, cultural services and supporting services. Vietnam needs to soon develop a database on the values of major ESs so that it can be easily integrated ecosystems and their services into the decision-making process as well as the strategic environmental assessment and environmental impact assessment related to the management and use of these services.
3. In terms of management viewpoint, it is necessary to think of legalization of the value of ESs so that they can be fully accounted for in the national accounting system.
4. Further research is needed on the drivers and pressures of change in ecosystem services according to specific scenarios in Vietnam and their impact on the socio-economy in order to respond through suitable measures for sustainable exploitation and use of ecosystem services and for biodiversity conservation in Vietnam.
5. Support and facilitate ethnic minority communities to preserve and develop traditional and indigenous knowledge of the conservation and sustainable use of natural biological resources.
6. Focus on the development and application of sustainable livelihood models to improve and enhance the living standards of communities in agriculture, forestry and fishery areas living in or around buffer zones of protected areas, in order to reduce pressures on ecosystems and their services. The livelihood models must be suitable for the natural conditions as well as the practices of each different ecological region.
7. Continue to restructure the organization of biodiversity management at central level to minimize focal agencies in ministries and improve capacity for human resource at local level.
8. Strengthen enforcement measures for biodiversity conservation laws.
9. Increase the search for sources of investment capital for biodiversity and ecosystem conservation.
10. Develop and implement a comprehensive programme on communication, education and awareness raising for all walks of life about the important role of biodiversity and ecosystem services.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The NEA report is based on secondary data and information, and according to the IPBES' process and approach. The logical framework was used for addressing each of these issues and their relationships such as the Driver-Pressure-State-Impact-Response (the DPSIR framework) to analyze factors and interactions with ecosystems and their services. The report synthesizes and evaluates information on three key ecosystems and their services in Vietnam, including forest ecosystems, wetland ecosystems, and marine and coastal ecosystems. The main results of the report can be summarized as follows:

1. The report provides an assessment of the **status of biodiversity and trends of the key ecosystems and the services they deliver in Vietnam**. In Vietnam, ecosystems are divided into three groups: (i) **terrestrial ecosystems** including forest, rocky mountain (no forest cover), agricultural and urban ecosystems; (ii) **wetland ecosystems** including three sub-groups such as: *inland wetlands* (streams, rivers, lakes, reservoirs, underground lakes in karst caves and peat swamps, etc.); *coastal wetlands* (coral reefs and seagrass beds (at a depth of below 6m at low tide), tidal flats, estuaries, mangroves, etc.;); and *artificial wetlands* (aquaculture lagoons, water reservoirs, etc.); and (iii) **marine ecosystems** including coral reefs, and seagrass beds **(**at a depth of over 6m at low tide), lagoons, pools, bays, island salty ponds, etc. Most of important ecosystems are located in a system of 176 protected areas, with a total area of about 2,512,530 ha. Currently, Vietnam has about 61,700 natural species of organisms; about 800 species of crops, more than 6,000 varieties of rice and 887 varieties of livestock. These are precious indigenous genetic resources that need to be protected, preserved and sustainably developed.

Ecosystem services in Vietnam can be categorised into four groups, including (i) provisioning services, such as providing food, water, timber and fiber; (ii) regulating services, such as the regulation of climate, floods, disease, wastes and water quality; (iii) cultural services, such as offering recreational, aesthetic, and spiritual benefits; and (iv) supporting services, such as soil formation, photosynthesis, and nutrient cycling.

The country’s important ecosystems are being degraded and are decreasing in area and biodiversity. For example, the natural forest area decreased from 10,304,816 ha in 2010 to 10,279,185 ha in 2020, while the area of planted forests increased from 3,083,300 ha in 2010 to 4,398,030 ha in 2020; the area of peatland decreased from 12,400 ha in 1976 to just 2,800 ha in 2016 in U Minh Thuong, and decreased from 20,200 ha in 1976 to 7,500 ha in 2016 in U Minh Ha; the area of seagrass decreased by 45.4% over the past two decades; the total number of species listed as threatened in 2007 was 882 species, consisting of 418 animal species and 464 plant species in 2007, but this has increased to 1,211 species in 2017, with 600 plant and fungi species and 611 animals species; etc.

2. The report summarizes and evaluates **the substantial contribution made by ecosystems to Vietnam's society and economy through provisioning, regulating, cultural and supporting services**. The agriculture, forestry and fishery sectors contribute significantly to GDP, and their export value increased from 19 billion USD in 2010 to 41.25 billion USD in 2020, accounting for 14.60% of the country's export turnover and 14.85% of GDP in 2020, and 12.36% of GDP in 2021.

Forest ecosystem services have also contributed to the socialization of biodiversity conservation and forest protection through Vietnam's PFES mechanism, supporting poverty reduction for communities participating in forest protection. In the period 2011-2020, the total amount of money collected from parties using forest environmental services was more than 16,746 billion VND (equivalent to 728.09 million USD) or 1,674 billion VND/year on average (equivalent to 72.78 million USD/year on average). This money has been used to pay

for more than 250,000 households and 10,000 communities living in and around forests, especially ethnic minority communities living in remote and mountainous areas.

The report also summarizes the results of evaluation studies of these ecosystems in Vietnam, highlighting their significant potential economic values. For example, the forest ecosystem services in Cat Tien NP generated goods and services worth 51.60 million USD/year in 2012; the total direct use value of wetland services in Xuan Thuy NP in 2010 was 4.09 million USD/year, while the total indirect use value was 325,550 USD/year, and the biodiversity conservation value was 19,950 USD/year; the total economic value of marine ecosystem services around selected islands in Vietnam fluctuated between 12 million USD to 26.62 million USD, and the total economic value of marine ecosystems ranged from 4,200 USD to 13,650 USD/ha/year.

3. The report identified **seven factors as drivers and five factors as pressures to change in the status and trends affecting ecosystems and their services,** including: (i) demographic change; (ii) economic development; (iii) overlapping functions and management of biodiversity among relevant agencies; (iv) policy and governance on biodiversity conservation; (v) communication, awareness and education; (vi) development of science and technology; and (vii) limited resources and investment for biodiversity conservation. These drivers are fundamental factors that create pressures affecting the ability of ecosystems to provide products and services.

Five factors are identified as pressures including: (i) conversion of land and water to other uses, for example, from 2006 to 2016, there were 2,991 projects that involved 386,290 ha of forest transferred to other purposes, comprising 300,120 ha of natural forest (accounting for 78.0%) and 86,170 ha of planted forest (22.0%); (ii) excessive and illegal exploitation of biological resources, such as in 2018 and 2019, the national forest protection force detected and handled 466 cases of violations of regulations governing the management and protection of endangered wildlife; (iii) environmental pollution: the phenomenon of algal bloom, mainly blue-green algae (*Microcystis* spp.) exhausts dissolved oxygen in lakes in Hanoi city, killing many fish. Red tide phenomenon is increasing in coastal waters (*MONRE, 2019*); (iv) climate change: According to climate change and sea level rise scenarios for Vietnam (*MONRE, 2016*), a sea level rise of 100cm results in a corresponding risk of flooding of 78 out of 286 "critical habitats", 46 protected areas, 09 biodiversity areas of national and international value and 23 other biodiversity areas in Vietnam would be severely affected; and (v) the introduction of invasive alien species, which have changed the status and trends of ecosystems and their services, for example, there are now 94 alien plant species imported into Vietnam, including 42 invasive species and 12 types of fast-growing invasive species such as *Mimosa pigra* and Japanese duckweed (*Eichhornia crassipes*). There are 48 alien aquatic animals that have entered Vietnam through various ways, of which 14 species are considered to have harmful effects on aquatic biodiversity.

The drivers and pressures affecting ecosystems and changing the provision of their services all have certain impacts on the socio-economy in Vietnam. There are drivers and pressures affecting ecosystem services that denote "positive" impacts, which are registered as continuously increasing output, quantity or revenue in a number of economic sectors such as agriculture, fisheries, industry and trade, and tourism, thus meeting the increasing needs of people. However, the downside of achieving such economically significant figures is the trade-off in ecosystem degradation, biodiversity loss and consequent reduction in ecosystem services. The areas of natural forests area and seagrass beds are reduced; coral reefs have lower coverage; endangered species have a reduced number of individuals; the yield of natural seafood exploitation has reached a critical threshold; exploitation rates in some species, mainly in marine areas, are high, signaling over-exploitation.

4. The report analysed **four future plausible scenarios for ecosystems and their services**, including (i) *development as usual scenario* (ii) *feasible base scenario*; (iii) *higher growth scenario*; and (iv) *sustainable development scenario associated with conservation*. Of the four scenarios, the s*ustainable development scenario associated with conservation* is considered to have a positive trend for ecosystems, based on its important goal of harmonizing conservation and development. This scenario also reflects Vietnam's determination to implement the Aichi Biodiversity Goals and the Sustainable Development Goals.

5. The report summarizes and evaluates the **legal and institutional framework on biodiversity and ecosystems in Vietnam**. Up to now, 193 policy documents have been issued for guiding the implementation of policies and laws related to biodiversity conservation. Despite of this, numerous regulations stemming from these policy documents are inconsistent or conflicting, resulting in obstacles or difficulties in implementation. This legal framework is gradually being completed and has had a significant impact on biodiversity conservation. However, the legal framework still has many shortcomings that need to be amended, adjusted and supplemented to better respond to current actual conditions.

Though the Government has made every effort to restructure biodiversity management at central and local levels, the system is still very unwieldy, with many focal agencies. The assignment of state management responsibility for biodiversity is unclear between the line ministries as well as between local management agencies, leading to overlaps and conflicts in functions and missions. In addition, interdisciplinary coordination in management is not strictly applied and is still limited due to factors such as passivity and lack of continuity among staff, leading to some shortcomings and obstacles in implementing this objective.

Recommendations

The NEA has identified a set of key issues, challenges and opportunities, such as:

- The need to prevent further ecosystem degradation and loss of biodiversity and ecosystem services, in order to maintain and improve the substantial contributions made by ecosystems and their services to the society and the economy;
- The need to minimize drivers and pressures affecting biodiversity and ecosystems; and
- The need to improve the legal and institutional framework on biodiversity and ecosystems.

In order to address these challenges, the Government of Vietnam needs to implement numerous measures simultaneously to reduce negative impacts on ecosystems and biodiversity, as follows:

1. **Enhance communication and education, and raise awareness** among people from of all walks of life about the important role of biodiversity and ecosystem services, and on that basis, develop an ecological consciousness, i.e. building self-awareness of the relationship between human-beings and nature: (i) Disseminate and raise awareness of all sectors at all levels to elicit a change in behavior and awareness on biodiversity and ecosystem services, and to consider biodiversity as important natural capital, the basis for sustainable development of Vietnam; (ii) Enhance education and raise consciousness of nature and biodiversity protection; development of nature-friendly behavioral culture; integration of biodiversity conservation contents into environmental protection contents in education curricula at all levels; strengthening of awareness of legal enforcement and social responsibility on biodiversity and ecosystems conservation and sustainable development; (iii) Diversify forms, contents and methods of providing information on biodiversity and ecosystem services in accordance with communication subjects; regularly disseminate policy documents on biodiversity and ecosystem services in the media; and (iv) Ensure equal involvement and rights of citizens including local communities and women in decision-making processes related to biodiversity and ecosystem services conservation and sustainable use.

2. In order to enhance and maintain the substantial contribution made by ecosystems to the socio-economy through provisioning, regulating, cultural and supporting services, there is a need for a comprehensive cooperation on biodiversity conservation. Relevant partners need to continue to promote international cooperation, interdisciplinary coordination, and participation of the private sector and local communities in order to implement plans on biodiversity conservation and restoration. Integrate biodiversity conservation into strategies and plans of economic sectors, particularly those having strong impacts on ecosystems, such as agriculture, fishery, forestry, tourism, transportation and energy.

Vietnam needs to promote the effective implementation of the policy of PFES, as well as extending it beyond forest ecosystems to other ecosystems (such as wetland, and marine and coastal ecosystems), in order to mobilize resources for the conservation and sustainable use of these ecosystems.

