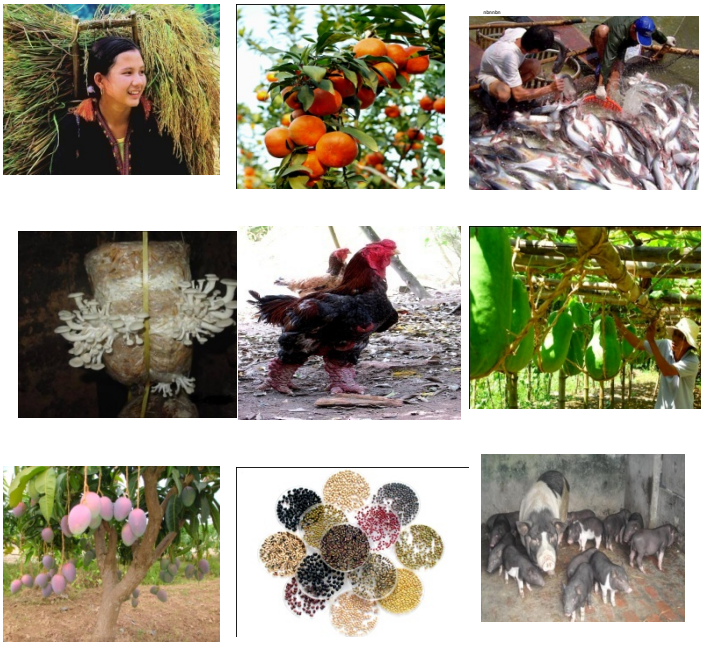
COUNTRY REPORTS

THE STATE OF **VIET NAM'S** BIODIVERSITY FOR FOOD AND AGRICULTURE

REPUBLIC SOCIALIST OF VIETNAM

COUNTRY REPORT FOR THE STATE OF THE WORLD'S BIODIVERSITY FOR FOOD AND AGRICULTURE



HANOI 2014

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LIST OF ABBREVIATIONS

ASEAN	Asian southeast association nations
ADB	Asian development bank
WB	World bank
UNESCO	United Nations Educational, Scientific and Cultural Organization
CBD	Convention on biological diversity
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
CITES	Convention on International Trade in Endangered Species
GEF	Global Environment Facility
FFI	Fauna & Flora International
MARD	Ministry of Agriculture and Rural Development
MOET	Ministry of Education and Training
MONRE	Ministry of Natural Resources and Environment
MOH	Ministry of Health
MOD	Ministry of Defense
MOET	Ministry of Education and Training
MOST	Ministry of Science and Technology
MOIT	Ministry of Industry and Trade

GDP	Gross domestic product
IUCN	International Union for Conservation of Nature
WWF	World Wide Fund for Nature
FAO	Food and Agriculture Organization

EXECUTIVE SUMMARY

Biodiversity for food and agriculture (BFA) is a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems, also named agro-ecosystems: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes.

Vietnam is one of the high biodiversity centers in the world in which the BFA is expressed through diversity in ecosystems, species composition and genetic resources as well.It plays a vital role in the provision of biodiversity services (provisioning services, regulatory services, cultural services and support services). Through these services, biodiversity makes a significant contribution to the national economy, providing a basis for ensuring food security, maintaining genetic resources of animals and plants; and providing materials for construction, fuel and pharmaceutical resources.

There are 24 production system in Vietnam such as Livestock grass-based systems, Livestock landless systems, Naturally regenerated forests, Planted forests, Self-recruiting capture fisheries, culture-based fisheries, fed aquaculture, Non-fed aquaculture, integrated crop (rice), Integrated crop (other), Rained crops, Mixed systems (livestock, crop, forest and/or aquatic and fisheries), production systems in national parks at the tropic and subtropics climate. There are two regions with the template climate such as Da Lat and Sapa but the productivities of those regions are too small. Moreover, there is no official description information for each production system.

BAF has changed significantly. Many drivers affecting these changes including changes in land and water use and management, pollution and external inputs, over-exploitation and overharvesting, climate change, natural disasters, pests, diseases, alien invasive species, markets, trade and the private sector, policies, population growth and urbanization, changing economic, socio-political, and cultural factors, advancements and innovations in science and technology. Of these, the pressure from the increasing human population combined with an increasing level of consumption which is resulting in overexploitation of biodiversity resources. In addition, 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. Natural resources, especially biological resources, are undergoing overexploitation. Of these, timber, non-timber and aquatic products are particularly vulnerable. Furthermore, alien species, environment pollution and climate change are all directly affecting the biodiversity of Vietnam.

The recent change in BAF of Vietnam is reflected in a variety of ways and aspects: although the area of Vietnam's forest cover has increased, much of this increase has been due to the planting of production forest; both inland water and marine ecosystems are being degraded due to inappropriate exploitative activities. Overall, the status of rare and endangered species is declining sharply; new crop varieties and animal breeds with high yields have pushed out the traditional ones that lead to a huge loss of precious indigenous genetic resources.

Vietnam's Government has issueda number of legal documents related tobiodiversity conservationin early 1960's. Since then, the national policies, programmes and enabling frameworks that support or influence conservation and sustainable use of biodiversity for food and agriculture and the provision of ecosystem serviceshave been significantly enhanced. It can be listed as policies for implementation of Ecosystem Based Approach, Payment for Ecosystem Services, enabling frameworks governing exchange, access and benefit policies (programs governing the access to its genetic resources of associated biodiversity), improving the stakeholder participation and ongoing activities that support maintenance of biodiversity for food and agriculture. In addition to these are policies and programs to encourage the collaboration between institutions and organizations, for capacity development: training and extension programmes, or elements of programmes, at all levels, exist that target the conservation and sustainable use of associated biodiversity.

Together with the promulgation of legal documents, Vietnam's government has also issued a number of national strategies, plans and priorities to secure and improve the conservation and sustainable use of biodiversity for food and agriculture. For instance, plans to improve the conservation and sustainable use of biodiversity to enhance its contribution to improving food security and nutrition;rural livelihoods; productivity;the sustainability and resilience of production systems;supporting ecosystem function and the provision of ecosystem services; sustainable intensification; improving the capacity and operations of the institutions, collaboration between stakeholders; supporting the development of new policies; implementing ecosystem approaches for the various components of biodiversity, to improve stakeholder awareness, involvement and collaboration in the conservation and sustainable use of biodiversity,to support the role of farmers, pastoralists, fisher folk, forest dwellers, and other rural men and women dependent on local ecosystems in the conservation and use of biodiversity for food and agriculture, to improve recognition of the contribution of women to the conservation and use ofthe different components of biodiversity for food and agriculture,

Gaps and priorities:

Despite some progress towards both the national targets and the strategic targets of the Convention on Biological Diversity, there remain some challenges in achieving these targets, particularly in the management of biodiversity. These include: lack of effective inter-sectoral coordination mechanisms to respond to overlap in functions among relevant ministries and agencies; laws and regulations to protect biodiversity are still unsystematic and lacking in uniformity; community involvement in biodiversity conservation has not been sufficiently mobilized, which leads to weak law enforcement; deforestation and illegal wildlife trade pose serious threats to biodiversity; overall investments in biodiversity are insufficient, resulting in a lack of financial, human and technological resources. In order to achieve both national targets and the CBD targets, the following priority activities are recommended:

- Enhance state management of biodiversity, including: clarifying the functions and mandates of both Ministry of Agriculture and Rural Development (MARD) and MONRE in biodiversity conservation management; promote the closer and integrated working relationships between key and relevant agencies and stakeholders in conservation; and enforce the law and legislation on biodiversity conservation;
- Increase investments of resources for biodiversity conservation, particularly biodiversity for food and agriculture. These investments should be targeted at: developing a biodiversity inventory; developing a comprehensive monitoring system for change in biodiversity; developing andoperating a biodiversity database system and identification of mechanisms to share, exchange, and manage information; strengthening capacity for staff; promoting supervision of law enforcement; and finally increasing investment for biodiversity conservation from the state budget;
- Ensuring maintenance of a national system of Protected Areas (terrestrial/ forest, wetland, and marine) and ensuring critical ecosystems are safeguarded and protected. Conservation priority is to be granted to Protected Areas in critical ecoregions.
- Promote biodiversity conservation and management at three levels namely ecosystem, species and genetic diversity. Control and take steps to stop illegal trade and overexploitation of biodiversity resources, especially rare, threatened and endangered species;
- Preserve and develop genetic resources by completing an inventory and compiling information on biodiversity resources, and related indigenous knowledge nationwide;
- Develop risk management and risk control of alien species, with a particular focus on genetically modified organisms (GMO), their use, and any potential impacts on the environment, biodiversity and human health;

- Study and evaluate the role of biodiversity in response to climate change and propose appropriate solutions;
- Promote integration of biodiversity conservation into development strategies, plans, and programs at central, ministerial and provincial levels;
- Increase financial resources allocated for biodiversity conservation and ensure effective management of the public budget for conservation; and
- Maintain and promote support from international community in conservation

Some obstacles when preparing the report:

In fact, most of the legal frameworks, planned actions and future priorities for biodiversity conservation are general, not specific as BFA. In other words, the information of biodiversity for food and agriculture are included in policies for biodiversity in general. In the legal documents related to biodiversity, only one or two articles or small parts mentioned to BFA. Take one of the newest planned actions related to biodiversity conservation "The master plan on biodiversity conservation in the whole country through 2020, with orientations toward 2030" of Vietnam government, the main concerns of this document is about establishment of protected areas and biodiversity corridors.

The information system associated to BFA is insufficient, fragmented and mostly not shared online. In addition, it is difficult to access the data and information of wild food species due to lack of studies and surveys on these species. Information needed to fill the tables in this report are mostly not available therefore the scores (2, 1, 0, -1, -2) are given as estimation, the specific figures are not available.