The economic evaluation of ecosystem services in Vietnam is still only occurring in research projects. The results have been reported to the central and local management levels to be considered when implementing economic development activities, to help ensure the continued conservation of biodiversity and the value of ecosystem services. However to date, estimated economic values for ecosystem services have not been included in the national accounting system. Therefore, in terms of management, it is necessary to think of legalization of the value of ecosystem services so that they can be fully accounted for in the national accounting system. It would be beneficial for Vietnam to continue to promote research on the values of ecosystem services (especially for wetland, and marine and coastal ecosystems) that include the full range of provisioning, regulating, cultural and supporting services. It is also necessary to soon develop a database on the values of major ecosystem services so that this consideration can be easily integrated into the decision-making process as well as into strategic environmental assessments and environmental impact assessments related to the management and use of these services. Scientific research should also be developed for the conservation and sustainable use of ecosystem services in the context of global climate change.

3. **Simultaneous measures are recommended to harmonize economic development and biodiversity conservation** in the context of increasing demands leading to conversion of land and water to other uses. For example, sustainable livelihood models could be developed and applied to improve the living standards of communities in agriculture, forestry and fishery areas, including those living in or around the buffer zones of protected areas, in order to reduce pressures on ecosystems and their services. Suitability of livelihood models to the natural conditions as well as the practices of each different ecological region could also be taken into account and adaptive management measures to climate change through ecosystem based adaptation could be enhanced.

4. **Further research is needed on the drivers and pressures changing ecosystems and their services according to specific scenarios** in Vietnam and impacts on the socio-economy, in order to respond through suitable measures for biodiversity conservation and sustainable use. The four future plausible scenarios for ecosystems and their services could be used to evaluate, revise, amend and supplement policies on biodiversity, including the movement of drivers and pressures according to the scenarios; predicted changes in quality of ecosystems and their services; and proposed measures for proactive management of ecosystems and their services to better respond to actual conditions.

5. **To improve the legal and institutional framework on conservation and sustainable use of biodiversity and ecosystems,** the Vietnam National Assembly could plan to soon adopt the revised Biodiversity Law, which has been updated by MONRE starting in 2016 according to the Government's request. Once the revised Biodiversity Law is adopted with improvements to many articles and regulations promoting consistency with relevant

specialized laws, such as the Law on Forestry and the Fisheries Law, and better suited to the current situation, then numerous existing policy documents under the Biodiversity Law 2008 will also need to be revised to fill gaps and avoid shortcomings and conflicts.

In addition, some new policies and regulations could be developed in relation to the revision of the Biodiversity Law and in order to align with current actual conditions in Vietnam, including: a pilot policy on payments for wetland, and marine and coastal ecosystem services; a coordination mechanism for the management of protected area systems; a coordination mechanism on genetic resource management and biosafety among the line ministries; and a technical guidance on ecosystem assessment should be developed, and then piloting carried out in a protected area or national park, which can then be scaled up at provincial, regional and national levels.

There are also a number of previous policies on biodiversity and ecosystems that could be reviewed, adjusted and supplemented, including: the strategy for management of the system of special-use forests, marine conservation zones, and inland water conservation zones in Vietnam to 2020, with a vision to 2030 (2014); the strategy for exploitation and sustainable use of natural resources and marine environment protection up to 2020, with a vision to 2030 (2013); the strategy for integrated coastal zone management of Vietnam to 2020, with a vision to 2030 (2014); the master plan on biodiversity conservation of the whole country to 2020, with a vision to 2030 (2014); and the Decree no.147/2016/ND-CP dated November 2, 2016 amending and supplementing a number of articles of the Government's Decree no. 99/2010/ND-CP dated September 24, 2010 on the policy on payment of a forest environmental service charge (2016).

Integrating biodiversity conservation requests into regional, sectoral and provincial planning also needs to be implemented. The report also presents some other recommendations in detail to support the legal framework to maintain and improve ecosystems and their services.

Regarding the institutional framework, the line ministries could strictly implement the Government's Decree no.101/2020/ND-CP dated August 28, 2020 on functions, mandates, powers and organizational structures of ministries and ministerial agencies. This provides details on restructuring the organizations in order to dissolve or minimize some agencies under the ministries. Restructure the organization of biodiversity management at central level to minimize the number of focal agencies in ministries and improve capacity for human resource at all levels.

The assignment of state management responsibility for biodiversity should be clear between the line ministries, especially, between MONRE and MARD as well as between the local management agencies, in order to avoid overlaps and conflicts in functions and missions. Interdisciplinary coordination in the management of biodiversity and ecosystems is also necessary. In terms of human resources at local levels, relevant officials should be trained in professional skills in biodiversity conservation, and awareness raised on the important roles and values of ecosystems and their services. Increase the search for sources of investment capital for biodiversity and ecosystem conservation from the private sector. Enforcement measures for the implementation of the laws related to biodiversity conservation should be further strengthened.

In summary, the NEA report provides significant information and data to give an overall picture, highlighting the following key points:

- The status and trends of ecosystems and their services;
- Options to maintain and improve the contributions they make to the socio-economy in the future;
- Factors of drivers and pressures changing the status and trends of ecosystems and their services and their impacts on the socio-economy;

- Four future plausible scenarios for ecosystems and their services with proposed measures for its proactive management; and
- Proposed policy measures to improve the legal and institutional framework on conservation and sustainable use of biodiversity and ecosystems targeting maintenance and enhancement of ecosystems services in Vietnam.

Due to being carried out in conditions of limited resources and a lack of experience and skills in ecosystem assessment, the evaluations, conclusions, suggestions and recommendations are acknowledged as having many limitations. Therefore, we warmly welcome any comments and feedback from all audiences in order to better improve the report, and to serve policy development to ensure practicability and conformity with the current actual conditions in Vietnam. It is also hoped the report will provide a valuable reference for policy makers as well as officials, experts and scientists in the field of biodiversity conservation and relevant areas of policy development.

Through more than five years of the NEA implementation in Vietnam, the capacity of the NEA team and main stakeholders has increased as progress has been made. The NEA implementation has also provided an opportunity for Vietnamese colleagues to continue to share information and exchange experience in biodiversity and ecosystem services via the network with other countries undergoing the NEA process.

ANNEX

Annex 1. Basic ecosystems on the mainland and sea waters of Vietnam

Ecosystem groups	Ecosystem	Ecological features	Distribution mainly according to ecological regions
1. Group of terrestrial ecosystems	Evergreen closed tropical humid forest ecosystem	The forest ecosystem is distributed at altitudes below 700 m in the North and below 1,000 m in the South, usually with a 5-storey structure: (i) layer exceeding canopy (ii) ecological dominant layer, (iii) layer under the canopy, (iv) the shrub layer and (v) the grass layer. Plant species composition of the flora of South Vietnam - Malaysia - Indonesia in the South and the North Vietnam - South China zones in the North.	Northeast, North Central, South Central (Thua Thien-Hue, Quang Nam), Central Highlands
	Semi-deciduous closed tropical humid forest ecosystem	Forest ecosystems are distributed at altitudes below 700 m in the North and below 1,000 m in the South. The structure of the forest is woody, typically deciduous: *Lagerstroemia tomentosa*, *Liquidambar formosana*. Plant species composition of the Malaysia - Indonesia and India - Myanmar in the South and North Vietnam - South China in the North.	Northeast, Northwest, North Central, Central Highlands, Southeast
	Evergreen broadleaf forest ecosystem on low-lying limestone mountains below 700 m	This type of forest ecosystem is distributed in the downs, slopes and tops of mountains. The ecosystem of evergreen broad-leaved forest on limestone mountains has many of the most precious tree species.	Northeast, Northwest, North Central,
	Ecosystem of evergreen broadleaf forest on limestone mountains with high 700 - 1,000 m	Forest ecosystems are distributed in valleys and foothills, mountain slopes and mountain peaks. Especially there is a dwarf forest of broadleaf trees at the top of the mountain.	Northeast, North Central,
	Natural coniferous forest ecosystem in low mountains	In the South, the tree layer is mainly *Pinus merkusii* and *Pinus kesiya*. In the North, typical trees are *Keteleeria davidiana*.	Northeast, Northwest, Central Highlands, South Central region
	Ecosystem of temperate natural coniferous forests of medium high mountains	Pure coniferous forests such as Po mu (*Fokienia hodginsii*), Samu (*Cunninghamia lanceolata*), *Podocarpus imbricatus*. Flat-leaf pine (*Ducampopimus krempfii*), Five-leaf pine (*Pinus dalatnensis*). The temperate high mountain belt of the Fansipan mountain	Northeast, Northwest, Central Highlands,

		range at an altitude of 2,400 - 2,900 m has *Tsuga yunnanensis*, an altitude of over 2,600 m (*Abies pindrow*).	
	The ecosystem of the Dipterocarpaceae (deciduous dipterocarp forest)	The flora is related to the flora of Malaysia - Indonesia with the dominant species of Dipterocarpaceae. The flora of the dipterocarp forest includes 309 species of trees belonging to 204 genera, 68 families, of which there are more than 90 species of trees with 54 species of large and medium trees.	Central Highlands, Southeast
	Dwarf forest ecosystem or moss forest;	The forest structure has only one floor with small trees about 6-10 m high. Typical species are: *Cycas* spp., *Pseudotsuga chinensis, P. brevifolia, Tsuga chinensis, Illicium griffithii.*	Northwest, South Central, Central Highlands
	Natural arid forest ecosystem (thorny trees)	Plants are mainly drought tolerant species; tropical thorny shrub type, the plants are mainly thorny species; type of savanna, shrubs, tropical dry tall grasses, mainly drought tolerant species; drooping leaves are slightly tropical, plants are mainly hardy evergreens; low land tropical moist evergreen closed forest.	South Central Coast (Ninh Thuan)
	Cave ecosystem in Limestone mountains	Lack or no light, the bottom and surrounding has limestone structure	Northeast, Northwest, North Central
	Other caves	Lack or no light, background of volcanic origin…	Northeast, Northwest, North Central, Central Highlands
2. Wetland ecosystem group	River and stream ecosystems;	Rivers and streams are inland wetland ecosystems with high levels of biodiversity, which disperse aquatic animals for other inland freshwater bodies in the catchment area. The aquatic fauna of streams and rivers is very diverse in species composition.	Northeast, Northwest, Red River Delta, North Central, South Central, Central Highlands, Southeast, Southwest
	Natural lake ecosystems	Vietnam currently has over 100 natural lakes with an area of over 10 hectares each. In general, natural lakes in Vietnam were formed a long time ago, with the age of hundreds of years or more. Deep lakes have a water stratification regime: surface layer, middle layer and bottom layer with different temperature, dissolved gas and nutrient factors. The composition of aquatic species in the lake is relatively uniform, depending on the geographical location of the lake, the origin of the lake, the water source, mainly the intrinsic species, where there is a lot of light	Northeast, Red River Delta, Central Highlands,

		and dissolved oxygen.	
	Underground waters in limestone caves	The water body lacks or has no light, the water temperature is low, the water level and the flow change according to the hydrological season. Aquatic animals mainly include fish, crustaceans, including 3 ecological groups: transient, living in low light areas or living only in underground caves. Body structure: eyes are reduced, no pigment, tactile organs are developed, body is small.	Northeast, North Central
	Swamp *Melaleuca cajuputi* forest ecosystem	Melaleuca forest (*Melaleuca cajuputi*) is concentrated in 7 provinces of the Mekong River Delta on acid soil or peatland.	Southwest
	Estuary ecosystem	The area has the interaction of two bodies of water: fresh water from rivers on the continent and surface water from the sea. Therefore, the outstanding features in estuary waters are changes in salinity, tidal activity, and the interaction between fresh water and salt water. The estuary is usually shallow, with high turbidity. Estuary waters are a complex with very high biological productivity.	Northeast Coast, Red River Delta, North Central, South Central, Southeast, Southwest
	Peat swamp ecosystem	Forested, shrubby or non-vegetated peatland is an area of peatland formed from vegetation that has been buried for many years, accumulated in waterlogged conditions, and is currently forest of wood trees, shrubs growing on or without vegetation cover.	Red River Delta, Southwest region
	Lagoon ecosystem (at a depth of less than 6 m during low tide)	Distributed along the central coast, from Thua Thien Hue to Ninh Thuan. It is in the form of a water body along the shore, separated from the sea by a long sand dune system, on the one hand receiving water from rivers from the mainland through estuaries, on the other hand, connecting to the sea through one or more inlets. Due to the location of each water body in each area with different geological and hydrological conditions, development dynamics has created different types of lagoons in terms of size, structure morphology, development trend. different evolutions, leading to different ecological and biological conditions.	South Central Coast
	Mangrove forest ecosystem	Formed in swampy tidal flats in estuaries along the coast, distributed in 4 areas and 12 sub-zones with different ecological characteristics. Plants are mainly salt-loving plants: *Rhizophora apiculata, R. mucronata*, *Brugyeria parviflora*, *B. Gymnorhiza*, *Kandelia ovata, Avicennia marina*,	Coastal regions of the Northeast, Red River Delta, North Central, South Central, Southeast,