CHAPTER I. INTRODUCTION TO VIETNAM AND THE ROLE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

1. Preparation of the country report

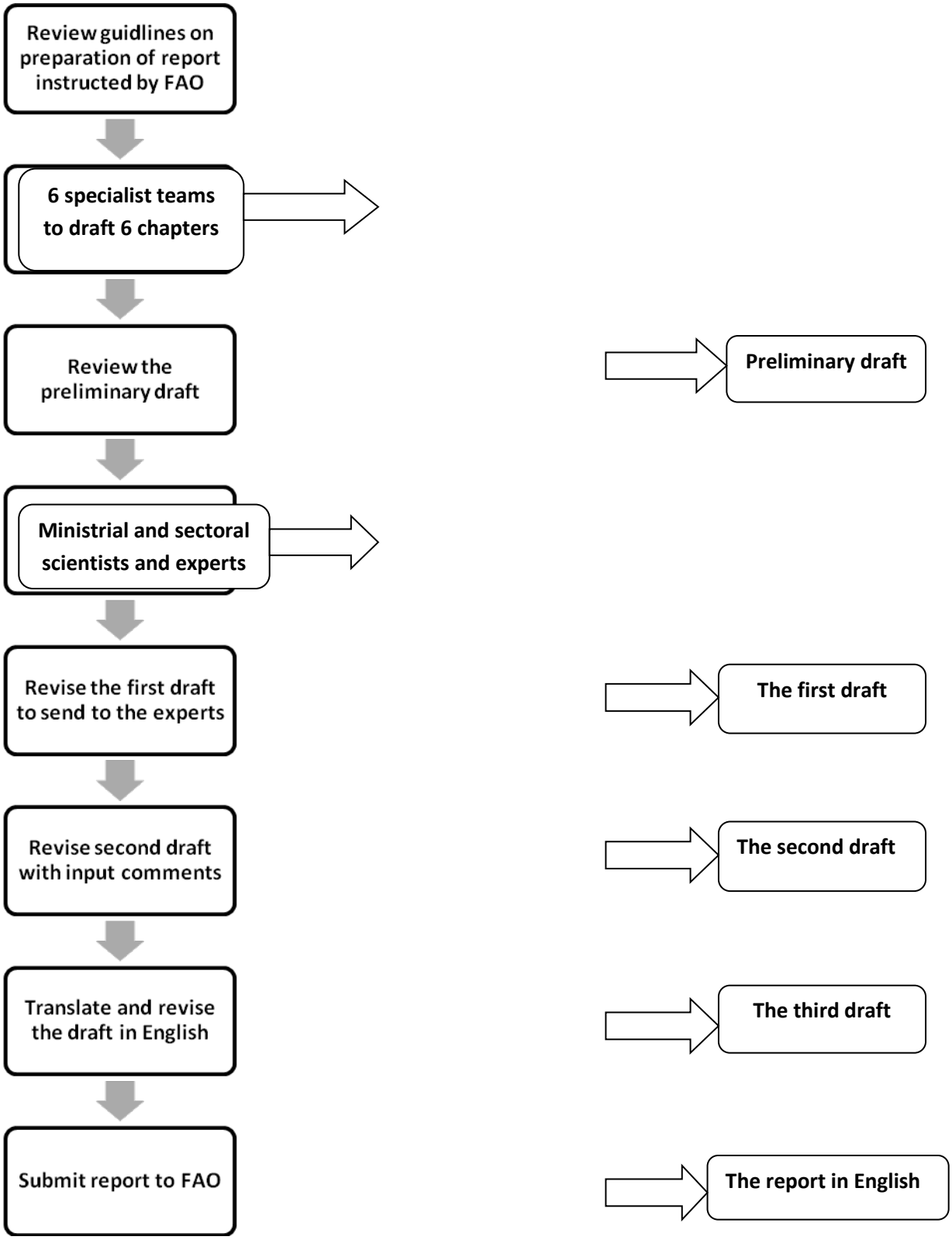

Figure 1. Process of the country report preparation

The country report was prepared in the following process: in 2013, Ministry of Agriculture and Rural Development (MARD) has been got the request from the Food and Agriculture Organization (FAO) to assign a national focal point (NFP) for preparation of the report. Plant Resources Center (PRC) was assigned as a host to organize the preparation of the country's report and the director of PRC was appointed as a NTP. In December 2013, FAO Vietnam signed a contract to provide fund for PRC team to collect data and information. A working team from different sectors was selected for collecting the data and information related to biodiversity for food and agriculture. The information and documents were provided for NFP. And, then NFP and experts started writing the preliminary draft from the beginning of 2014 until September 2014. The national workshop for revising the national report on the state of biodiversity for food and agriculture was organized with the supported fund from FAO on 30 October 2014 for comments. Then the report wasrevised to have the first draft then it was sent to relevant organizations, experts for comments. Again it was revised and edited to have the second draft, which was translated into English. The finalized Country Report eventually was submitted to FAO and the government for official endorsement.

2. *General introduction to Vietnam*

Figure 2. Vietnam's administrative map

Country name: Socialist Republic of Vietnam

Capital: Hanoi

Inland area: 331,688 sq km

Continental shelf area: 700,000 sq km

Population: Over 90 million

Inland co-ordinates: Latitude 102,10 - 109,30 East Longitude 8,30 - 22,30 North

Vietnam is located in the centre of the Southeast Asian region. It lies in the eastern part of the Indochina peninsular bordering China to the north, Laos and Cambodia to the west and the East Sea and Pacific to the east and south.

Viet Nam's coastline is 3260 kilometers long and its inland borderline measure is 3730 kilometers. The country's total length as the bird flies is 1650 kilometers from the northernmost point to the southernmost. Its width, stretching from the eastern coast to the western border, continental shelf area is not included, is 600 kilometers at the widest point in the north, and 50 kilometers at the narrowest part in the Quang Binh province on the central coast.

Climate:

Vietnam is located in the tropical and temperate zone. It is characterized by a strong moon soon influence, a considerable amount of sunny days, and with a high rate of rainfall and humidity. Some places located near the tropics or in mountainous regions are endowed with a temperate climate. Average temperatures for the year range from 22 to 27^0C. In Hanoi the average is 23^0C, in Ho Chi Minh City, 26^0C, and in the ancient capital city of Hue, 25^0C.

The climate in Vietnam is divided into two distinguished seasons: the cold season (from November to April) and the hot season (from May to October). The most noticeable seasonal changes in temperature are found in the Northern provinces, where a difference of 12 degrees Celsius is possible. The difference in temperature, estimated at 3 degrees Celsius, between the two seasons in southern Vietnam is almost unnoticeable. Four distinct seasons are most evident in the Northern provinces.

Topography:

Three quarters of Viet Nam's territory is made up of mountainous and hilly regions. Except for several deltas and narrow plains, Vietnam is endowed with vast expanses of mountains and forests. Vietnam has four distinctive mountain zones each having its own unique features. The first zone is the Northeastern zone which stretches from the Red River valley to the Gulf of Tokin. Apart from having the topical characteristic features of a tropical forest area, the mountainous area of Viet Bac is crowned with nationally famous sights such as Dong Nhat (First-Rate Grotto), Dong Nhi (Second-Rate Grotto) and Tam Thanh in Lang Son province; Pac Bo Grotto and Ba Be Lake in Cao Bang province; Yen Tu mountain, and Tay Con Linh, a mountain peak 2314 metres above sea level, and Ha Long Bay in Quang Ninh province.

The second zone is the Northwestern mountain range running from the northern area on the Sino-Vietnamese border to the western region in Thanh Hoa, Nghe An and Ha Tinh provinces on the central coast. This magnificent high mountain range is famous nation-wide for its Sapa resort town in Lao Cai province. Sapa is perched on a high mountain slope, 1,500 metres above sea level, and is endowed with a temperate climate all year round and with snowflakes during winter time. The Northwestern zone is also famous for the historical site of Dien Bien Phu and for its Fanxipang mountain peak 3,143 metres above sea level, which is considered the rooftop to Vietnam.

The third mountain zone is the North Truong Son Range, a long low mountain range running from the western part of Thanh Hoa province to the Hai Van Pass. The zone is reputed regionally for its

picturesque Phong Nha Grotto and fantastic looking passes such as the Ngang Pass and the Hai Van (Sea Cloud) Pass. It is also known nationwide for being the location of the legendary Ho Chi Minh Trail.

The four and last mountain zone is the South Truong Son, a mountain range located in the western side of provinces situated on the southern end of the central coast. Behind these huge mountains is located a vast expanse of red soil known locally as Tay Nguyen (the Central Highlands). The legendary Central Highlands contains numerous mystic accounts of flora and fauna as well as the lives of the people of several different ethnic minority groups.

Forests and forest land accounts for 50 per cent of Viet Nam's total land area. These forests are home to many kinds of plants and animals not found elsewhere in Southeast Asia or in many other parts of the world. The most valuable timber plants include lat hoa (chkrasia), dinh (markhamia), lim (ironwood), sen (madhuca pasquieri) and tau (tonkinensis), to cite just a few. Besides valuable timber Viet Nam's forests are also home to many other valuable forest products much sought after in overseas outlets. They include stick lac, cinnamon, pine resin, anise and pine oil.

Vietnam has two major deltas: the Red River delta in the northern part and the Mekong River delta in the south. The Red River delta is 15,000 square kilometers in area. It is comprised, from time immemorial, of deposits of alluvium carried in from two major rivers: the Red River and the Thai Binh River. The basin of the two rivers was the location for the settlement of the Viet people. Sine then the wet rice civilization has been established. The Mekong River delta is 36,000 km^2 in area. This is a fertile arable area endowed withfavorable climatic conditions. This region is the largest rice production area of Vietnam.

Vietnam is criss-crossed by thousands of large and small rivers. There is a river mouth on every 20 kilometers of coastline. However, the rivers that run through Vietnam are generally small and short. The major rivers like the Red River and the Mekong River has only their lower section running through Vietnam[1].

3. Role of biodiversity for food and agriculture

Biodiversity for food and agriculture (BFA) is a broad term that includes all components of biological diversity of relevance to food and agriculture, and all components of biological diversity that constitute the agricultural ecosystems, also named agro-ecosystems: the variety and variability of animals, plants and micro-organisms, at the genetic, species and ecosystem levels, which are necessary to sustain key functions of the agro-ecosystem, its structure and processes.