		A. alba, A. oficinalis, Sonneratia alba, S. Caseolaris); *Phoenix paludosa*	and Southwest regions
	Intertidal ecosystem without mangrove forests	Tidal flats are distributed throughout the coastal area of Vietnam. The areas along the west coast of the Gulf of Tonkin and the east coast of the Southeast have the diurnal tidal regime with the largest tidal amplitude in Vietnam (maximum more than 4 m), so the tidal flats here are often large. These two areas are considered as typical areas for intertidal ecosystems. The intertidal flats are distinguished: swampy tidal flats in estuaries without mangroves; sandy tidal flats, reef tidal flats, dead coral tidal flats far from the river mouth. The intertidal zones are divided into three zones: high-tide zone, medium-tidal zone and low-tide zone, in which each intertidal zone has its own distinct ecosystem.	Northeast, Red River Delta, North Central, South Central, Southeast, and Southwest regions
	Coral reef ecosystems (at a depth of less than 6 m during low tide)	Coral reefs with different levels of development are found along the coast and along the island in the waters of Vietnam, mostly found in shallow water near the shore, with great clarity. Coral reef ecosystems are likened to "undersea tropical rainforests" and are also the most vulnerable ecosystems to climate change. Coral reef ecosystems in Vietnam also have high biological productivity. The fauna living in the reef is extremely rich and diverse.	Northeast, North Central, South Central, Southeast, Southwest
	Sea-weed ecosystem	Distributed in coastal areas, islands. Seagrass beds can be purebred, with only one species growing, or a collection of species. Seagrass sometimes grows into large seagrass beds of 10-1,000ha in coastal areas and islands. However, the fauna living in the seagrass beds is quite rich. Seagrass is often the main food for dugon	Northeast, North Central, South Central, Southwest
3. Marine ecosystem group	Gulf, Bay ecosystems	Gulfs, Bays, such as those parts of the sea that lie within an indentation of the coastline, or parts of the coastal sea that are protected by islands outside. The ecosystem of gulfs and bays is a mixture of estuary ecosystems and coastal waters. This determines the composition of the biota in the coastal bays of Vietnam. The main biological feature of gulf and bay ecosystems is the appearance of coral reefs, groups of mollusks, crustaceans and fish representing the coastal waters of Vietnam	Gulf of Tonkin, Central Coast Sea, South Central Coast, Southeast Sea, Southwest Sea
	Coral reef ecosystems (at a depth of more than 6 m during low tide)	Coral reefs with different levels of development are found along the coast and along the island in the waters of Vietnam, mostly found in shallow water near the shore, with great clarity. Coral reef ecosystems are likened	Gulf of Tonkin, Central Coast Sea, South Central Coast, Southeast Sea,

		to "under sea tropical rainforests" and are also the most vulnerable ecosystems to climate change. Not only that, the coral reef ecosystem in Vietnam also has high biological productivity. The fauna living in the reef is extremely rich and diverse	Southwest Sea, waters around Truong Sa and Hoang Sa archipelagos
	Saltwater lake ecosystem on islands	"Ang" are karst reservoirs located between islands, and "Tung" are pools of water with a relatively large inlet connecting to the outside, water is circulated, but relatively closed, with high clarity, few waves. Ang, Tung - are actually wells (or funnels), lakes on the island are flooded with sea water, with closed form or connected to the sea through underground caves, formed by the process of natural erosion and weathering. According to a survey of scientists, in the area of Ha Long Bay, Bai Tu Long Bay and Cat Ba, there are 62 ang and 57 tung. The total area of 62 ang is 289.4 ha, of 57 tung is 1,186.2 ha. Depending on each species, the number of species is different, concentrated in 3 groups of corals, benthic animals and seaweed. In the spare parts, you can find special species such as snout otter clam (*Lutaria philippinarum)*, crabs, blood cockles, feather scallops, pearl mussels...	Gulf of Tonkin
	Coastal limestone island ecosystem	The large limestone islands have forest vegetation and fauna living in them. The small islands have scattered shrubs, the typical fauna is land snails and land animals. The waters around the island have tidal flats, coral reefs, and seagrass beds.	Gulf of Tonkin, South West Sea
	Offshore archipelago ecosystem	The Paracel Islands are a group of atolls off the coast of the East Sea. Truong Sa archipelago has more than 100 floating islands and shoals. The surface is flat or slightly concave, floating 2.5-3.5 m above the sea surface. Due to the harsh natural conditions, the vegetation is poor. Around the red areas, there are coral reefs and seagrass beds	The sea around the Truong Sa and Hoang Sa archipelagos
	Ecosystem on open seas	From the continental shelf to the continental slope, corresponding to the water mass from the coastal zone to the deep sea. Large clarity, high salinity, stable. There is a water stratification regime: surface layer, middle layer and bottom layer with different temperature, dissolved gas and nutrient factors.	Gulf of Tonkin, Central Coast Sea, South Central Coast, Southeast Sea, Southwest Sea, waters around Truong Sa and Hoang Sa archipelagos
4. Other	Plantation forest	Mainly pure-species plantations	Northeast, North Central,

ecosystem groups	ecosystem		South Central, Central Highlands, Southeast
	Bamboo forest ecosystem	Bamboo forests in Vietnam include the following types: *Dendrocalamus barbatus*, *Acidosasa* and *Indosasa*; bamboo forest (*Neohouzeaua*, *Bambusa balcoa*	Northeast, North Central, Central Highlands, South Central, Southeast
	Ecosystems of grasslands, shrubs, scattered trees, bare mountains	Forest ecosystems have been strongly impacted, unable to improve	Northwest, Northeast, Central Highlands, Southeast
	Reservoir ecosystem	Dams built on rivers for hydroelectric and irrigation purposes. Reservoir catchment area is usually narrow and long, the watershed is river, and the part near the dam is lake. There is water stratification: surface, middle and bottom layers with different temperature, dissolved gas and nutrient factors.	Northwest, Northeast, North Central, Central Highlands, Southeast
	Residential Ecosystem	Inhabited land with infrastructure	Northwest, Northeast, Red River Delta, North Central, South Central, Central Highlands, Southeast, Southwest
	Agriculture Ecosystem	Lands used for agricultural cultivation	Northwest, Northeast, Red River Delta, North Central, South Central, Central Highlands, Southeast, Southwest

Annex 2. A summary of some results gained from the promulgation of legal framework to reduce the drivers and pressure on biodiversity and ecosystem services

Driver and pressure affecting biodiversity and ecosystem services	Policy documents responding to the driving forces and pressures on biodiversity and ecosystem services in Vietnam	The impact of policies through the basic results achieved
Drivers		
1. Population growth; population density increases in urban areas; free migration increases	- Strategy on Population and Reproductive Health for the period 2011-2020 - Strategy on Vietnam Population to 2030 - Strategy on Socio-economic Development for the period 2011-2020	- 2019 is the 13th consecutive year that Vietnam has maintained a replacement fertility rate. Population quality has improved in many ways; the stature and physical strength of the Vietnamese have been improved; and average life expectancy of the people continues to increase. Focusing on population work in 2020, the population sector strives to actively maintain replacement fertility; reduce the sex ratio gap at birth; manage healthcare for the elderly, adapt to population aging; and improve the quality of the population to meet the high-quality human resources serving the industrialization and modernization and rapid and sustainable development of the country. - In the period from 2005 to April 2019, the total number of free-migrant households was about 67,000 households, but in recent years, with the fierce participation of the authorities and the awareness of the people. The number of free migrants has declined sharply, especially the number of people who migrated from the northern provinces to the Central Highlands provinces (in 2005 it was 2,690 households, in 2017 it was 318 households, in 2018 it was 238 households and in the first 4 months of 2019 it was 104 households). In the period 2005 - 2017, localities have stably resettled more than 42,000 households that migrated freely and the managed the situation of free migration. - The National Office for Poverty Reduction (Ministry of Labor, Invalids and Social Affairs) said that by the end of 2018, the average rate of poor households nationwide decreased to about 5.35% on average, the rate of poor households in the poor districts decreased to below 35% on average, the rate of poor households in communes with extreme difficulties in coastal and island areas, communes with extreme difficulties, in border communes, in safe communes in ethnic minority areas and in mountainous areas decreased by 3-4% compared to 2017.
2. Increased consumption of natural resources,	- Land Law - Law on Environmental Protection - Law on Forestry	According to MARD (2021): By 2020, Vietnam has 14,677,215 ha of forest land. Of which, 10,279,185 ha is natural forest and 4,398,030 ha is planted forest. The area of forested land eligible

especially land resources, fuel (fossil) and biological resources	- Fisheries Law - Biodiversity Law - National Strategy on Green Growth for the period 2011-2020 and vision to 2050 - Vietnam Forestry Development Strategy 2006-2020 - Fisheries Development Strategy to 2020 - Decision 899/QD-TTg dated 10/6/2013 approving the project of Restructuring the Agriculture sector towards increasing added value and sustainable development. - Decision no.76/2016 / QD-TTg signed on January 11, 2016, by the Prime Minister approving the National Action Program on sustainable production and consumption up to 2020, with a vision to 2030. - Decision no.886/2017 / QD-TTg signed on June 16, 2017, the Prime Minister approving the Target Program for Sustainable Forestry Development for the 2016-2020 period. - Strategy for sustainable exploitation and use of marine resources and environmental protection to 2020, with a vision to 2030 - Decision no.432/QD-TTg dated 12/4/2012 of the Prime Minister approving the Strategy for Sustainable Development of Vietnam for the period 2011 - 2020 - Decision no. 622 / QD-TTg dated 10/5/2017 of the Prime Minister promulgating the National Action Plan to implement the 2030 Agenda for Sustainable Development.	for calculation of the national coverage rate is 13,919,557 ha, the coverage rate is 42.01 %. According to MONRE (2019): - Development of forest land lease: According to data of MARD (2017): + The area of forest allocated or leased to entities nationwide as of December 31, 2015 is 14,061,856 ha, of which: 10,175,519 ha is natural forest (accounting for 72.36%%) and 3,886,337 ha is plantation forest (27.64%). + Regarding the granting of land use right certificates: as of December 2013, for forestry land, the whole country has granted 1,934,871 certificates with an area of 12,221,816 ha, reaching 97.8% compared to that of the land area to be issued the Certificate. + From 2006 to date, there have been 2,991 projects, with 386,290 ha of forests being converted to other purposes, of which: natural forest totals 300,120 ha (accounting for 78.0%), and plantation forest totals 86,170 ha (accounting for 22, 0%). - According to the Government's report (draft) in 2018 on the results of the three-year implementation of the Targeted Program for Sustainable Forestry Development in the 2016-2020 period, a number of targets and tasks have been met and exceeded as follows: By 2018, 35,237 ha of degraded forest has been restored (31,060 ha of natural forest, 4,213 ha of plantation forest). It is estimated that 45,270 ha will be restored by 2020, reaching 170% of the program's mission. The total forest area certified for sustainability under the FSC system is 229,281 ha (plantation forest 147,677 ha, natural forest 81,604 ha) in 17 provinces with 36 certified units. - In 2019, the whole country collected more than 2,800 billion VND of PFES money to pay support in the management and protection of 6.3 million ha of forests, accounting for 43% of the total national forest area. - Policies to encourage breeding and reproduction of endangered species and species of high economic value, so some species still exist and develop, typically the star deer (Cervus nippon), which is extinct in the wild. Vietnam has long been studying opportunities for breeding. Breeding aquatic species with economic value has created opportunities for socio-economic development in localities, contributing to conservation of genetic resources, reducing pressure on the exploitation of wild animals in the wild, especially aquatic species of economic value, commercially raised, are re-stocked annually in the wild. - The total area of aquaculture including both brackish and freshwater farming in 2019 is about 730 thousand ha, with an estimated output of 4,432 thousand tons,

	- Decision no.681/QD-TTg dated June 4, 2019 of the Prime Minister promulgating a Roadmap for the implementation of Vietnam's sustainable development goals up to 2030. - Decision no.1250/QD-TTg dated July 31, 2013 of the Prime Minister approving the National Strategy on Biodiversity to 2020, with a vision to 2030. - Resolution no. 55-NQ/TW dated February 11, 2020 on Vietnam's national energy development strategic orientation to 2030, with a vision to 2045 - Projects to develop biodiversity conservation models and initiatives and ecosystem services: Community-based conservation model group; Group of conservation management models; Livelihood model group for local community; Agro-Forestry-Fishery model group - Strategies and policies related to reducing the increase in resource consumption (for example, building materials and replacing natural sand.)	contributing largely to seafood export turnover in 2019 (about 8.6 billion USD). The proportion of aquaculture production increased continuously, accounting for 54% in 2019. It is estimated that by 2020, the fishing output will account for about 35%; and aquaculture output will account for about 65% (General Department of Fisheries, 2020), reducings pressure on natural fishing. - By 2017, there have been many renewable energy development projects implemented such as wind power projects, and solar power projects. The country currently has 77 wind power projects on an industrial scale registered in 18 provinces and cities nationwide with a total capacity of up to 7,000 MW. - According to a report from the Ministry of Industry and Trade, by December 2019, there were more than 87 solar power projects in operation with maximum design capacity, with more than 260 solar projects waiting for approval. According to EVN as of May 30, 2019, there were 47 solar power projects with a total capacity of 2,300 MW connected to the national grid. - In the period 2011-2015, the energy saving rate of Vietnam reached 5.6%, equivalent to the total energy savings of nearly 11.3 million tons of oil equivalent (TOE). In particular, the energy intensity of the energy-consuming industries of industrial production decreased gradually: the steel industry decreased by 8.1%, cement decreased by 6.3%, and textiles decreased by 7.3%. - The tourism industry has built and developed tourism models associated with biodiversity conservation applicable to protected areas and broader biosphere reserves such as Green Tourism, Ecotourism, Community-based ecotourism, sustainable tourism in the PAs, the Biosphere Reserves
3. Socio-economic development under unsustainable growth model; conflict between conservation and development	- Law on Natural Resources and Environment of Sea and Islands - Decision no.76/2016/QD-TTg signed on January 11, 2016, the Prime Minister approving the National Action Program on sustainable production and consumption up to 2020, with a vision to 2030. - Decision no.886/2017/QD-TTg dated June 16, 2017, the Prime Minister approving the Targeted Program for	- By 2020, the system of protected areas will have a total area of 2,512,530.78 ha by 2020 with 176 protected areas across the country, distributed in both terrestrial and aquatic ecological zones, including 33 national parks, 67 nature reserves, 18 species and habitat reserves, and 56 landscape reserves. Vietnam's system of protected areas accounts for 7.6% of the country's area. - International recognition of the importance and diversity of multi-ecosystems of Vietnam including 6 priority ecological regions, 9 Ramsar zones (120,549 ha), 11 World Biosphere Reserves (4,900. 872 ha), 6 World Natural Heritage with biodiversity criteria (1,537,952 ha), 10 ASEAN Heritage Parks (355,710 ha), 63 Important Bird Areas (1,689,900 ha), and 104 Key Biodiversity Areas (3.35 million

	Sustainable Forestry Development for the 2016-2020 period. - Decision no.1250/QD-TTg dated July 31, 2013 of the Prime Minister approving the National Strategy on Biodiversity to 2020, with a vision to 2030.	ha).
4. The overlap in biodiversity functions and management among relevant agencies	- Decision no. 25/2014 / QD-TTg dated March 25, 2014 defining the functions, tasks, powers and organizational structure of the General Department of Environment under the Ministry of Natural Resources and Environment. - Decree no.36/2017/ND-CP of the Government defining the functions, tasks, powers and organizational structure of MONRE - Decree no.15/2017/ND-CP of the Government defining the functions, tasks, powers and organizational structure of MARD - Program of cooperation between MONRE and MARD	- Article 6 of the 2008 the Biodiversity Law stipulates: The Government unifies the state management of biodiversity; MONRE is responsible to the Government for performing the state management of biodiversity; Ministries and ministerial-level agencies shall, within the scope of their respective tasks and powers, perform the state management of biodiversity as assigned by the Government; People's Committees at all levels within the scope of their duties and powers to perform the state management of biodiversity as decentralized by the Government. - Management of special-use forests and marine protected areas is under the authority of MARD. Management of protected areas with wetland ecosystems, including wetlands listed under the Ramsar Convention and Decision 1093/2016 / QD-TCMT, is under the responsibility of MONRE. - MONRE has been coordinating with the Ministry of Home Affairs to guide the consolidation of specialized agencies' apparatus to help the provincial People's Committee to manage the state on natural resources and environment in the direction of clearly assigning the focal unit to advise and organize the implementation of the Biodiversity Law in the area.
5. Policy and governance on biodiversity conservation and ecosystem services	- Biodiversity Law - Law on Forestry - Fisheries Law - Decree no. 99/2010/ND-CP on the policy of PFES in Vietnam - Decree no.147/2016/ND-CP of the Government amending and supplementing a number of articles of Decree no.99/2010/ND-CP dated September 24, 2010 of the Government on the policy of PFES. - Decree no.66/2019/ND-CP of the Government on the conservation and	- In addition to laws, the Government and ministries and agencies have developed and issued more than 196 policy documents guiding the implementation of the Biodiversity Law or other laws related to biodiversity conservation, including Decrees and Decisions. Decrees, Resolutions and Directives of the Prime Minister; Circulars, Joint Circulars of the Ministries and branches concerned. The legal system of forest protection and biodiversity conservation in special-use forests and other protected areas is more and more complete, contributing positively to the adaptation and mitigation of climate change. According to MARD, in 2019 alone, the whole country collected more than 2,800 billion VND of PFES to pay support in the management and protection of 6.3 million ha of forests, accounting for 43 % of the total forest area of the country helps maintain forest cover, improve forest quality, gradually improve the

	sustainable use of wetlands - Decision no.380/2008/QD-TTg dated April 10, 2008 approving the Policy on PFES - Decision no.485 /QD-TTg dated May 2, 2008 of the Prime Minister approving the Scheme on the protection of rare and endangered aquatic species up to 2015, vision to 2020. - Decision no.1250/QD-TTg dated July 31, 2013 of the Prime Minister approving the National Strategy on Biodiversity to 2020, with a vision to 2030. - Decision no.188 /QD-TTg dated February 13, 2013 of the Prime Minister approving the Program on protection and development of aquatic resources up to 2020. - Decision no.763 /QD-TTg dated 21/5/3013 of the Prime Minister approving the master plan for elephant conservation in Vietnam for the period 2013-2020 - Decision no.539/QD-TTg dated April 16, 2014 of the Prime Minister approving the National Tiger Protection Program for the period 2014-2022 - Decision no.1671 / QD-TTg dated September 28, 2015 of the Prime Minister approving the Program on conservation and sustainable use of genetic resources up to 2025, with an orientation to 2030. - Decision no. 1141/QD-TTg dated June 27, 2016 approving the Project to strengthen capacity in managing access to genetic resources and fair and rational	ecological environment, and mitigate impacts caused by climate change. After 10 years of implementation (2011-2020), PFES mechanism has generated a total revenue of 16,746 billion VND (or 1,674 billion VND per year on average), equivalent to 95.3% of the total state budget and 18.5% of social budget for forestry sector (*VFD, 2021*). The PFES policy has created many jobs and a positive change in awareness and responsibility of stakeholders for forest management and protection. Therefore, in 03 years 2016-2018, implementing the Program on Sustainable Forestry Development for the period 2016-2020, according to the Government Report (2018), a number of targets have been met and exceeded the plan such as: in 3 years 2016-2018, the average number of violations of the law on forest protection and development is 17,665 cases /year, an average decrease of 9,600 cases /year compared to the period 2011-2015; the damaged forest area averaged 2,430 ha /year, decreased 270 ha/year, corresponding to a decrease of 10% compared to the period 2011-2015; the area of forest contracted to households, individuals and communities increased from 4,944 million ha / year in the period 2011-2015 to 6,143 million ha/year. According to MONRE (2019), the contents of environmental protection and biodiversity conservation have been mainstreamed by the Government of Vietnam in national plans, programs and policies as follows: - Strategy on hunger eradication and poverty alleviation: the goals of environmental protection in general and biodiversity in particular, are as follows: The program of afforesting 5 million ha of forests, increasing the forest coverage area from 33% in 2000 to 41.89% in 2019. - National strategy to respond to climate change: Improving the quality of forests, afforestation, greening bare land and barren hills, ensuring efficient exploitation of all types of forests to maintain and improve the ability to prevent natural disasters, combating desertification, erosion and land degradation. - Vietnam Sustainable Development Strategy for the period 2011 - 2020: rationally using and developing all types of natural resources, including biological resources and biodiversity. - The number of individuals in some primate species increases. According to FFI (2016), Nguyen Dinh Hai, Nguyen Xuan Dang et al (2016), discovered more than

	sharing of benefits arising from the use of genetic resources in the period. 2016 - 2025 - Decision no.628/QD-TTg dated 10/5/2017 of the Prime Minister approving the Emergency Action Plan for Primate Conservation of Vietnam until 2025, with a vision to 2030. - Decision no.1176 /QD-TTg dated September 12, 2019 Approving "Program for conservation of endangered turtles of Vietnam to 2025, with a vision to 2030" - Decision no. 626/QD-TTg dated 10/5/2017 of the Prime Minister approving the Project on strengthening the management capacity of the conservation area system to 2025, with a vision to 2030. - Directive 03/CT/TTg. February 20, 2014 of the Prime Minister strengthened the direction and implementation of measures to control and conserve endangered, precious and rare wildlife - Programs for conservation and preservation of genetic resources of animals, plants and microorganisms have been continuously implemented since 1987 up to now (managed by the Ministry of Science and Technology.	500 individuals of the gray-shanked douc langur (*Pygathrix nemaeus cinerea*) in Konplon, Kon Tum and more than 200 individuals of the Indochina (*Trachypithecus barbei*) in Xuan Lien NR, Thanh Hoa. At the time of its establishment, Van Long Wetland Nature Reserve in 2001, had 43 individuals of the Delacour's langur (*Trachypithecus delacouri*). Thanks to good protection, the number of douc individuals is increasing, in 2010 there were 110 statisticians and by 2016 it increased to about 150 individuals. Currently, there are 7 groups of white-headed langurs with about 40 newly discovered individuals in the limestone mountains of Ha Nam province. - Management of the protected area is carried out by the Management Board in accordance with the approved Management Plan. This activity is carried out in 80% of existing protected areas, helps guide activities in conservation of important ecosystems and endangered species, and conduct biodiversity monitoring and research, raising awareness, and supporting the development of livelihood models such as ecotourism for communities in the buffer zone. Up to now, 85% of the management boards of special-use forests and protection forests have developed autonomy plans, approved by competent agencies and classified the degree of autonomy. Initially, all MBs have autonomously developed plans to perform the task of biodiversity conservation; financial autonomy, implementation of public non-business services, ecotourism service development and other career services to attract financial resources to strengthen forest protection and biodiversity conservation (*MARD, 2019*). - According to MARD (2013), the number of staff members of the PAs nationwide is nearly 5,000 people, including about 2,880 staff in the national park system and about 1,840 people in the special forests. The remainder belongs to other marine protected areas that are under management. In addition, there are 19 special-use forest protection units, which are the administrative organization of the Central Forest Protection Department for special-use forests managed by the central government. Special-use forest rangers are established in the National Park, natural reserves, and species-habitat conservation areas with an area of 15,000 hectares or more (*Article 11, Decree 01/2019 / ND-TTg*.). According to the 2009 statistics, among the staff currently working in the special-use forest management boards: some 1%have postgraduate degrees, 27% have university degrees 33% have intermediate degrees, and 39% have other education. - According to MONRE (2019), about 60,000 samples have been kept, including