Associated biodiversity: For the scope of this report, associated biodiversity comprises those species of importance to ecosystem function, for example, through pollination, control of plant, animal and aquatic pests, soil formation and health, water provision and quality, etc., including inter alia:

a) Micro-organisms (including bacteria, viruses and protists) and fungi in and aroundproduction systems of importance to use and production such as mycorrhizal fungi, soil microbes, planktonic microbes, and rumen microbes;

b) Invertebrates, including insects, spiders, worms,and all other invertebrates thatare of importance tocrop,animal, fish and forest production in different ways, including as decomposers, pests, pollinators, and predators, in and around production systems;

c) Vertebrates, including amphibians, reptiles, and wild (non-domesticated) birds and mammals, including wildrelatives,of importance to crop, animal, fishand forest production aspests, predators, pollinators or in other ways, in and around production systems;

[1] Embassy of the Socialist Republic of Vietnam in the Kingdom of Sweden, 2014 http://www.vietnamemb.se/en/index.php?option=com_content&view=article&id=68&Itemid=62 (Accessed 4 Dec 2014)

d) Wild and cultivated terrestrial and aquatic plants other than crops and crop wild relatives, in and around production areas such as hedge plants, weeds, and species present inriparian corridors, rivers, lakes and coastal marine waters that contribute indirectly to production.

BFA is essential to both nature and human society in Vietnam. Ecosystems provide habitats for a great variety and number of wildlife. In addition, ecosystems provide a range of services. The 4 main ecosystem services recognized in Vietnam are outlined below:

Provisioning Services: Ecosystems provide direct benefits to humans via providing a range of "provisions" to support society including contributions to the national economy – through provisioning agricultural, forestry and fishery products. Particularly, food security is ensured through agriculture and maintaining breeding livestock; forests provide construction materials and sources of raw and pharmaceutical materials; and the rivers and seas provide fishery products. For example, about 80% of fishery products are harvested from coastal seas and meet nearly 40% of the protein demand of Vietnam's people. Fisheries provide the main source of income for about 8 million people and contribute a portion of the income for about 12 million people[2].

Cultural services: Ecosystems not only provide direct material benefits, but also provide cultural and recreational opportunities for communities, which can motivate people to conserve biodiversity. The ecosystems with charismatic and visible biodiversity provide opportunities to develop the recreational industry of Vietnam, particularly ecotourism that can generate income and increase awareness on the importance of biodiversity and its conservation. About 70% of Vietnam's rapid tourism growth is occurring in the coastal areas and these areas contain natural ecosystems with high biodiversity. Fourteen of the 30 National Parks and Natural Reserves indicated they welcomed 728,000 visitors in 2011 with total revenue of over 30 million VND.

Regulatory Services: Include climate regulation through carbon storage, rainfall control, air and water purification, waste decomposition and contribute to the mitigation of the adverse impacts of natural disasters such as landslides or floods. Carbon stored as plant biomass is the largest carbon stock and is easily impacted by deforestation and degradation. Vietnam's forests are highly valued in terms of carbon storage and sequestration, especially the natural forests. This value is directly proportional to the forest timber volume and biomass[3].

4. Production systems present in Vietnam

Based on the climatic characteristics, the following production systems are recognized in Vietnam. Some areas like Sapa (Lao Cai Province), Da Lat (Lam Dong Province) are sub-climate regions with temperate climate. However, in these regions, the production systems are scattered and at small scale so the temperate production systems are not listed here.

***Table 1**. Production systems present in Vietnam*

Sector	Code	Production system names	Present (Y/N)
Livestock	L1	Livestock grassland-based systems: Tropics	Y
	L2	Livestock grassland-based systems: Subtropics	Y
	L3	Livestock grassland-based systems: Temperate	N
	L4	Livestock grassland-based systems: Boreal and/or highlands	N
	L5	Livestock landless systems: Tropics	Y
	L6	Livestock landless systems: Subtropics	Y
	L7	Livestock landless systems: Temperate	N

[2]Ministry of Natural Resources and Environment, 2011

[3]Vietnam Environment Administration, 2013

Sector	Code	Production system names	Present (Y/N)
	L8	Livestock landless systems: Boreal and/ or highlands	N
Forest	F1	Naturally regenerated forests: Tropics	Y
	F2	Naturally regenerated forests: Subtropics	Y
	F3	Naturally regenerated forests: Temperate	N
	F4	Naturally regenerated forests: Boreal and/or highlands	N
	F5	Planted forests: Tropics	Y
	F6	Planted forests: Subtropics	Y
	F7	Planted forests: Temperate	N
	F8	Planted forests: Boreal and/or highlands	N
Aquaculture and Fisheries	A1	Self-recruiting capture fisheries: Tropics	Y
	A2	Self-recruiting capture fisheries: Subtropics	Y
	A3	Self-recruiting capture fisheries: Temprate	N
	A4	Self-recruiting capture fisheries: Boreal and/or highlands	N
	A5	Culture-based fisheries: Tropics	Y
	A6	Culture-based fisheries: Subtropics	Y
	A7	Culture-based fisheries: Temperate	N
	A8	Culture-based fisheries: Boreal and /or highlands	N
	A9	Fed aquaculture: Tropics	Y
	A10	Fed aquaculture: Subtropics	Y
	A11	Fed aquaculture: Temperate	N
	A12	Fed aquaculture: Boreal and /or highlands	N
	A13	Non-fed aquaculture: Tropics	Y
	A14	Non-fed aquaculture: Subtropics	Y
	A15	Non-fed aquaculture: Temperate	N
	A16	Non-fed aquaculture: Boreal and /or highlands	N
Crops	C1	Irrigated crops (rice) : Tropics	Y
	C2	Irrigated crops (rice) : Subtropics	Y
	C3	Irrigated crops (rice) : Temperate	N
	C4	Irrigated crops (rice) : Boreal and /or highlands	N
	C5	Irrigated crops (other) : Tropics	Y
	C6	Irrigated crops (other) : Subtropics	Y
Crops	C7	Irrigated crops (other) : Temperate	N
	C8	Irrigated crops (other) : Boreal and /or highlands	N
	C9	Rained crops : Tropics	Y
	C10	Rained crops : Subtropics	Y
	C11	Rained crops : Temperate	N

Sector	Code	Production system names	Present (Y/N)
	C12	Rained crops : Boreal and /or highlands	N
Mixed	1	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	Y
	M2	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	Y
	M3	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Temperate	N
	M4	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Boreal and /or highlands	N
Others	O1	Production systems in national parks,	Y

Table 2. *Production systems present in Vietnam*

Code	Production system names	Present (Y/N)	Description
L1	Livestock grassland-based systems: Tropics	Y	
L3	Livestock grassland-based systems: Subtropics	Y	
L5	Livestock landless systems: Tropics	Y	
L7	Livestock landless systems: Subtropics	Y	
F1	Naturally regenerated forests: Tropics	Y	
F3	Naturally regenerated forests: Subtropics	Y	
F5	Planted forests: Tropics	Y	
F7	Planted forests: Temperate	Y	
A1	Self-recruiting capture fisheries: Tropics	Y	
A3	Self-recruiting capture fisheries: Subtropics	Y	
A5	Culture-based fisheries: Tropics	Y	
A7	Culture-based fisheries: Subtropics	Y	
A9	Fed aquaculture: Tropics	Y	
A11	Fed aquaculture: Subtropics	Y	
A13	Non-fed aquaculture: Tropics	Y	
A15	Non-fed aquaculture: Subtropics	Y	
C1	Irrigated crops (rice) : Tropics	Y	
M1	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	Y	
M2	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	Y	

Note: The information is not available

Available information of characteristics of some agricultural production systems in Vietnam

Livestock landless systems:

In Viet Nam ruminant production is based on small households; there are few dairy cattle in largecommercial units. About 90 percent of farm households keep three to five cattle, mainly for draught, which can be sold when they need cash. There is some 10% of semi-commercial ruminant production units with 50 to 100 head in the North East, North West and North Central Coast; specialized cattle fattening is a source of main or additional income where crop production is not remunerative. Ruminant production is classified into dairy cattle, buffaloes and small ruminants

Grazing systems: Before 1995 in hilly land, an area of forest after burning was used for crops such as maize, rainfed rice, and cassava. With no fertilizer use there was rapid exhaustion of soil nutrients. Areas could be used for 2 to 3 years then most remained fallow for 6 months to 1–2 years, even 10–12 years and were used for grazing volunteer vegetation. Cattle, buffaloes, goats and sheep grazed these fields until fertility recovered and farmers could have the next cycle of crops. Other sources of grazing were free in common areas or land around national forests, where feed was available. Since 1995 the forest is being divided for farmers according to Government policy. Grazing is limited to land very far from farm houses inducing a high risk. In intensive farming there is little space to keep livestock and grow improved grasses. Farmers prefer small ruminants to cattle and buffalo; they keep livestock as savings: chickens and pigs are sold to meet daily needs, small ruminants are sold to meet seasonal needs (e.g. school fees, clothing); large ruminants are sold to meet occasional needs (e.g. weddings, building special houses). In intensive crop areas ruminants are kept for draught and saving and are always stall-fed. For improved forage, cut and carry is usual and forage is fed at night as a supplement. Under coconuts, oil palm and rubber stall-feeding or tethering may be used. Free grazing is only done on uncropped land, common land or fallow. In the high mountain areas of the North Northeast and North-Viet Hoang Lien Son there are two feeding systems (i) semi-intensive grazing and (ii) "feeding on the back". In the first, farmers keep their stock at home and cut and carry is used during the rainy season when crops are growing. After harvest ruminants are allowed to graze the fields until the next crop and are housed at night. For the second, animals are penned all the time and farmers feed them during the day. Feed is collected from the field and forests; fodder shrubs and trees have been used to overcome feed shortage. In the North Central highlands where farmers keep big flocks (goats, sheep, cattle), animals graze forest land far from the houses. Children or a man always look after the grazing animals. At night animals are penned within a fence of Cactus, to protect them from wild animals[4].

The pasture resources: Total grassland is 534 100 ha, or 5.7% of all cultivated land, which can be suitable for crops, trees, aquaculture and forestry. The productivity of grasslands has been adversely affected due to their small extent and overgrazing; at present they are producing about 20% of their potential because of poor management. In hilly areas natural grazing is still important for feeding cattle and buffaloes. Depending on cropping patterns from region to region, pastures in Viet Nam are classified as: Natural resources in the high land, almost 70–80% of grasslands are covered with dominant species such as *Digitaria adscendens, Panicum repens, Brachiaria dystachia, Brachiaria mutica, Chloris barbata, Cyperus rotundus, Cynodon dactylon, Axonopus compressus, Eragrostis nigra, Paspalum dilitatum and Panicum coloratum* and shrubs or trees such as *Artocapus heterophyllus, Hibiscus rosa-sinensis, Flemingia* sp. Several plants from rice and maize fields serve as

[4] *Country Pasture/Forage Resource Profile*

forage, the majority them are weeds, and include *Cynodon dactylon, Digitaria* sp. and *Dactyloctenium aegyptium*. Other grasses used as feed are *Imperata cylindrica, Paspalum conjugatum and Cyrtococcum* sp. which grow naturally in orchards and wastelands or idle lots where most of the broadleaf species, such as *Synedrella nodiflora, Pseudoelephantopus spicatus* and *Asystasia gangetica*, are also found. In summer, most land is planted with rice, maize, groundnut, soybean and sweet potatoes. Forage from these crops provides the bulk of fodder for stall-feeding, especially for dairy cows. Urban cattle also feed on vegetable and fruit wastes. Community and government wastelands are used to some extent. Usually milking animals are stall-fed with green fodder and concentrates. Dry and draught animals are maintained on straw, maize stover, and community grazing lands. In winter all farmers sow green maize intercropped with vegetables. According to holding and herd size rice straw provides feed in winter. Other crop residues such as maize grain, maize stalk, cassava leaves, tubers, stalks and sugar cane tops, leaves or stalks are also components of livestock diets.

Natural resources

In the high land, almost 70-80 of grasslands are covered with dominant species such as *Digitaria adscendens, Panicum repens, Brachiaria dystachia, Brachiaria mutica, Chloris barbata, Cyperus rotundus, Cynodon dactylon, Axonopus compressus, Eragrostis nigra, Paspalum dilitatum* and *Panicum coloratum* and shrubs or trees such as *Artocapus heterophyllus*, *Hibiscus rosa-sinensis, Flemingia* sp. Several plants from rice and maize fields serve as forage, the majority them are weeds, and include *Cynodon dactylon, Digitaria* sp. and *Dactyloctenium aegyptium*. Other grasses used as feed are *Imperata cylindrica*, *Paspalum conjugatum* and *Cyrtococcum* sp. which grow naturally in orchards and wastelands or idle lots where most of the broadleaf species, such as *Synedrella nodiflora*, *Pseudo-elephantopus spicatus* and *Asystasia gangetica*, are also found. In summer, most land is planted with rice, maize, groundnut, soybean and sweet potatoes. Forage from these crops provides the bulk of fodder for stall-feeding, especially for dairy cows. Urban cattle also feed on vegetable and fruit wastes. Community and government wastelands are used to some extent. Usually milking animals are stall-fed with green fodder and concentrates. Dry and draught animals are maintained on straw, maize stover, and community grazing lands. In winter all farmers sow green maize intercropped with vegetables. According to holding and herd size rice straw provides feed in winter. Other crop residues such as maize grain, maize stalk, cassava leaves, tubers, stalks and sugar cane tops, leaves or stalks are also components of livestock diets.

Improved pastures

Since the mid nineteen-seventies, a dramatic shift in the paddy growing system took place, from single cropping to two or three crops annually. As a consequence, there is a serious shortage of space and forage for livestock. With the increased demand for milk, meat, and other dairy products, some farmers cultivate large areas of Elephant grass (*Pennisetum purpureum*), *Brachiaria* sp., Guinea grass and maize. Some farmers around such big cities as Ho Chi Minh City plant grass to sell green fodder to farmers raising dairy cows and forage cut-and-carry feeding plays a vital role for dairy goats, cattle and buffalo production. Every farmer allocates a piece of land for fodder crops in irrigated areas if they keep ruminants. Several hundred improved tropical pasture accessions have been introduced and evaluated in different ecological environments over the last 20 years by the National Institute of Animal Husbandry (NIAH), and promising forages have been identified. Ruzi grass (*Brachiaria ruziziensis*), imported in 1991, grows well on grey-soil in the South East region and hilly land of the North of Viet Nam. The cutting cycle of Ruzi grass is quite good at re-growth 40 days with yields of 25

tons dry matter (DM) /ha/year (Duong Quoc Dung, 1995). In high land with low fertility soil *Panicum maximum* Hamil, *Panicum maximum* Likoni, *Pennisetum purpureum* King grass, and *Brachiaria mutica*, have good production records; from 10- 23 tons dry matter/ha/years (Nguyen Ngoc *et al*., 1995). Other promising grasses including Guinea *(Panicum maximum)* and Signal Grass (*Brachiaria decumbens*) which are able to perform in any of the sedentary and alluvial soils in all agro-climatic zones (Table 11). *Brachiaria humidicola* and*Tripsacum andersonii* (Guatemala grass) are important on acid sulphate soil and in areas with a high water table (Dung *et al*., 1999); on all soil, Napier (*Pennisetum purpureum)* is outstanding, *Brachiaria ruziziensis, Panicum maximum* TD58*, Panicum maximum* K280*,* and *Panicum maximum* Likoni have shown vigorous growth in acid soil.

Mixed Rainfed Systems[5]

Fourty percent of the land area in Viet Nam is under mixed rainfed systems, accounting for 128,000 km². The average size of agricultural holdings in Viet Nam is 0.5 ha. Farming households concentrate in the northern (Red river) and southern (Mekong river) delta regions. The densely populated Mekong and Red river delta areas are the rice bowls of the country. Markets are well developed and demand for food products from the bigger cities is high. The rainfed rice-based system is the oldest in the Mekong Delta. Farmers grow either deep-water rice or grow rice only in the rainy season ("rainy season rice system"). But in many cases soil and water conditions make a mixed form most appropriate. In areas with improved in-field canal systems, farmers are able to cultivate an extra crop. The Mekong Delta is not only the main supplier of rice for the whole country, but also of 36 3. Livestock Systems in South Asia and the Mekong Region pigs, ducks, eggs and chicken meat to Ho Chi Minh City Major livestock kept in the region are ducks, water buffaloes and pigs. Common pig breeds are Ba Xuyen and the Thuoc Nhieu. The production is largely dependent on crop by-products and residues and by employing family labor. The northeast and northwest of the country are characterized by mountains, poor transportation facilities and poor market access. The narrow strip along the north central coast, dominated by mountains in the west, shows a tendency for an increase in industrial crops, such as peanuts, coffee and rubber. However, the generally poor area suffers frequently from food deficits. In the Central Highland region of Viet Nam the production of industrial crops, such as coffee and rubber is nowadays common. Water scarcity and deforestation are the main environmental problems affecting livelihoods in this area. The northern mountainous area, is mainly inhabited by ethnic minorities, such as the Tay, Thai, Muong, H'mong, Dao etc. Farming systems are very complex, including paddy-fields, home gardens, free gardens, Swidens (rice and cassava), forest, fish ponds and livestock as key components, hence farmers predominantly rely on smallholder mixed farming, mainly for subsistence. Major livestock species in these very complex systems are buffaloes, cattle, pigs and chicken. Livestock provides manure for crop production and in turn, cattle and buffaloes are grazed on harvested and fallow fields and pigs are fed with cassava, sweet potato leaves, vegetables, maize rice bran etc. Many of the areas suffer from population pressure and resulting deforestation, and land ownership is still undefined in parts, which limits the utilization of land for agricultural purposes. Lack of pasture and market demand in the area put a constraint on the development of buffalo and cattle husbandry.

Mixed irrigated systems

[5] N. Teufel, A. Markemann, B. Kaufmann, A. Valle Zárate and J. Otte. Livestock Production Systems in South Asia and the Greater Mekong Sub-Region, A Quantitative Description of Livestock Production in Bangladesh, Cambodia, India, Lao PDR, Nepal, Pakistan, Sri Lanka, Thailand, and Viet Nam)

In Viet Nam, mixed irrigated systems in sub-humid/humid zones cover between 20 and 25% of each of the country's land area. In Viet Nam, by far the most poor are found in the sub-humid/humid mixed irrigated systems. In the two large delta regions of Viet Nam, namely the Mekong and the Red River delta, irrigation is widespread. The densely populated areas can be considered as the rice bowls of the country. Markets are better developed and demand for food products from the bigger cities is high. In the Mekong Delta, a "horizontal development" of farming systems had taken place, transforming rainfed rice-based systems into irrigated rice-based systems as a result of greater market orientation of farmers, government policies and the construction of irrigation facilities. Multi-cropping involving cash crops and rice has become a common practice with the reduction of farm sizes. It is possible to grow up to three crops per year or even seven crops in two years in areas with favorable soil conditions. The irrigated systems are generally highly diversified, including animal husbandry and non-farm activities.

Main forest ecosystems in Vietnam

Except the mono simple structured forest ecosystem, that occupies small area on the territory such as coniferous forest, mangrove forest, bamboo forest, and plantation forest ecosystem. Majority of tropical forest is mixed forest species, primary or less affected mixed forest species which are very necessary for biological productivity prediction. These ecosystems only distribute in nature reserve areas, national parks, remote and isolated areas, mountainous areas, etc. The following parts describe typical natural ecosystems.

1. Evergreen closed tropical rain forest: Forest ecosystems belong to this vegetation is very diversified, abundant and often distributed in provinces 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, ThuaThien Hue, Quang Nam, Tay Nguyen provinces. Regarding elevation distribution in comparison with sea level, this forest ecosystem is distributed at area of elevation below 700m in the north and less than 1,000 m in the south. This forest ecosystem has storey oriented structure with 5 storeys:

a. Upper storey A1: wood trees with height up to 40 - 50 m, belonging to *Dipterocarpaceae, Moraceae, Leguminosae*, etc.

b. Ecological dominance storey A2: Majority is evergreen species belonging to *Fagaceae, Lauraceae, Caesalpiniaceae, Mimosaceae, Papilionaceae, Sapindaceae, Meliaceae, Magnoliaceae* and *Burseraceae, etc.*

c. Lower storey A3: with height from 8 - 15 m, grew scatteredly under forest canopy and belonging to *Clusiaceae, Ulmaceae, Myristicaceae, Annonaceae, Flacourtiaceae*

d. Bushes storey B: with height from 2 - 8 m, belonging to *Rubiaceae, Apocynaceae, Rutaceae, Annonaceae, Melastomaceae, Araliaceae, Euphorbiaceae,* etc.

e. Climber storey C: with height less than 2m and belonging to *Acanthaceae, Urticaceae, Araceae, Zingiberaceae, Liliaceae* and various fern species, etc.