		30,000 genetic resources of agricultural crops; over 2,000 species of forest trees; 2,998 medicinal plant species that need to be preserved; about 70 livestock objects and 2,999 aquatic genetic resources, and about 22,000 microorganisms strains are preserved as collections by 4 different methods.
6. Communication, awareness and education	- Decision no.200/QD-BTNMT 2015 approving the communication program to raise awareness about preventing and controlling invasive alien organisms in Vietnam for the period 2015-2020 - Decision no.1250/QD-TTg dated July 31, 2013 of the Prime Minister approving the National Strategy on Biodiversity to 2020, with a vision to 2030. - Policies on education and communication on environment	- MONRE and related ministries and agencies have developed and implemented public education programs on nature conservation and sustainable use of biodiversity in the form of scientific reports and media documentaries and mass information outlets such as radio, television, newspapers. Most localities have well carried out public education activities related to biodiversity conservation. - Enterprises' awareness of biodiversity conservation has been gradually improved. Many participating businesses pay only for forest environmental services. - Local people's awareness has a basic understanding of forests, forest resources, marine resources and the importance of forests and seas to the society, especially related to daily life, consciously protecting resources such as timber, fuelwood, arable land, animals, and valuable fisheries. - The network of education and training of managerial and technical human resources in the field of biodiversity conservation in Vietnam has been widely developed at university, and intermediate levels, regularly organizing training courses on conservation knowledge and skills for local staff, especially for staff of the protected area. - In 2015, the General Department of Environment developed guidance on the contents, methods and order of developing a national, provincial and conservation area report in accordance with Articles 29 and 72 of Law on Biodiversity (2008). These guidelines together with the sets of guidelines for the development of biodiversity indicators and biodiversity survey and monitoring have been the basis for organized training courses for localities in the three regions of the North, the Central and the South with the subjects of technical and managerial staff in the NRs, officials from the Departments of Natural Resources and Environment and Agriculture and Rural Development of the localities.
7. Science and Technology Development	- Law on Science and Technology - Law on Environmental Protection - Strategy for Science and Technology Development for the period 2011 - 2020 - Cleaner production strategy in industry - Policy for science and technology	- Vietnam currently has 33 provinces and municipalities that practice organic agriculture and produce organic products. There are many seafood businesses that have been certified for sustainable seafood production from the Aquaculture Stewardship Council (ASC). - Green growth strategy: promote the process of restructuring and improving economic institutions towards more efficient use of natural resources, enhance the competitiveness of the economy, through increased investment in innovation of

	development - Programs on Development of organic agriculture; Building the process of agricultural production according to GAP; Developing a certified sustainable aquaculture (ASC) aquaculture facility	technology, natural capital, and market-based instruments. It is expected that this will contribute to coping with climate change, reducing poverty and ensuring sustainable economic development.
8. Limited resources for biodiversity conservation / investment	- Biodiversity Law - Law on Forestry - Fisheries Law - Decision no.114/2008/QD-BNN dated 28/11/2008 of MARD on the establishment of Vietnam Forest Protection and Development Fund - Decree no.156/2018/ND-CP dated November 16, 2018 of the Government detailing the implementation of a number of articles of the Law on Forestry (Chapter V - Forest environment services, forest protection and development funds) - Joint Circular no.160/2014/TTLT BTC-BTNMT of the Ministry of Finance-Ministry of Natural Resources and Environment guiding the management, use and settlement of recurrent expenditures from the state budget for the implementation of tasks and projects according to the National Strategy on biodiversity to 2020, with a vision to 2030. - Circular no.04/2018/TT-BTC 17/1/2018 guiding the management and use of budgets from payment for forest environmental services.	- The Vietnam Special-use Forest Conservation Fund (VCF) is a trust financing mechanism from foreign aid sources established in 2005, with a total amount of up to 15 million USD refundable from the World Bank, Global Environment Fund and the Dutch Government. VCF will provide financial and technical assistance to projects that strengthen the management of special-use forests in Vietnam. The Fund has supported about 50 Special-use Forests to implement conservation-related activities. This is a form of support with good results, especially for small NRs, with local capital facing many difficulties. In addition, there are other funds such as the Trust Fund (TFF), the Conservation Fund of Vietnam (VCF) and REDD +. These funds have been established to support the Forestry Development Strategy. These funds are financed by ODA sources. Since 2016, the funds have been integrated into the VNFF; The Vietnam Aquatic Resource Renewal Fund (VIFARR) was established in 2007 to support biodiversity conservation projects in the fisheries sector. - Currently, SNV is implementing a pilot project of mainstreaming REDD + in high-diversity areas to promote biodiversity conservation in implementing REDD + projects. The implementation of REDD + is an opportunity to mobilize finance for biodiversity conservation if the biodiversity conservation goals are well integrated into the overall goal of forest ecosystem development. - The budget for biodiversity conservation at the central level (about 60-80%) is mainly concentrated in MONRE, MARD and MOST. - GEF projects for biodiversity from the first cycle to cycle 7 are listed with a budget of 70,161,420 USD. In addition to funding from the GEF, Vietnam also attracts ODA from other development donors.

Pressures		
1. Land / water surface conversion for infrastructure development lacks a scientific basis	- Planning Law - Land Law (chapter on land use planning) - Law on Forestry - Fisheries Law - Law on Natural Resources and Environment of Sea and Islands (coastal protection part)	
2. Illegal and excessive exploitation of biological resources	- Law on Environmental Protection - Law on Forestry - Fisheries Law - Biodiversity Law - Law on Natural Resources and Environment of Sea and Islands - Criminal Law - Decision no.1250/QD-TTg dated July 31, 2013 of the Prime Minister approving the National Strategy on Biodiversity to 2020, with a vision to 2030. - Decision no.78/2018/QD-TTg approving the National Action Plan to prevent, reduce and eliminate illegal, unreported and unregulated fishing until 2025 - Directive 03/CT/TTg. February 20, 2014 of the Prime Minister strengthened the direction and implementation of measures to control and conserve endangered, precious and rare wildlife - Decision no.11/2013 /QD-TTg dated January 24, 2013 of the Prime Minister prohibiting the export, import, trading and transportation of specimens of some	- According to the report of MARD (2016): law violations in the field of forest protection, development and management have been reduced in both the number of cases and the extent of damage: the number of violations detected decreased from 39,165 cases / year in the period 2006-2010 to 26,265 cases / year; the number of forest fires decreased from 571 cases / year in the 2006-2010 period to 344 cases / year; damaged forest area decreased from 5,546 ha / year in the 2006-2010 period to 2,316 ha / year in the period from 2011 to 2015. - Implement the policy of socializing the management and protection of forests, ensuring that each forest has a real owner through the implementation of the policy of land allocation and forest allocation. Forest protection bonds increased from 2,600,000 ha / year in the 2006-2010 period to 4,900,000 ha / year from 2011 to 2015. - Regularly organize propaganda, education and mobilization of local people and local authorities to pay attention to the management and protection of forests, creating a change in awareness of Party committees, local authorities, especially basic awareness of the authorities and active participation of people in forest protection. Organized to sign more than 62,000 copies of regulations on forest protection and development in village communities. In 03 years 2016-2018, the average number of violations of the Law on Forest protection and development was 17,665 cases / year, an average decrease of 9,600 cases / year compared to the period 2011-2015. It is estimated that in the period 2016-2020, the number of violations will be reduced by 39% compared to the period 2011-2015 (*MARD, 2019*). - The organizational system of the forest protection force has been strengthened from the central to local levels. Up to now, 42,000 mass groups for forest protection

	animal species under the Convention on International Trade endangered species of wild fauna and flora	have been formed nationwide.
3. Environmental pollution	- Law on Environmental Protection 2020 - Decision no.1216 /QD-TTg on approving the National Strategy for environmental protection to 2020, vision 2030 - Decision no.166/2014/QD-TTg on the implementation plan of the National Strategy for environmental protection to 2020, vision to 2030.	Currently, all constructions of public, agricultural and mining facilities must undergo an environmental impact assessment. Thereby, the potential impacts of the works on the environment and biodiversity are identified and evaluated, thereby proposing measures to minimize the impacts. All Industry - Agriculture sectors must comply with the Environment Law, the Law on Biodiversity as well as other relevant legal documents during their operations. - According to 2015 statistics, out of 787 urban centers across the country, there are 42 urban centers with wastewater treatment facilities meeting the prescribed standards of 5.3%. In which, the number of urban centers with standard wastewater treatment facilities is proportional to the urban level. According to data from the Ministry of Construction in 2015, 52 urban areas with ODA projects on drainage and wastewater treatment have been implemented with a total of 77 wastewater treatment systems with a total design capacity of about 2,400,000 m3 / day. Most hospitals in Hanoi and Ho Chi Minh City have built and operated medical wastewater treatment systems. By the end of 2015, there were about 35 urban daily-life solid waste treatment facilities built and put into operation.
4. Climate change	- Law on Environmental Protection 2020 - Decision no.1216 /QD-TTg on approving the National Strategy for environmental protection to 2020, vision 2030 - Decision no.166/2014/QD-TTg on the implementation plan of the National Strategy for environmental protection to 2020, vision to 2030. - National strategy on climate change - Strategy on using clean technology in the period to 2020, with a vision to 2030 - Vietnam Industrial Development Strategy to 2025, vision to 2035 - Program to reduce greenhouse gas emissions from deforestation and forest degradation (REDD +) efforts since 2008	- Since 2008, Vietnam has cooperated with the World Bank, the UN-REDD program and a number of international NGOs to build capacity to implement REDD +, including a system to reduce greenhouse gas emissions by efforts to reduce deforestation and forest degradation, and pay local REDD + practitioners. - According to the report of MARD (2016), in the period 2011-2015, afforestation (afforestation, reforestation) comprised 1,088,700 ha; zoning for regeneration promotion on average 361,000 ha / year, forest protection contracting 4,900,000 ha / year, forest rehabilitation and restoration 11,800 ha, an average of 2,360 ha / year, as well as newly planted 1,968 hectares of coastal forests (1,103 ha of mangroves; 301 ha of wind and sand-blocking forest, and 564 ha of production forest combined with protection forest).

	- Decision no.120/QD-TTg dated January 22, 2015 approving the Scheme on the protection and development of coastal forests in response to climate change for the period 2015-2020. - Decree no.37/2019/ND-CP dated May 7, 2019 detailing the implementation of a number of articles of the Planning Law.-MONRE has a project "Biodiversity conservation corridor of the Greater Mekong Subregion - Phase 2 (2014-2019)" funded by the Asian Development Bank (ADB). - Afforestation Projects, such the 5 million ha reforestation project.	
5. The introduction of invasive alien species	- Biodiversity Law 2008 - Decree no.06/2019/ND-CP dated 22 January 2019 of the Government on management of endangered, precious and rare forest plants and animals and the implementation of the Convention on International Trade in Animals endangered, wild plants - Decision no.1896/QD-TTg dated December 17, 2012 of the Prime Minister approving the Scheme on prevention and control of invasive alien organisms in Vietnam until 2020. - MONRE and MARD issued joint circular no. 27/2013/TTLT-BTNMT-BNNPTNT defining criteria to identify invasive alien species and issue a list of invasive alien species. - Circular no.35/2018/TT-BTNMT dated December 28, 2018 of the Minister of	- In 2012, the Biodiversity Conservation Agency in the Vietnam Environment Administration reviewed and counted the list of potentially invasive alien species compiled from international information and other sources. Documents issued include a list of 130 species belonging to 06 different groups, including microorganisms, invertebrates, birds, reptiles, plants, animals of which there are species that have not appeared in Vietnamese territory. - The Ministry of Natural Resources and Environment: + To assume the prime responsibility for, and coordinate with the ministries and branches in, formulating relevant legal documents and guidelines. + Results from conducting pilot eradication of *Mimosa diplotricha* at Cuc Phuong National Park (2013-2015) show the effectiveness of its eradication through a combination of chemical and forest measures. + In 2013-2015, in the framework of the Project to prevent and control invasive alien organisms in production and protected forests in Southeast Asia, the Ministry of Natural Resources and Environment conducted an investigation into distribution, mapping the occurrence of invasive alien species in national parks and nature reserves. - The Ministry of Agriculture and Rural Development: + Strictly control the process of phytosanitary and imported animals to prevent invasive

	Natural Resources and Environment stipulating criteria for identifying and issuing the List of invasive alien species. - Decision no.1250/QD-TTg dated July 31, 2013 of the Prime Minister approving the National Strategy on Biodiversity to 2020, with a vision to 2030.	alien organisms. + Control and eradicate pests such as beaver rats, hamsters, red-eared turtles, control and evaluation of black velvet mink farming and have recommendations for local people not to spread black velvet mink, strictly controlled 293 farming facilities. Coordinate with the local authority to direct and settle the production and trading of spontaneous cockroaches because the land cockroaches are at risk of harming natural ecosystems and the environment. + Check invasive alien organisms in the field of plant protection and quarantine, and propose management of invasive alien species. Construction results are reported on the pest risk assessment of 8 pests that are in danger of becoming invasive alien species in the field of plant protection and quarantine, whether or not present in Vietnam, with distribution maps in Vietnam of 7 predator species. - The financing: + Organized training courses for quarantine officers at 47 quarantine stations / posts, Customs officers at 18 international border gates on identification of invasive alien species, quarantine regulations, border inspection gender to control foreign organisms when imported into Vietnam. + Allocate funding for the tasks under Decision No. 1896 / QD-TTg. - In localities, the control of invasive alien organisms focuses on eradicating some invasive alien species that have the most impact on production as well as people's lives such as apple snails, mimosa, and giant sensitive plant (*Mimosa diplotricha*).

Annex 3. List of policy documents related to biodiversity conservation from 2008 to date

No	Legal normative documents
Government and Prime Minister's documents issued	
	Government
1.	Resolution No. 22/2020/NQ-CP dated March 1, 2020 on Stability of free migrants and management and use of land originating from agriculture and forestry
2.	Directive No. 45/2020/CT-TTg dated December 31, 2020 on the organization of the movement "Tree planting festival" and strengthening forest protection from the beginning of 2001
	Ministry of Natural Resources and Environment
3.	Decree No. 57/2008/ND-CP promulgating the Regulation on management of marine protected areas of Vietnam of national and international importance
4.	Decree No. 120/2008/ND-CP dated December 1, 2008 on River basin management
5.	Decree 65/2010/ND-CP detailing and implementing a number of articles of the Law on Biodiversity
6.	Decree No. 69/2010/ND-CP dated June 21, 2010 of the Government on biosafety of genetically modified organisms, genetic specimens and products of genetically modified organisms
7.	Decree No. 108/2011/ND-CP dated November 30, 2011 amending a number of articles of Decree No. 69/2010 /ND-CP
8.	Decree No. 179/2013 / ND-CP dated November 14, 2013 of the Government on sanctioning of administrative violations in the field of environmental protection
9.	Decree No. 59/2017 / ND-CP dated 12/5/2017 on Management of access to genetic resources and benefit sharing from the use of genetic resources
10.	Decree No. 36/2017 / ND-CP of the Government defining the functions, tasks, powers and organizational structure of the Ministry of Natural Resources and Environment
11.	Decree No. 66/2019 / ND-CP dated July 29, 2019 of the Government on Conservation and Sustainable Use of Wetlands
12.	Decision No. 1250 / QD-TTg dated July 31, 2013 approving the National strategy for biodiversity to 2020, with a vision to 2030
13.	Decision No. 149 / QD-TTg dated January 28, 2022 approving the National strategy for biodiversity to 2030, with a vision to 2050
14.	Decision No. 1896 / QD-TTg dated December 17, 2012 of the Prime Minister approving "Project on prevention and control of invasive alien organisms in Vietnam until 2020".
15.	Decision No. 1216/2012 / QD-TTg, dated September 5, 2012 of the Prime Minister on approving the National Strategy for Environmental Protection to 2020 and Orientation to 2030
16.	Decision No. 450/2022 / QD-TTg, dated April 13, 2022 of the Prime Minister on approving the National Strategy for Environmental Protection to 2030 and Orientation to 2050
17.	Decision No. 1570 / QD-TTg dated September 6, 2013 approving the Strategy for sustainable exploitation and use of marine resources and environmental protection to 2020, with a vision to 2030.
18.	Decision No. 166 / QD-TTg dated 21/01/2014 approving the Plan to implement the National Strategy on environmental protection to 2020 and orientation to 2030
19.	Decision No. 45 / QD-TTg dated 08/01/2014 approving the master plan for

	biodiversity conservation of the whole country to 2020, with a vision to 2030.
20.	Decision No. 182 / QD-TTg dated January 23, 2014 approving the national action plan to improve efficiency of management, protection and use of integrated water resources for the period 2014 to 2020
21.	Decision No. 25/2014 / QD-TTg dated March 25, 2014 defining the functions, tasks, powers and organizational structure of the General Department of Environment under the Ministry of Natural Resources and Environment.
22.	Decision No. 2295 / QD-TTg dated December 17, 2014 approving the Vietnam Coastal Management Strategy to 2020, with a vision to 2030.
23.	Decision No. 1671 / QD-TTg dated September 28, 2015 approving the Program on conservation and sustainable use of genetic resources to 2025, with a vision toward 2030.
24.	Decision No. 914 / QD-TTg dated May 27, 2016 approving the Action Plan to implement the Vietnam Coastal Management Strategy to 2020, with a vision to 2030.
25.	Decision No. 1141 / QD-TTg dated June 27, 2016 approving the Project to strengthen capacity in managing access to genetic resources and fair and reasonable sharing of benefits arising from the use of genetic resources in 2016 - 2025
26.	Decision No. 90 / QD-TTg dated 12/01/2016 approving the master plan on national natural resources and environment monitoring network period 2016 - 2025, with a vision to 2030
27.	Decision No. 628 / QD-TTg dated 10/5/2017 of the Prime Minister approving the Emergency Action Plan for Primate Conservation of Vietnam until 2025, with a vision to 2030
28.	Decision No. 1618 / QD-TTg dated October 24, 2017, the Prime Minister approving the Project to Build a National Database of Natural Resources and Environment Monitoring
29.	Decision No. 1176 / QD-TTg dated September 12, 2019 Approving "Program for conservation of endangered turtles of Vietnam until 2025, with a vision to 2030"
30.	Decision No: 174/QD-TTg dated February 3, 2020 Approving the task of making Master planning for biodiversity conservation in the period of 2021-2030, with a vision to 2050
31.	Decision No: 1055/QD-TTg dated February 3, 2020 promulgating the National Plan to adapt to climate change for the period of 2021 - 2030, with a vision to 2050.
32.	Resolution No. 10 / NQ-CP dated 12 February 2014 regarding accession to the Nagoya-Kuala Lumpur Supplementary Protocol on legal obligations and compensation under the Cartagena Protocol on Biosafety
33.	Resolution 17 / NQ-CP dated 17 March 2014 of the Government on the accession to the Nagoya Protocol on Access to genetic resources and fair and equitable sharing of benefits from genetic resources under the Convention on Diversity biological
34.	Resolution No. 26/NQ-CP dated March 5, 2020 of the Government on the Promulgation of the Master Plan and the Government's 5-year plan for the implementation of Resolution No. 36-NQ/TW of October 22, 2018 of the Government. The Eighth Conference of the 12th Central Committee of the Communist Party of Vietnam on the Strategy for Sustainable Development of Vietnam's Marine Economy to 2030, with a Vision to 2045
35.	Resolution No. 05/NQ-CP dated January 15, 2021 of the Government approving the policy that Vietnam supports the Commitment of World Leaders on Nature on the occasion of the Summit on Biodiversity within the framework of the 75th session of

	the United Nations General Assembly
36.	Directive 03 / CT / TTg. February 20, 2014 of the Prime Minister strengthened the direction and implementation of measures to control and conserve endangered, precious and rare wildlife.
	Ministry of Agriculture & Rural Development
37.	Decree No. 57/2008 / ND-CP dated May 2, 2008 Promulgating regulations on management of marine protected areas of Vietnam of national and international importance
38.	Decree No. 33/2010 / ND-CP regulating the management of fishing activities inside and outside the sea areas of Vietnam.
39.	Decree No. 117/2010 / ND-CP dated December 24, 2010 on organization and management of special-use forests
40.	Decree No. 99/2010 / ND-CP on the policy of payment for forest environmental services in Vietnam
41.	Decree No. 114/2013 / ND-CP dated October 3, 2013 of the Government regulating the sanctioning of administrative violations in the field of plant varieties, plant protection and quarantine
42.	Decree No. 157/2013 / ND-CP dated 11 November 2013 of the Government on sanctioning of administrative violations in the areas of forest management, forest protection and management of forest products
43.	Decree No. 64/2019/ND-CP replaced Decree No. 160/2013 / ND-CP dated November 12, 2013 on criteria for species identification and management regime for species on the list of endangered precious and rare species prioritized protection.
44.	Decree No. 103/2013 / ND-CP dated September 12, 2013 on penalties for administrative violations in fisheries activities
45.	Decree No. 162/2013 / ND-CP dated November 12, 2013 on sanctioning of administrative violations on sea areas, islands and continental shelf of the Socialist Republic of Vietnam
46.	Decree No. 36/2014 / ND-CP dated April 29, 2014 on farming, processing and exporting pangasius products.
47.	Decree No. 40/2015 / ND-CP dated April 27, 2015 amending and supplementing a number of articles of Decree No. 157/2013 / ND-CP dated November 11, 2013 on sanctioning of administrative violations of forest management, development, protection and management of forest products
48.	Decree No. 147/2016 / ND-CP dated November 2, 2016 Amending and supplementing a number of articles of the Government's Decree No. 99/2010 / ND-CP dated September 24, 2010 on translation payment forest environment department
49.	Decree No. 168/2016 / ND-CP dated December 27, 2016, providing for the contracting of forests, gardens and water surface areas in the Management Boards of special-use forests, protection forests and agricultural one-member limited companies, State forestry
50.	Decree No. 15/2017 / ND-CP of the Government defining the functions, tasks, powers and organizational structure of MARD
51.	Decree No. 65/2017 / ND-CP dated May 19, 2017 on specific policies on breeds, capital and technology in the development of farming, planting and exploitation of medicinal herbs.
52.	Decree No. 156/2018 / ND-CP dated November 16, 2018 detailing the implementation of a number of articles of the Law on Forestry