Vegetation subzones including in this forest ecosystem are as follows:

- Flora of Southern Vietnam – Malaysia and Indonesia with *Dipterocarpaceae* dominance:

Recognizable typical features of this subtype are dominance of *Dipterocarpaceae* in upper storey. Majority of forest trees are evergreen species as *Hopea odorata, Hopea pierrei, Hopea ferrea, Hopea mollissima, Vatica tonkinensis, Vatica fleuryana, Parashorea stallata*. In the south, particularly in

Central highland, typical species are *Dipterocarpus alatus* and *Dipterocarpus turberculatus*. Apart from *Dipterocarpaceae*, there are other evergreen species as Sindora, Ormosia, Cassia, etc; belonging to *Leguminosae* family as Lithocarpus, Castanopsis, Quercus, etc., belonging to *Fabaceae* family as *Syzygium, Eugenia; Myrtaceae* family as *Camellia, Terstoemia, Schima*; *Theaceae* family as Garcinia, Mesua, Calophyllum; *Clusiaceae* family as *Dracotomelum, Bouea*; *Anacardiaceae* family *as Aglaia, Aphanamixis, Dysoxylon, Chisocheton*; and *Meliaceae* family.

Key dominant groups comprise: *Hopea odorata; Hopea pierrei; Parashorea chinensis; Dipterocarpus tonkinensis; Dipterocarpus alatus; Vatica sp.; Anisoptera costata*.

b. Flora of Northern Vietnam – South of China: This subzone is often distributed in low land, in northern part with elevation of less than 700 m above sea level and on Isotherm during the coldest months of 20^0C; in the south, it is distributed in low humid area of less than 1,000m above sea level and in Truong Son mountain range. Main dominant groups include: *Lauraceae; Fagaceae; Meliaceae; Moraceae; Magnoliaceae; Leguminosae; Anacardiaceae; Burseraceae; Sapindaceae; Sapotaceae*, etc..

2. Semi-deciduous closed tropical humid forest

This forest ecosystem is distributed in Quảng Ninh, Bắc Giang, Bắc Kạn, Tuyên Quang, Phú Thọ, Yên Bái, Sơn La, Lai Châu, Thanh Hoá, Nghệ An, Tây Nguyên and south-east region, etc. In comparison with elevation above sea level, this forest ecosystem is often distributed at the elevation of less than 700 m in the north and less than 1,000 m in the south.Forest composition comprises timber trees (A1, A2 and A3) with two typical deciduous species as *Lagerstroemia tomentosa* and *Liquidambar formosana*. In addition, there exists as well other species as *Dipterocarpaceae, Meliaceae, Leguminosae, Datiscaceae, Moraceae, Anacardiaceae, Combretaceae, Lauraceae, Burseraceae, Sapindaceae*, etc. Population height reaches 40m with numbers of species with buttress roots. Various subzones are as follows:

a. Flora sub-zone that is close to flora of Malaysia-Indonesia and flora of India Myanma: This subzone was recorded in Muong Xen, Con Cuong (Nghe An province), with typical species of *Lagerstroemia tomentosa*, which grows in the mixture with *Erythrophoeum fordii, Peltophorum tonkinensis, Madhuca pasquieri. In addition, there are number of other deciduous species as Quercus acutissima, Quercus serrata, Quercus griffithii, Styrax tonkinensis, Melia azedarach, Peltophorum tonkinensis*. Their exists as well population of mono deciduous species as *Lagerstroemia tomentosa* in Con Cuông (Nghệ An), Liquidamba formosana in Huu Lung (Lang Son) and Bien Dong (Bac Giang). Vietnam flora comprises various deciduous speices belong to different families such as *Dipterocarpaceae, Leguminosae, Combretaceae, Datiscaceae, Sterculiaceae, Anacardiaceae,* Xoan *(Meliaceae),* Nhãn *Sapindaceae, Bignoniaceae, Ulmaceae, Moraceae, Verbenaceae*.

b. Flora subzone that is close to indigenous flora of north Vietnam – south China and migrating flora of India - Myanma: This subzonecomprises deciduous species belonging to different families as *Meliaceae, Sapindaceae, Leguminosae, Anacardiaceae, Burseraceae, Verbenaceae*.

3. Evergreen broad leaved forests on limestone

Limestones could be found in 24 provinces and cities but mainly distributed in north and northcentral region. Provinces with limestones are Đien 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. It is possible to divide limestones into the following 5 zones: Cao Bang - Lang Son; Tuyen Quang - Ha Giang; Tay Bac - Tay HoaBinh - Thanh Hoa; North Trường Sơn and islands.

By latitude, this forest ecosystem stretches from Ha Tien to Cao Bang 23^0 N on ward. By elevation, this ecosystem distributed at the elevation from several tens of meters to 1,200 m above the sea level. It has storey oriented structure with rather abundant species composition. It is possible to divide this forest ecosystem according to the following elevations:

3.1. Forests on limestone below 700m

a) Evergreen closed forest on foot of limestone: complex forest structure with 5 storeys:

Upper storey (A1): Tree height of over 40 m belonging different families as Leguminosae or *Combretaceae, Dipterocarpaceae* in addition to some common species as: *Dracontomelum duperreanum, Tetrameles nudiflora, Pometia pinnata, Anogeissus acuminata*.

Ecological dominant storey (A2): including trees with from 20 - 30m height and belonging to different families as: *Fagaceae, Lauraceae, Caesalpiniaceae, Mimosaceae, Fabaceae, Sapindaceae, Magnoliaceae, Meliaceae and various Hopea siamensis, Knema* sp and *Hopea* sp.

Lower storey (A3): including trees below 15m hight and grow scateredly and belong to various families as*Clusiaceae, Ulmaceae, Annonaceae* with many genus: *Hydnocarpus*sp., *Sterculia* sp., *Pterospermum*sp., *Baccaurea ramiflora*and typical species as *Streblus ilicifolius, Streblus macrophyllus,* etc.

Bushes storey (B): including bushes, small trees below 8 m height belonging to various families as *Apocynaceae, Rubiaceae, Melastomataceae, Araliaceae, Euphorbiaceae* and *Acanthaceae*, etc.

Fresh vegetation storey (C): including low plant below 2 m and belonging various families as*Araceae, Acanthaceae, Urticaceae, Zingiberaceae, Begoniaceae, Convallariaceae*, v.v. Other plants include liana of different families *Vitaceae, Fabaceae, Connaraceae* in addition to medlar-trees and parasitic plants of different families as *Orchidaceae, Loranthaceae and Araceae*, etc.

b) Evergreen forests on limestone slopes:

Evergreen forest species in limestone includes *Streblus ilicifolius, Streblus macrophyllus, Clausena lansium, Walsura sp., Arytera sp, Celtis sp., Garcinia fagraeoides, Phoebe sp, Chukrasia tabularis, Drypetes perreticulata, Alphonsea sp., Miliuisa balansae, Glycosmis sp., Diospyros sp., Arenga pinnata, Knema sp., Cleistanthus sumatranus, Polyalthia sp., Vitex sp., Aglaia gigantea, Spondias lakonensis*, etc.

c) Evergreen forests on top of limestone's

Simple forest structure with 1-2 storey comprising trees from 8-15 m height as *Schefflera*spp., *Memecylon* spp., *Sinosideroxylon*sp., *Boniodendron* sp., *Pistasia cucphuongensis*., *Mallotus philippensis*. Low storey plants are bushes as *Melastoma spp., Syzygium* spp. and fresh vegetation as *Dryopteris spp., Colysis cucphuongensis, Tectaria spp., Selaginella spp., Alpinia spp, Begonia spp., Impatiens spp., Kalanchoe*sp. In comparison with other species belonging to families of *Orchidaceae, Loranthus spp., Jasminum sp., Coccinia grandis, Hodgsonia macrocarpa*, etc.

3.2. Forests on limestones with elevation of 700 – 1000m

Limestones area is at elevation of over 700m, mainly distributed in the north, particularly north-east, including Cao Bang, Ha Giang, Lang Son, etc. Besides, there are some scattered limestones in north-central region along Viet-Lao border as: Pu Xai, Lai Leng, Pù Hoat, Pu Huong, Xuan Lien. Main forest types include:

a) Evergreen broad leaved forests on valley and foots of limestone:

Common species include *Aglaia* sp.,*Dipterocarpus retusus, Shorea chinensis, Vatica diospyroides, Quercus spp., Lithocarpus spp., Michelia sp., Manglietia sp. and Litsea spp, Cryptoccarya spp., Machilus s*pp. In the 1 st storey, there are *Dipspyros* spp, *Engelhardtia* sp., *Bischofia javanica*, *Cipadessa baccifera, Hydnocarpus clemensorum, Pterospermum sp., Celti cinamomea, Eriobotrya poilanei, Cinnamomum bonii, Toona sinensis, Koelreuteria*sp. In the 2nd storey, there are *Diospyros spp., Gironniera subaequalis, Polyalthia sp. and Clausena* spp.

b) Evergreen broad leaved limestone forest:

Common species are Burretiodendron, with diameter from 70 - 80 cm*, Garcinia sp., Marchantia sp., Pterospermum heterophyllum, Syzygium spp, Diospyros sp., Phoebe sp, Polyalthia sp, Alangium chinense*.

c) Mixed broad and needle leaved forests on top of limestone

Common species are *Ficus sp., Syzygium spp, Schefflera octophylla, Juglans sp., Ulmus sp., Pittosporum sp., Schefflera halongensis*. Apart from the above mentioned broad leaves as *Cycas spp., Cupressus torulosa, Dacrydium elatum, Nageia fleuryi, Podocarpus pilgeri, Pinus kwangtungensis, Keteleeria davidiana var. davaniana, Amentotaxus hatuyenensis, Amentotaxus yunnanensis, Taxus chinensis, Pseudotsuga chinensis, Xanthocyparis vietnamensis*. Common species in low storey are *Pistacia weimanifolia, Calophyllum bonii, Clausena indica, Dracaena cambodiana, Laportea sp., Begonia sp., Mahonia nepalensis, Setaria palmifolia*, etc.

d) Short broad leaved forest on top of limestone

One storey forest composition with small timber trees of 6-10 m height, typical species are as follows *Cycas spp., Pseudotsuga chinensis, P. brevifolia, Tsuga chinensis, Illicium griffithii, Schefflera spp, Quercus spp., Lithocarpus spp., Ternstroemia japonica, Pistacia weimanifolia, Ericaceae as: Rhododendron spp., Vaccinium dunalianum* and *Cinnamomum sp., Jasminum lanceolarium, Tirpitrzia sinensis*, etc.