53.	Decree No. 01/2019 / ND-CP dated January 1, 2019 on Forest Protection and Specialized Forces for Forest Protection
54.	Decree No. 06/2019 / ND-CP dated 22 January 2019 on management of endangered, precious, and rare wild plants and animals and implementation of the Convention on International Trade in Fauna and Flora endangered wild
55.	Decree No. 26/2019 / ND-CP dated 8/3/2019 detailing a number of articles and measures to implement the Law on Fisheries
56.	Decree No. 12/2020 / ND-CP dated 20/1/2020 Termination of implementation of Article 63, Point c Clause 1 Article 64, Point b Clause 2 and Clause 3 Article 65 of Decree No. 26/2019 / ND-CP detailing a number of articles and measures to implement the Fisheries Law
57.	Decision No. 380/2008 / QD-TTg dated April 10, 2008 approving the Policy on Payment for Forest Environmental Services
58.	742 / QD-TTg. signed on May 26, 2010 approving the master plan on Vietnam's marine protected area system up to 2020
59.	Decision No. 1690 / QD-TTg, September 16, 2010 approving the Fisheries Development Strategy up to 2020
60.	Decision No. 07/2012 / QD-TTg on promulgating a number of policies to strengthen forest protection
61.	Decision No. 57 / QD-TTg., 01/2012 Approving National Forest Protection and Development Plan for the period 2011-2020
62.	Decision No. 126 / QD-TTg dated February 2, 2012 on pilot benefit sharing in sustainable management, protection and development of special-use forests
63.	Decision No. 24/2012 / QD-TTg dated June 1, 2012 on investment policy for development of special-use forests for the period 2011 - 2020
64.	Decision No. 940 / QD-TTg dated July 19, 2012 of the Prime Minister approving an urgent action plan until 2020 for elephant conservation in Vietnam.
65.	Decision 799 / QD-TTg dated June 27, 2012 approving the National REDD Action Plan 2011-2020
66.	Decision No. 1896/2012 / QD-TTg Approving the project "Preventing and controlling invasive alien organisms in Vietnam until 2020
67.	Decision No. 11/2013 / QD-TTg dated January 24, 2013 of the Prime Minister prohibiting export, import, trading and transportation of specimens of some animal species under the Convention on International Trade in Species endangered wild animals and plants
68.	Decision No. 188 / QD-TTg dated February 13, 2013 of the Prime Minister approving the Program for the protection and development of aquatic resources up to 2020.
69.	Decision No. 1455/QD-TTg dated August 16, 2013 of the Prime Minister approving the Master plan on fishery development of Vietnam to 2020, vision to 2030
70.	Decision No. 763 / QD-TTg dated May 21, 2013 of the Prime Minister approving the Master Plan for Vietnam Elephant Conservation for the period 2013 - 2020
71.	Decision 899 / QD-TTg dated 10/6/2013 approving the project of Restructuring the Agriculture sector towards increasing added value and sustainable development.
72.	Decision No. 2630 / QD-TTg dated December 31, 2013 of the Prime Minister on the establishment of Bach Long Vi MPA
73.	Decision No. 539 / QD-TTg dated April 16, 2014 of the Prime Minister approving the National Program on Tiger Conservation for the period 2014 - 2022
74.	Decision No. 218 / QD-TTg dated February 7, 2014 approving the Strategy for

	management of special-use forests, marine protected areas, and inland water conservation zones of Vietnam to 2020, with a vision to 2030.
75.	Decision 1976 / QD-TTg dated 30/10/2014 approving the planning for the system of special-use forests nationwide to 2020, with a vision to 2030
76.	Decision No. 120 / QD-TTg dated 22 January 2015 approving the Scheme on the protection and development of coastal forests in response to climate change for the period 2015-2020
77.	Decision No. 44/2016 / QD-TTg dated October 19, 2016 of the Prime Minister On the specialized protection force of forest owners
78.	Decision No. 49/2016 / QD-TTg dated November 2, 2016 on the Regulation on the management of production forests
79.	Decision No. 419 / QD-TTg, April 5, 2017 approving the National Program on Reducing Greenhouse Gas Emissions through Limiting Forest Loss and Degradation; Conservation and enhancement of carbon stocks and sustainable management of forest resources until 2030
80.	Decision No. 626 / QD-TTg dated May 10, 2017 of the Prime Minister approving the Project on strengthening the management capacity of the conservation area system to 2025, with a vision to 2030.
81.	Decision No. 886 / QD-TTg, June 16, 2017 approving the National Target Program for Sustainable Forest Development for the 2016-2020 period
82.	Decision No. 28/2017 / QD-TTg, July 3, 2017. defining the functions, tasks, powers and organizational structure of the General Department of Forestry under the Ministry of Agriculture and Rural Development
83.	Decision No. 1857/QD-TTg dated November 23, 2017 establishing the State Steering Committee on Program 886 on the basis of the State Steering Committee on Forest Protection and Development Plan 2011-2020.
84.	Decision No. 78/2018 / QD-TTg approving the National Action Plan to prevent, reduce and eliminate illegal, unreported and unregulated fishing until 2025.
85.	Decision No. 79/2018 / QD-TTg, January 18, 2018, promulgating the National Action Plan for Vietnam Shrimp Industry Development until 2025
86.	Decision No. 1288/QD-TTg, October 1, 2018 on approving the Scheme of Sustainable Forest Management and Forest Certification
87.	Decision No. 297/QD-TTg dated March 18, 2019 of the Prime Minister approving the Project on sustainable forest protection, restoration and development in the Central Highlands in the 2016-2030 period
88.	Decision No. 536/QD-TTg dated April 17, 2020 of the Prime Minister approving the task of formulating the national forestry planning period 2021-2030, with a vision to 2050
89.	Decision No. 541/QD-TTg dated April 20, 2020 of the Prime Minister approving the task of formulating a master plan on protection and exploitation of aquatic resources for the period of 2021 - 2030, with a vision to 2050.
90.	Decision No. 885/QD-TTg dated June 23, 2020 of the Prime Minister approving the Scheme on organic agriculture development in the period of 2020 - 2030
91.	Decision No. 524/QD-TTg dated April 1, 2021 of the Prime Minister approving the Project "Growing a billion trees in the period of 2021 - 2025"
92.	Decision No. 339/QD-TTg dated 11/03/2021 of the Prime Minister approving the Strategy for development of Vietnam's fisheries to 2030, with a vision to 2045
93.	Decision No. 523/QD-TTg dated April 1, 2021 of the Prime Minister approving the

	Vietnam forestry development strategy for the period of 2021 - 2030, with a vision to 2050
	Ministry of Health
94.	Decision No. 1796 / QD-TTg dated October 30, 2013 of the Prime Minister on master plan on development of medicinal herbs to 2020 and orientations to 2030.
	Ministry of Science and Technology
95.	Decision No. 1671 / QD-TTg dated September 28, 2015 of the Prime Minister on the Program on conservation and sustainable use of genetic resources up to 2025, with an orientation to 2030.
	Ministry of Planning and Investment
96.	Decree No. 37/2019 / ND-CP dated 7/5/2019 detailing the implementation of a number of articles of the Law on Planning
97.	Decision No. 432 / QD-TTg dated April 12, 2012 of the Prime Minister approving the Vietnam Strategy for Sustainable Development for the period 2011 - 2020
98.	Decision No. 1393 / QD-TTg dated September 25, 2012 of the Prime Minister approving "National strategy on green growth for the period 2011-2020 and vision to 2050"
99.	Decision No. 1658 / QD-TTg dated October 1, 2021 of the Prime Minister approving "National strategy on green growth for the period 2021-2030 and vision to 2050"
100.	Decision No. 622 / QD-TTg dated 10/5/2017 of the Prime Minister promulgating the National Action Plan to implement the 2030 Agenda for Sustainable Development.
101.	Decision No. 681 / QD-TTg dated June 4, 2019 of the Prime Minister promulgating a Roadmap for the implementation of Vietnam's sustainable development goals up to 2030
Documents, Resolutions of Party, National Assembly	
102.	Communist Party of Vietnam, Document of Congress XI: Socio-economic development strategy 2011 - 2020
103.	Resolution No: 24-NQ / TW, June 23, 2013 on Proactively responding to climate change, strengthening resource management and environmental protection
104.	Directive 13/2017 / CT-TW on strengthening the party's leadership role in forest management and protection
105.	Resolution No. 36-NQ / TW, October 22, 2018 Resolution of the Eighth Conference of the XII Central Executive Committee on Vietnam's Strategy for Sustainable Marine Economic Development to 2030, with a Vision to 2045
106.	Resolution No. 134/2016 / QH13 dated 9/4/2016 of the National Assembly on adjustment of land use planning to 2020 and land use plan for the final period (2016-2020) at national level
Ministry-level documents	
	Ministry of Natural Resources and Environment presides over and coordinates with the construction and issuance
107.	Decision No. 2293 / QD-BTNMT dated November 30, 2009 approving the Program on implementing the Law on Biodiversity of the Ministry for the period 2009-2015
108.	Circular No. 22/2010 / TT-BTNMT dated October 26, 2010 Technical regulations on survey and investigation of integrated marine resources and environment by ship
109.	Circular No. 23/2010 / TT-BTNMT signed 26 / 10,2010 on "Regulations on surveying and assessing coral ecosystems, seagrass ecosystems and wetlands in coastal areas and islands".
110.	Circular No. 22/2011 / TT-BTNMT dated 1 July 2011 of the Minister of Natural

	Resources and Environment regulating criteria for determining invasive alien species and issuing the list of invasive alien species
111.	Circular No. 09/2012 / TT-BTNMT dated 22 August 2012 regulating the provision and exchange of information and data on genetically modified organisms
112.	Circular No. 28/2012 / TT-BTNMT dated December 28, 2012 of the Ministry of Natural Resources and Environment regulating the content and regime of reporting on the management of basic investigation, exploitation and use of resources and environmental protection of sea and islands
113.	Circular No. 13/2013 / TT-BTNMT dated June 21, 2013 of the Minister of Natural Resources and Environment regulating technical procedures and economic-technical norms in the detection of genetically modified organisms by fecal method analyzing qualitative and quantitative deoxyribonucleic acid
114.	Circular No. 14/2013 / TT-BTNMT dated June 21, 2013 of the Minister of Natural Resources and Environment regulating technical processes and technical and economic norms on designing and building models of biodiversity conservation community-based learning in the coastal wetland ecosystem
115.	Circular No. 08/2013 / TT-BTNMT dated May 16, 2013 of the Ministry of Natural Resources and Environment promulgating regulations on procedures for issuance and revocation of certificates of biosafety for genetically modified plants
116.	Circular No. 29/2013 / TT-BTNMT dated October 9, 2013 of the Ministry of Natural Resources and Environment promulgating the system of natural resources and environment sector's statistical indicators.
117.	Circular No. 36/2014 / TT-BTC dated 24 March 2014 of the Ministry of Finance promulgating regulations on submission of rates, collection, payment, management and use of fees for appraisal of dossiers for issuance of Security Certificates biosafety of genetically modified crops
118.	Circular No. 26/2014 / TT-BTNMT dated May 28, 2014 Promulgating the process and economic-technical norms for building a database of natural resources and environment
119.	Circular No. 25/2016 / TT-BTNMT dated September 22, 2016 on Guidance on registration form, certificate of biodiversity conservation facility and report form of conservation status of species on the List of Endangered Species The precious and rare species are prioritized for protection by biodiversity conservation facilities
120.	Circular No. 50/2016 / TT-BTNMT dated December 30, 2016 providing for the organization and operation of the Council of Appraisal of Wild Fauna and Flora species on the List of endangered, precious and rare species Priority protection
121.	Circular No. 35/2018 / TT-BTNMT dated December 28, 2018 regulating the criteria for identifying and issuing the list of invasive alien species.
122.	Decision 200 / QD-BTNMT 2015 approving the communication program to raise awareness about prevention and control of invasive alien organisms in Vietnam for the period 2015-2020
Joint Circular	
123.	Joint Circular No. 27/2013 / TTLT-BTNMT-BNNPTNT regulating criteria for determining invasive alien species and promulgating the list of invasive alien species
124.	Joint Circular No. 50/2014 / TTLT-BTNMT-BNV dated August 28, 2014 of the Ministry of Natural Resources and Environment, Ministry of Home Affairs guiding the functions, tasks, powers and organizational structure of the Department of Natural Resources and Environment under the People's Committees of provinces and centrally-