4. Natural needle leaved forests

Needle leaved forest ecosystem comprises 2 types: oLwland sub-tropical needle leaved forest, which mainly distribute in mountainous areas as Yen Chau, Moc Chau (Son La), Nghe An, Ha Giang, Da Lat (Lam Dong), etc and temperate highland needle leaved forest mainly distribute in Sa Pa (Lao Cai), Tuan Giao (Lai Chau) Ha Giang, Tay Con Linh (Cao Bang), Chu Yang Sinh (Nam Trung bo), Lam Dong, etc. Natural needle leaved forest ecosystems include:

a) Lowland sub-tropical needle leaved forest

In the south, main timber species are Pinus merkusii, Pinus kesiya that grow alternatively with *Dipterocarpus* obtusifolius. In the north, typical species are *Keteleeria davidiana, Pinus merkusii*. There are 2 subtypes of this ecosystem:

Sub-zone that is close to India – Myanma flora: in the south, typical species are natural *Pinus merkusii* growing alternatively with *Dipterocarpus obtusifolius, Lithocarpus harmandii, Michelia bailonii*, etc. Low bushes include species, as *Vaccinium chevalierri and Schima crenata* meanwhile fresh vegetation comprise *Dicranopteris linearis, Nephrolepis hirsuta*, etc.

In the north, there are some species as *Erythrophoeum fordii Olive, Castanopsis* t*ribuloides,* Re *(Cinnamomun* sp) in Quảng Yên (Quảng Ninh). Bushes include: *Vaccinium chevalierri, Wendlandtis glabrata.*

Subzone that is close to Himalaya - Van Nam - Quí Châu flora: with typical species as *Pinus kesiya* that grow alternatively with *Quercus helferiana, Lithocarpus dealbata, Lithocarpus pynostachya*, etc. Besides, there are also some species of *Ericaceae* family.

In high moutainous area of Moc Chau (Son La), Thuan Chau (Lai Chau), etc, there are *Keteleeria davidiana,* which is dominant on upper storey together with some species as *Quercus griffthii*, Quercus serrata, Quercus acutissima and other species of *Lauraceae* family.

b) Temperate needle leaved forests on medium mountains:

Within this belt, there exists mono species needle leaved forest as *Fokienia hodginsii, Cunninghamia lanceolata, Podocarpus imbricatus*. In alternative with *Fokienia hodginsii*, there are also *Ducampopimus krempfii, Pinus dalatnensis*. Besides, in high mountainous tropical belt belonging to Panxipang mountain – at the elevation from 2,400 – 2,900 m and over 2,600 m, there exist *Tsuga yunnanensis* and *Abies pindrow* respectively. Sub-type of this ecosystem is the flora subzone that is close to the North Vietnam-South China flora. This subtype is found in Muong Phang at the height of 1,335 m above sea level with 3 dominant storey as alocedrus macrolepis at the height up to 35m, grow alternatively with Actinodaphne sinensis, Phoebe sp, Litsea baviensis etc. belonging to Lauraceae family and Castanopsis hickelii belonging to Fagaceae family. Storey A2 is at the height from 10 -20 m, including some species of *Lauraceae, Sapindaceae, Myristicaceae and Ulmaceae* family. Storey B comprises some species as Blastus sp, *Pinanga baviensis*), Lasianthus sp, *Gymnosphoera podophylla* and *Arundinaria* sp.

5. Dry dipterocarp forest

Dipterocarp forest distribution concentrated in the provinces of Dak Lak, Gia Lai. There is also at Di Linh (Lam Dong) and small clusters distributed dipterocarp forest in Ninh Thuan, Binh Thuan, Song Be, Tay Ninh. Regarding latitude, dipterocarp forest distributed from latitude 14^0N (Gia Lai) to latitude 11^0North (Tay Ninh). Dry dipterocarp forest distributes intensively at the height from 400 to 800m above sea level. Dipterocarp forest flora associated flora Malaysia - Indonesia with dominant species of *Dipterocarpaceae* family of 204 genus, 68 families, of which over 90 timber species with 54 large and medium timber species.

Other dominant dipterocarpus species include: *Xylia xylocarpa* of *Mimosaceae* family, *Dilleniahe terosepala* of *Dilleniaceae* family, *Vitex pendencularia* of *Verbenaceae* family, *Buchanania arborescens* of *Anacardiaceae* family, etc. On good conditions, there exist as well some valuable species as *Pterocarpus macrocarpus*, *Dalbergia bariensis*, etc. The following part introduces popular Dipterocarpus dominance.

Shorea siamensis dominance: Shorea siamensis grow in mixture with other 2 common species as *Dipterocarpus tuberculatus* and *Pterocarpus macrocarpus*. In addition, there exist as well other species as *Shorea obtusa*, *Nauclea* spp., *Lagestroemia* spp., etc.

Shorea obtuse dominance: *Shorea obtuse* account 50% of the entire population.

Dipterocarpus tuberculatus dominance: 3 common species grow alternatively with *Dipterocarpus tuberculatus* are *Shorea siamensis*, *Shorea obtusa*, of which *Dipterocarpus tuberculatus* and *Shorea siamensis* largely contribute to forest volume.

Dipterocarpus obtusifolius dominance: This dominance distributes intensively on areas from 600 - 900 m above sea level in Dak Lak, Gia Lai and Lam Dong provinces

6. Mangrove forests

Mangrove forest ecosystem distribute along Vietnam coastal line in 28 provinces and cities. Phan Nguyên Hồng (1999) divided mangrove forest in Vietnam into 4 zones with 12 subzones and at the same time identified ecological conditions for each zone: zone I – north east coastal; zone II – northern coastal; zone III – coastal area in central region from Lach Truong cape to Vung Tau cape; zone IV – coastal area from Vũng Tàu to Nãi, Hà Tiên cape (eastern coastal of Ca Mau peninsula).This ecosystem represents salt demanding species as *Rhizophora apiculata, R. Mucronata, Brugyeria parviflora, B. Gymnorhiza, Kandelia ovata* that are belonging to *Rhizophoraceae* family; *Avicennia marina, A. Alba, A. Oficinalis of Avicenniaceae* family; *Sonneratia alba, S. Caseolaris* of *Sonneratiaceae* family; *Phoenix paludosa* of *Palmae* family.

7. *Melaleuca cajuputi*

This ecosystem distributes in 7 Mekong delta provinces, forming the following 3 region: i) Thap Muoi detla stretches over territory of the 3 provinces: Long An, Tien Giang and Dong Thap; ii) Long Xuyen quadrangular that shares territory of An Giang and Kien Giang province; and iii) U Minh Thuong, U Minh Ha in Ca Mau and Kien Giang province. Previously, scientific name of Melaleuca was defined as *Melaleuca eucodendron*. In 1993, this scientific name was redefined as *Melaleuca cajuputi* (Scott Poynton, 1993). Melaleuca species in Vietnam has at least 4 varieties as Malaleuca population and communities that distribute naturally on acid soil in Mekong delta meanwhile some Malaleuca population distribute naturally in Quang Binh, Quang Tri and Thua Thien Hue. As Melaleuca forest ecosystem established under typical alum inundated environment, only some species could adapt and survive to this habitat. As the results, forest composition is much simple incomparison with evergreen mixed forest ecosystem.

8. Bamboo forest

Bamboo and rattan is common name for all plants of Bambusoidae, Gramineae or Poaceae. Bamboo and rattan widely distribute from tropical, sub-tropical to temperate, from latitude 51^0 N to 47^0 S. Worldwide, there are about 1,3000 species of over 70 genus, distributed in 3 main regions: Asia Pacific, Americas and Africa, of which the Asia Pacific region is seen as the bamboo distribution centre, which accounts to 80% of the total species and area worldwide. Vietnam is one of the bamboo distributis worldwide.There are 133 species of 24 genus. Bamboo and rattan ecosystem in Vietnam comprises the following ecosystem:

Dendrocalamus barbatus: Scientifc name is *Dendrocalamus barbatus* Hsueh et Li. Previously, it was called *Dendrocalamus membranaceus*. *Dendrocalamus barbatus* is widely distributed in many provinces as Thanh Hoá, Nghệ An, Hà Tĩnh, Sơn La, v.v, and mostly focused in Thanh Hoá. Natural *Dendrocalamus barbatus* is found along Ma river, Son La province and the remaining area is plantation *Dendrocalamus membranaceus*.

Acidosasa and Indosasa: Acidosasa and Indosasa is common name for some scattered bamboo species belonging to Acidosasa and Indosasa genus, including some main species as: Indosasa sp., Indosasa amabilis, Acidosasa sp., Acidosasa sp., etc. Among all the Acidosasa and Indosasa in Vietnam, Acidosasa sp has the most significant meaning thanks to large and intensive distribution area with high dimension and economic value. As such, this part will introduce on Acidosasa and Indosasa.

Acidosasa and Indosasa distribute largely in some provinces as Lào Cai, Yên Bái, Hà Giang, Tuyen Quang, Bac Kan, Phu Tho, Thai Nguyen, Lang Son, Quang Ninh, Son La, Hoa Binh, Thanh Hoa, etc.

Neohouzeaua forest: Neohouzeaua is a common name for some group growing species that belong to Schizostachyum genus. Previously, it was included in Neohouzeaua genus, of which *Schizostachyum funghomii* and *Schizostachyum pseudolima* have high economic value and distribute largely all over the country. *Schizostachyum pseudolimadistributes* largely in the whole country but intensively focus in the central north and north central region.

Bambusa balcoa: *Bambusa balcoa* has many different names and currently, it could be called *Bambusa balcoa* Roxb. *Bambusa balcoa* distributes largely in south-central, central highland and south east region and mostly focuses in south east region, particularly Binh Phuoc province[6]

Fisheries and aquaculture

Vietnam has more than one million km^2 of fishery area. Apart from the exploited area at sea, there is also a great deal of area for raising fresh water fish together with welloff raising area in Mekong river delta and midland region. Exploiting regions are allocated as follows:

• Highland and northern mountainous region raises and exploits fishery products species of subtropical and temperate climate. Area of water reservoirs, natural lakes, small ponds and lakes are suitable for extensive, semi-intensive and raft raised in the rivers.

• Red river delta region raises and exploits brackish water fishery products. Potential aquaculture in tide area is about 58,800 hectares which is equal to 9.54% of natural area the whole region and domestic fresh water area of 126,500 hectares which is equal to 8.48% area of the whole region. Besides, there is also 39,700 hectares of closed gulfs along the coastline

• Area for aquaculture in the Northern central region is not large. Tide area is about 52,000 hectares (in which there are 18,500 small ponds and lakes, 24,500 large water surfaces, 24,700 low-lying fields), area of lagoon is 37,600 hectares.

• Aquaculture area in the coastal southern central region is 43,000 hectares. Tide area accounts for only 1% natural area of the whole region and more than 22,000 hectares of airtight channel with high degree of salting which is suitable for different scales and methods of raise. Area of fresh water is inconsiderable about 18,000 hectares.

• Area of small ponds and lakes in the central highland is about 2,600 hectares.

• The southeast region has the advantage of raising and exploiting fishery products of fresh, salt and brackish water. Potential area for aquaculture is more than 19,000 hectares. Besides, there is

[6]Vu Tan Phuong, 2011. Forest ecological stratification in Vietnam
http://vietnamredd.org/Upload/Download/File/Final_submited_Forest_ecological_stratification_After_Aki_comment_E_VTP_13102011_2240.pdf

approximately 11,000 hectares of gulf for aquaculture at sea. Aquaculture area in this region is about 78,500 hectares which is mainly water surface of 83,000 hectares.

• Mekong river delta is suitable for raising shrimp due to the characteristic of geological composition with salinity area accounting for 46.15% area of the whole region. Area for fresh water aquaculture accounts for more than 400,000 hectares[7].

The fisheries sector in Vietnam can be divided in three main sub-sectors; the marine, the inland and the aquaculture sub-sector. The recreational fisheries sector is still not developed except from the production of ornamental fish. Marine fisheries are the biggest contributor to the fisheries production, followed by aquaculture.

Marine sub-sector

Catch profile

Viet Nam has a coastline of 3 260 km that crosses 13 latitudes, from 8°23'N to 21°39'N. There are four main fishing areas: Gulf of Tonkin, shared with China; Central Vietnam; South-eastern Vietnam; and South-western Vietnam (part of Gulf of Thailand), shared with Cambodia and Thailand. Marine catches are highest in Central and Southeast Vietnam. The Mekong river delta provides over 75% of the total marine landings and therefore most of the fishing industry is concentrated in the southern provinces, from Khanh Hoa to Ca Mau.

Apart from these geographical zones the fishing areas can be divided in inshore-coastal fishery and offshore fishery. Inshore waters are considered the waters of less than 30 m deep in the Tonkin Gulf and the South and less than 50 m deep in the centre of Vietnam.

Aquaculture sub-sector (FAO, 2005)

The aquaculture sector can be divided in marine, brackish and freshwater aquaculture. The total aquaculture area in 2003 was 902 229 hectares; 575 137 hectares (63.7%) for marine and brackish water and 327 092 hectares (36.3%) of freshwater aquaculture.

Marine aquaculture

In comparison with other countries in the region, sea fish farming is still not much developed in Vietnam. However fisheries based aquaculture, which is based on catching young wild fish (mostly by hook and line) and raising it in cages to commercial size, is more and more practiced. One of the difficulties of farming sea fish species is the problem of reproduction. Unlike fresh water species, the artificial reproduction techniques for sea fish are still not well developed. Methods of marine aquaculture include cage farming of groupers and cobia, float-raising of lobsters, oyster raising for pearl, marine fish raising in ponds and mollusc raising. In 1995 there were 600 cages throughout the country, in 2003, the total number was 40,159 (excluding cages for oyster raising).

Brackish aquaculture

Vietnam has huge potential of coastal aquaculture with shrimp culture being dominant. The farming system of brackish water culture can be divided into traditional extensive, improved extensive, semi-intensive and intensive culture. The cultured species are; shrimp, mud crab, bivalve and artemia. Brackish-water shrimp (*Penaeus* species) is the main species raised along the coast. The total area used for brackish-water shrimp culture in 2003 was 546,757 hectares, an increase of 14.2% compared to 2002.

The coastal provinces in south of Vietnam are producing most of the shrimp using 476,582 ha (87%) followed by 41,372 ha (8%) in the Northern provinces and 28,803 ha (5%) in central Vietnam.

[7]FAO, 2005. Overrall fisheries of Vietnam

The enormous increase of the brackish-water aquaculture has some negative impacts as the silting of the inland area as the aquaculture areas are up to 10 km inland and the reduction of the mangrove area.

Freshwater aquaculture

Freshwater production environments include ponds, ditches, cages, net enclosures and pens in reservoirs, lakes, rivers and channels, and paddy fields. In the North, pond poly culture is the most important farming system and commonly stocked with Chinese carps (silver carp, grass carp and bighead). The main freshwater aquaculture production takes place in the south of Vietnam, especially the cage culture in the Mekong and Bassac rivers. Cage culture of catfish 'Basa', 'Tra', common carp, Indian major carps (rohu, mrigal) and snakehead are mainly carried out in the bordering to Cambodia. The culture of prawn by monoculture system in rice fields is extensively practiced in the Mekong Delta.

In recent years, red tilapia is cultured in ponds by using intensive monoculture system while giant prawn is cultured in ponds and ditches using a semi-intensive system. In addition, an integrated VAC system (V: garden, A: fish pond, C: livestock) is also common in the country.

Rice production in Vietnam is divided into two agro-ecosystems: irrigated and rainfed areas. In the irrigated area there are 4 major rice cultivation systems, i.e. 3 rice crops per year, 2 rice crops + 1 upland crop and 2 rice crops, 2 rice crops + fish/shrimp cultivation. In the rainfed areas four different systems of rice production have been practiced: single traditional rice (transplanting rice crop), single medium rice crop of high yield varieties with 110- 140 days of growing crop, 2 rice crops (1 traditional crop + 1 medium rice) and 1 rice + fish/shrimp.

Map of production systems in Vietnam (Not available)

There is not enough information and data to fulfill table 3

***Table 3**. Area under production, production quantity and contribution to the agricultural sector economy for production systems in the Vietnam*

Code	Production system names	Area	Production-quantity	Contribution to the agriculture sector economy	Ref. years
L1	Livestock grassland-based systems: Tropics	42.735 (ha)	NA		2013
L3	Livestock grassland-based systems: Subtropics	NA			
L5	Livestock landless systems: Tropics	scattle			
L7	Livestock landless systems: Subtropics	NA			
F1	Naturally regenerated forests: Tropics	276 ha			
F3	Naturally regenerated forests: Subtropics	NA			
F5	Planted forests: Tropics	2.050.904 (ha)			2013
F7	Planted forests: Subtropics	NA			

Code	Production system names	Area	Production-quantity	Contribution to the agriculture sector economy	Ref. years
A1	Self-recruiting capture fisheries: Tropics	NA			
A3	Self-recruiting capture fisheries: Subtropics	NA			
A5	Culture-based fisheries: Tropics	699.132 (ha)	3.215,9 (ton)		2013
A7	Culture-based fisheries: Subtropics	NA			
A9	Fed aquaculture: Tropics	NA			
A11	Fed aquaculture: Subtropics	NA			
A13	Non-fed aquaculture: Tropics	NA			
A15	Non-fed aquaculture: Subtropics	NA			
C1	Irrigated crops (rice) : Tropics	3.265.916 (ha)	18.200 (ton)		2013
1	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Tropics	NA			
M2	Mixed systems (livestock, crop, forest and /or aquatic and fisheries): Subtropics	NA			

CHAPTER II. DRIVERS OF CHANGE

5. Effects of drivers of change on associated biodiversity

a. The most important drivers affecting the extension and distribution of associated biodiversity

For the extension and distribution of associated biodiversity, policies of the government are the most influential driver. They can have both direct and indirect impacts. The policies to establish protected areas, national parks, reforestation and agricultural extension programs have positive impacts on extension and distribution of associated biodiversity while some policies, particularly ones for economic development often limit the extension and distribution of associated biodiversity. For example, the policies for the conversion of naturally forested land and wetlands for agriculture, industrial plantations and aquaculture, coupled with urbanization and infrastructure development has led to the loss or fragmentation of ecosystems and natural habitats, and contributed to the degradation and loss of biodiversity. The conversion of poor forest to rubber plantation has significantly reduced the area of dipterocarp forests (semi-deciduous forests in the Central Highlands) and other natural forests throughout the country. For instance, in 2008, the Government agreed to convert 150,000 hectares of degraded forest to rubber plantations in Central Highland. To date, Dak Lak Province has converted a total of about 69,557 ha of forest to rubber plantation, of which 53,122 hectares was dipterocarp forest; Gia Lai Province converted 51,000 ha, and Binh Phuoc Province converted about 42,000 ha. Since 2008, about 100,000 hectares of dipterocarp forest in the Central Highlands has been converted, representing the disappearance of a once typical ecosystem[8]. Furthermore, surveys indicated the main cause of mangrove forest loss is due to conversion of mangroves into shrimp ponds. The vast natural tidal estuaries of the Northern and Southern deltas have also dwindled in size due to conversion of land into clam ponds. Recently, a significant water surface area in Ha Long Bay and Bai Tu Long Bay (Quang Ninh province) was used to develop cage aquaculture. These aquaculture practices are one of the causes of water degradation, loss of coral reef and sea grass ecosystems.

One of the outstanding successes of the policies is the conversion of Dong Thap Muoi area (in the south) from a huge uncultivated and alum swamp into a vast field of rice with over 2.7 million tonnes annually. However, Dong Thap Muoi area with natural characteristics of alum marsh ecosystem with ancient plant communities such as melaleuca, lotus, and the wildlife in it with basic functions as water storage, groundwater recharge and reducing the impact of floods. This area is shrunk to move into rice field ecosystems to function primarily as the food supply but not high in biodiversity attributes anymore. That has narrowed the habitat of many native aquatic species, particularly species in the "black fish" (*Channidae*, *Anabantidae*, *Claridae*, *Sybranchydae*, *Notopteridae*) is a group of native fish[9].

In addition, policies to promote new crop varieties and livestock breeds with high yields have caused the loss of many traditional cultivars which have many good characteristics and adapted very well to the local conditions. The introduction of new plant varieties, particularly in agriculture, especially hybrid varieties with high productivity, has led to a decrease in both the planted area and genetic diversity of native crop varieties. This introduction has depleted native and traditional genetic resources, and has resulted in the loss of several traditional agricultural plant gene varieties[4].