	run cities; The Department of Natural Resources and Environment belongs to the People's Committee of districts, towns and cities of the province
Decision	
125.	Decision No. 200 / QD-BTNMT dated January 29, 2015 of the Minister of Natural Resources and Environment approving the awareness raising communication program on prevention and control of invasive alien organisms in Vietnam period 2015 - 2020
126.	Decision No. 1107 / QD-BTNMT dated May 12, 2015, Announcing the List of protected areas as a basis for the management and implementation of biodiversity conservation activities.
127.	Decision No. 1093 / QD-TCMT June 22, 2016. Technical guidelines for wetland classification are issued.
128.	Decision No. 1307 / QD-BTNMT dated April 26, 2018 defining the functions, tasks, powers and organizational structure of the Department of Nature Conservation and Biodiversity under the General Department of Environment.
	The Ministry of Agriculture and Rural Development presides over and coordinates with in formulating and promulgating
129.	Circular No. 13/2009 / TT-BNN dated 12/03/2009 of the Ministry of Agriculture and Rural Development guiding a number of issues on the management and use of revenues from handling administrative violations for trading illegal, commercial fraud in the field of forest management and forest protection
130.	Circular No. 25/2009 / TT-BNN dated 5/5/2009 of the Ministry of Agriculture and Rural Development guiding the implementation of forest statistics, inventory and forest management records.
131.	Circular No. 53/2009 / TT-BNN dated 21/8/2009 of the Ministry of Agriculture and Rural Development Regulation on the management of alien aquatic organisms in Vietnam
132.	Circular No. 58/2009 / TT-BNNPTNT dated 9/9/2009 of the Ministry of Agriculture and Rural Development guiding the planting of rubber on forest land
133.	Circular No. 34/2009 / TT-BNN dated 10/6/2009 of the Ministry of Agriculture and Rural Development regulating criteria for forest identification and classification.
134.	Circular No. 69/2009 / TT-BNNPTNT dated October 27, 2009, on pilot testing to assess risks to biodiversity and the environment of genetically modified plant varieties.
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138.	Circular No. 59/2010 / TT-BNNPTNT dated 19/10/2010 of the Ministry of Agriculture and Rural Development promulgating the list of wild fauna and flora species under the management of the Convention on International Trade endangered species of wild animal and plant.
139.	Circular No. 63/2010 / TT-BNNPTNT dated November 1, 2010 of the Ministry of Agriculture and Rural Development guiding the regulation of the Certificate of Free Sale for products and goods exported and imported under the management responsibilities of the Ministry of Agriculture and Rural Development.

140.	Circular No. 01/2011 / TT-BNNPTNT dated 5 January 2011 of the Minister of Agriculture and Rural Development regulating the amendment and supplementation of the list of rare and endangered aquatic species that need to be protected, recovered and developed issued together with Decision No. 82/2008 / QD-BNNPTNT dated 17 July 2008 of the Minister of Agriculture and Rural Development.
141.	Circular No. 78/2011 / TT-BNNPTNT dated 11/11/2011 of the Ministry of Agriculture and Rural Development detailing the implementation of Decree No. 117/2010 / ND-CP dated December 24, 2010 of the Government on organization and management of the special-use forest system.
142.	Circular No. 88/2011 / TT-BNNPTNT dated 28/12/2011 of the Ministry of Agriculture and Rural Development guiding the Government's Decree No. 12/2006 / ND-CP dated January 23, 2006, detailing enforce the Commercial Law on international goods trading and agency, purchase, sale, processing and transit with foreign countries in the agricultural, forestry and fishery sectors.
143.	Circular No. 89/2011 / TT-BNNPTNT dated 29/12/2011 of the Ministry of Agriculture and Rural Development promulgating the List of areas banned from exploitation for a period of a year.
144.	Circular No. 35/2011 / TT-BNNPTNT dated 20/5/2011 of the Ministry of Agriculture and Rural Development guiding the exploitation and salvage of timber and non-timber forest products.
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146.	Circular No. 80/2011 / TT-BNNPTNT dated 23/11/2011 of the Ministry of Agriculture and Rural Development guiding the method of determining the payment for forest environmental services.
147.	Circular No. 01/2012 / TT-BNNPTNT dated 04/01/2012 of the Ministry of Agriculture and Rural Development regulating the legal records of forest products and checking the origin of forest products.
148.	Circular No. 20/2012 / TT-BNNPTNT dated May 7, 2012 of the Ministry of Agriculture and Rural Development guiding the procedures for checking and accepting the payment for forest environmental services
149.	Circular No. 42/2012 / TT-BNNPTNT dated 21/08/2012 of the Ministry of Agriculture and Rural Development on amending and supplementing a number of articles of Circular 01/2012 / TT-BNNPTNT 04/01/2012 legal forest product record and check the origin of forest products.
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151.	Circular No. 11/2012 / TTLT-BNNPTNT-BTC-BKHDT dated March 1, 2012 between the Ministry of Agriculture and Rural Development, the Ministry of Finance and the Ministry of Planning and Investment on guiding the management and use regime State budget funding for the Project on development of agricultural, forestry, livestock and aquatic breeds until 2020.
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154.	Circular No. 51/2012 / TT-BNNPTNT dated October 19, 2012 of the Ministry of Agriculture and Rural Development guiding the implementation of forest protection and development tasks specified in Decision No. 57 / QD-TTg dated January 9, 2012 by the Prime Minister
155.	Circular No. 23/2013 / TT-BNNPTNT dated May 4, 2013 of the Ministry of Agriculture and Rural Development regulating the improvement of poor natural forests that are production forests (this Circular repeals Circular No. 56/2012 / TT-BNNPTNT dated November 6, 2012).
156.	Circular No. 24/2013 / TT-BNNPTNT dated May 6, 2013 of the Ministry of Agriculture and Rural Development on regulations on planting replacements when changing forest use purposes to other purposes
157.	Circular No. 29/2013 / TT-BNNPTNT dated June 4, 2013 on regulations on the establishment and management of marine protected areas at provincial level
158.	Circular No. 44/2013 / TT-BNNPTNT dated 23 October 2013 on the annulment of Article 6 and amending Article 15 of Circular 29/2013 / TT-BNNPTNT dated June 4, 2013 on regulations on establishment and management of management of marine protected areas at the provincial level
159.	Circular No. 80/2013 / TTLT-BTC-BNN dated June 14, 2013 between the Ministry of Finance and the Ministry of Agriculture and Rural Development guiding the management and use of non-business funding for the implementation of the forest protection and development.
160.	Circular No. 26/2013 / TT-BNNPTNT dated May 22, 2013 on the management of aquatic breeds, which stipulates the testing and inspection of aquatic breeds to ensure harm assessment of aquatic breeds for first time importation and for entering Vietnam, and contributing to the prevention and control of exotic aquatic breeds that are likely to be invaded.
161.	Circular No. 23/2013 / TT-BNNPTNT dated May 4, 2013 of the Ministry of Agriculture and Rural Development regulating the improvement of poor natural forests which are production forests.
162.	Circular No. 24/2013 / TT-BNNPTNT dated May 6, 2013 of the Ministry of Agriculture and Rural Development regulating replacement forest planting when changing forest use purpose to other purposes.
163.	Circular No. 40/2013 / TT- BNNPTNT dated September 5, 2013 of the Ministry of Agriculture and Rural Development promulgating the list of wild fauna and flora species specified in the Annexes to the Convention on Trade endangered species of wild fauna and flora.
164.	Circular No. 33/2014 / TT-BNNPTNT dated October 30, 2014 of the Minister of Agriculture and Rural Development regulating the order and procedures for plant quarantine for import, export, transit and post-import subject to plant quarantine, having defined cases of detecting a batch of objects infected with plant quarantine objects, objects subject to control of Vietnam or strange harmful organisms, the plant quarantine agency shall decide. Appropriate phytosanitary treatment measures.
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167.	Circular No. 02/2014 / TT-BNNPTNT dated 24 January 2014 of the Ministry of Agriculture and Rural Development regulating the order and procedures for issuance and revocation of certificates of genetically modified plants eligible for use as food, animal feed.
168.	Circular No. 29/2014 / TT-BNNPTNT dated September 5, 2014 amending and supplementing Article 7 of Circular No. 23/2010 / TT-BNNPTNT dated April 7, 2010 on the recognition of biotechnology technical progress of agriculture and rural development
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171.	Circular No. 04/2015 / TT-BNNPTNT dated February 12, 2015 of the Minister of Agriculture and Rural Development guiding the implementation of some contents of the Decree No. 187/2013 / ND-CP dated November 20, 2013 of The Government details the implementation of the Commercial Law regarding international goods sale and purchase and goods agency, purchase, sale, processing and transit with foreign countries in the agricultural, forestry and aquatic sectors.
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173.	Circular No. 04/2017 / TT-BNNPTNT dated February 24, 2017 of the Minister of Agriculture and Rural Development issuing the list of wild species specified in the Appendices to CITES
174.	Circular No. 22/2017 / TT-BNNPTNT dated November 15, 2017 guiding the implementation of the policy on payment for forest environmental services (PFES)
175.	Circular No. 19/2018/TT-BNNPTNT dated November 15, 2018 guiding the protection and development of aquatic resources
176.	Circular No. 21/2018 / TT-BNNPTNT dated November 15, 2018 regulating the recording and submission of fishing reports and logs; announcement of a designated fishing port to certify the origin of aquatic products from fishing; a list of illegal fishing vessels; certification of raw materials, certification of the origin of the caught seafood.
177.	Circular No. 24/2018 / TT-BNNPTNT dated November 15, 2018 regulating the updating, exploitation and management of national fisheries database.
178.	Circular No. 33/2018 / TT-BNNPTNT regulating forest investigation, inventory and monitoring
Joint Circular	

179.	Joint Circular No. 98/2010 / TTLT-BQP-BNN dated July 19, 2010 between the Ministry of Defense and the Ministry of Agriculture and Rural Development guiding the implementation of a number of articles on coordination between the Militia Forces self-defense against forest rangers in forest protection work according to Decree 74/2010 / ND-CP dated 12/07/2010 of the Government.
180.	Joint Circular No. 07/2011 / TTLT / BNNPTNT-BTNMT dated January 29, 2011 between the Ministry of Agriculture and Rural Development and the Ministry of Natural Resources and Environment guiding a number of contents on forest allocation and forest lease with land allocation, and forestry land lease.
181.	Joint Circular No. 11/2012 / TTLT-BNNPTNT-BTC-BKHDT dated March 1, 2012 between the Ministry of Agriculture and Rural Development, the Ministry of Finance and the Ministry of Planning and Investment on guiding the management regime, to use state budget funds to spend on projects on development of agricultural, forestry, livestock and aquatic breeds until 2020.
182.	Joint Circular No. 62/2012 / TTLT-BNNPTNT-BTC dated November 16, 2012 between the Ministry of Agriculture and Rural Development and the Ministry of Finance guiding the management regime and use of payment for forest environmental services.
183.	Joint Circular No. 10/2013 / BNNPTNT-BKHDT dated February 1, 2013 between the Ministry of Agriculture and Rural Development and the Ministry of Planning and Investment guiding the management and use of investment capital from the real state budget for forest protection and the development plan for the period 2011-2020 according to the Decision No. 57 / QD-TTg dated January 9, 2012 of the Prime Minister
184.	Joint Circular No. 100/2013 / TTLT-BTC-BNNPTNT dated July 26, 2013 between the Ministry of Finance and the Ministry of Agriculture and Rural Development guiding the implementation of a number of articles of Decision No. 24/2012 / QD-TTg June 1, 2012 of the Prime Minister on the policy of investment and development of special-use forests for the period 2011-2020
185.	Joint Circular No. 45/2015 / TTLT-BNNPTNT-BKHCN dated November 23, 2015 of the Ministry of Agriculture and Rural Development and the Ministry of Science and Technology guiding the labeling of goods as genetically modified foods packing available.
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186.	Decision No. 79/2015 / QD-TCLN-VP dated February 9, 2015 Approving the Scheme on propaganda in the forestry sector 2015, with a vision to 2020, contributing to the implementation of forestry restructuring
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188.	Circular No. 17/2016 / TT-BKHCN on the management and implementation of the program on conservation and use of genetic resources until 2025, with a vision towards 2030
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191.	Circular No. 36/2014 / TT-BTC dated 24 March 2014 regulating the collection rate, regime of collection, payment, management and use of fees for appraisal of application for biosafety certificates for variable crops genetically modified.
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