The policies for construction of dams, reservoirs, roads and other infrastructures has directly caused the degradation and fragmentation of ecosystems, creating barriers to the migration of species and loss of natural habitats, resulting in harmful and long-term impacts on the survival of wildlife populations. In relation to hydropower projects, by 2010 over 1,020 hydropower projects (total capacity of 24,246 MW) were planned throughout the country, of these planned projects 138 projects are planned to be built on the mainstream of the main rivers by the Ministry of Industry and

[8] Vietnam's fifth National report to the United Nations Convention on Biological Diversity, Reporting period: 2009-2013 (2014), MONRE 2011

[9] Reasons for erosion of biodiversity of Vietnam, BIODIVN 2014

Trade. Hydropower development is essential for the socio-economic development of Vietnam. However, from an ecology and biodiversity conservation perspective, research suggests the construction and operation of dams and reservoirs have very large downstream impacts including: (i) changes in habitat type along and within the river-streams system including river sand, riverbeds and riparian vegetation. This will change the community structure and populations of aquatic species; (ii) changes in lifecycles and growth stages of aquatic life such as reproduction, feeding, in response to habitat change; (iii) physical barriers created for many aquatic species, particularly distant migratory species (sea-land), or species moving along river, and (iv) changes in flow may create favorable conditions for the introduction and spread of alien species into riverine systems. The construction of reservoirs results in the cutting of natural forests, and also prevents fish migration by impounding natural river stream flow. Some hydroelectric dams that have operated outside permitted procedures (violations) have caused damage to people and property and downstream ecosystems through periodic water releases. The development of infrastructure that contributes to an increase in population and/or migration into an area is also the cause of biodiversity degradation[4].

b. The effects of climate change on associated biodiversity

Vietnam is one of the countries in the world predicted to be the most affected by climate change. Under current climate change scenarios, Vietnam is predicted to have fragmented ecosystems that will undergo a high rate of loss of biological diversity resources compounding its vulnerability to climate change.

According to the Institute of Hydrometeorology and Environment under MONRE, at the end of this century, the average temperature in Vietnam will have increased by about 2.3^0 C. The total wet season rainfall and the total annual rainfall will increase however the total dry season rainfall will decrease. Projections for a rise in sea levels are between 75cm to 1 m compared with the average level of the 1980-1999 period. As a result of this increased level it is estimated approximately about 20-38% of the area of the Mekong Delta and about 11% of Red River Delta would be inundated, and 78 important natural habitats (27%), 46 PAs (33%), 9 areas of national and international importance for biodiversity conservation (23%) and other 23 high value of biodiversity areas (21%) would be seriously affected[10].

Climate change affects associated biodiversity in different ways: Sea level rise can make the existing mangrove forests shrunken, which in turn has negative effects on indigo forest and forests planted on acid contaminated land in Southern provinces. *Dipterocarpaceae* can move northward and upward to the higher belts while deciduous forests with high percentage of drought-resistant trees are growing strongly. In addition, high temperature combined with rich sunlight may boost photosynthesis, thus enhance tree assimilation process. However, the growth rate of forest plants, in terms of biomass, could be reduced due to lower humidity. Plants and animals are at higher risk of extinction, particularly some valuable species. Increase of temperature and drought may cause forest fire, pests outspread and diseases, etc. In aquaculture, sea level rise and salt-water intrusion could result in the followings: salt water reaches further upstream therefore progressively damaging the habitat of some fresh water creatures. Existing mangrove forests are getting shrunken, thus interfere the ecosystem of some marine species. The ability to sustain organic matter of seaweeds would be weakened and in return, this would result in a reduced supply of those products needed for photosynthesis and nutrients for benthos. Therefore, the habitat of many marine species would be degraded. Distinctly different temperature layers in still waters, thus, directly affect the habitat of marine creatures. Some species would be forced to move to the Northwards or to deeper water, causing a shift in depth-wise pattern of marine creatures. Shorter photosynthesis and faster decomposition of organic substances will affect the food sources for marine creatures. Consequently, they would spend more energy for respiratory process and other associated living activities, and productivity and quality of marine products will eventually be degraded. Coral reefs would be

[10] Vietnam's National Biodiversity Report, MONRE 2011

degraded and destructed, and physiological and biochemistry processes under the interactive relation between coral reefs and seaweeds would be alternated. High intensity rainfall would lower sea water salinity in certain period of time, resulting in mass death of brackish water and coastal creatures, particularly Malocology (shell and oyster) since they cannot adapt to the change in salinity.

Effects of drivers of change on biodiversity for food and agriculture

The production systems of Vietnam listed in chapter 1 are mostly scattered and at small scale. There is not enough data/information because the detail surveys about these systems have not officialy carried out. Therefore, for table 4, the production systems are put into larger groups.

In this section, the production systems are not divided according to climatic characteristics (tropic and subtropic)

Table 4. Effect of drivers on sector biodiversity within production systems in the country by animal (AnGR), plant (PGR), aquatic (AqGR) and forest (FGR) genetic resource

Production Systems	**Drivers**	**Effect of drivers on sector biodiversity for food and agriculture** (2, 1, 0,-1, -2, NK, NA)			
Code or name		PGR	FGR	AnGR	AqGR
Naturally regenerated forests	Changes in land and water use and management	NA	-2	-2	-1
	Pollution and external inputs	-1	-1	-1	-2
	Over-exploitation and overharvesting	-1	-2	-2	-2
	Climate change	-NA	-1	-1	-1
	Natural disasters	-1	-1	-1	-1
	Pests, diseases, alien invasive species	-1	-1	NK	-1
	Markets, trade and the private sector	0	-1	-1	-1
	Policies	NA	NA	NA	NA
	Population growth and urbanization	-1	-2	-2	-2
	Changing economic, socio-political, and cultural factors	NK	1	NK	NK
	Advancements and innovations in science and technology	1	1	1	1
Planted forests	Changes in land and water use and management	1	-2	-1	1
	Pollution and external inputs	-1	-1	-1	-1
	Over-exploitation and overharvesting	-1	-2	-2	-2
	Climate change	-1	-1	-1	-1
	Natural disasters	-1	-1	-1	-1
	Pests, diseases, alien invasive species	-1	-1	-1	-1
	Markets, trade and the private sector	-1	-1	-1	-1
	Policies	NA	NA	NA	NA
	Population growth and urbanization	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	NK	NK	NK	NK
	Advancements and innovations in science and technology	NA	NA	NA	NA
Livestock grassland-	Changes in land and water use and management	-1	-1	-1	-1

Production Systems	**Drivers**	**Effect of drivers on sector biodiversity for food and agriculture** (2, 1, 0,-1, -2, NK, NA)			
Code or name		PGR	FGR	AnGR	AqGR
based systems	Pollution and external inputs	-1	-1	-2	-1
	Over-exploitation and overharvesting	-2	-2	-1	-2
	Climate change	-1	-1	-2	-1
	Natural disasters	-1	-1	-2	-1
	Pests, diseases, alien invasive species	-1	-1	-2	-2
	Markets, trade and the private sector	0	0	2	0
	Policies	-1	-1	2	-1
	Population growth and urbanization	-1	-1	2	-1
	Changing economic, socio-political, and cultural factors	0	0	2	0
	Advancements and innovations in science and technology	0	0	2	0
Livestock landless-based systems	Changes in land and water use and management	1	1	2	1
	Pollution and external inputs	-1	-1	-1	-1
	Over-exploitation and overharvesting	-2	-2	0	-2
	Climate change	-1	-1	-1	-1
	Natural disasters	-1	-1	-2	-1
	Pests, diseases, alien invasive species	0	0	-1	0
	Markets, trade and the private sector	0	0	2	0
	Policies	1	1	2	1
	Population growth and urbanization	-1	-1	2	-1
	Changing economic, socio-political, and cultural factors	-2	-2	2	-2
	Advancements and innovations in science and technology	0	0	2	0
Self-recruiting capture fisheries	Changes in land and water use and management	1	1	1	1
	Pollution and external inputs	-1	-1	-1	-2
	Over-exploitation and overharvesting	-2	-2	-2	-2
	Climate change	-1	-1	-1	-1
	Natural disasters	-1	-1	-1	-1
	Pests, diseases, alien invasive species	0	0	0	-1
	Markets, trade and the private sector	0	0	0	2
	Policies	1	1	1	2
	Population growth and urbanization	-1	-1	-1	2
	Changing economic, socio-political, and cultural factors	-2	-2	-2	2
	Advancements and innovations in science and technology	0	0	0	2

Production Systems	**Drivers**	**Effect of drivers on sector biodiversity for food and agriculture** (2, 1, 0,-1, -2, NK, NA)			
Code or name		PGR	FGR	AnGR	AqGR
	Other				
Culture based fisheries and fed aquaculture	Changes in land and water use and management	1	1	1	2
	Pollution and external inputs	-1	-1	-1	-2
	Over-exploitation and overharvesting	-2	-2	-2	0
	Climate change	-1	-1	-1	-2
	Natural disasters	-1	-1	-1	-2
	Pests, diseases, alien invasive species	0	0	0	-2
	Markets, trade and the private sector	0	0	0	2
	Policies	1	1	1	2
	Population growth and urbanization	-1	-1	-1	2
	Changing economic, socio-political, and cultural factors	-2	-2	-2	2
	Advancements and innovations in science and technology	0	0	0	2
	Other				
Semi intensive fish culture	Changes in land and water use and management	1	1	1	1
	Pollution and external inputs	-1	-1	-1	-1
	Over-exploitation and overharvesting	-2	-2	-2	-2
	Climate change	-1	-1	-1	-1
	Natural disasters	-1	-1	-1	-1
	Pests, diseases, alien invasive species	0	0	0	-1
	Markets, trade and the private sector	0	0	0	0
	Policies	1	1	1	1
	Population growth and urbanization	-1	-1	-1	-1
	Changing economic, socio-political, and cultural factors	-2	-2	-2	-2
	Advancements and innovations in science and technology	0	0	0	0
	Other				
Irrigated crop	Changes in land and water use and management	2	1	1	1
	Pollution and external inputs	-2	-1	-1	-1
	Over-exploitation and overharvesting	0	-2	-2	-2
	Climate change	-2	-1	-1	-1
	Natural disasters	-2	-1	-1	-1
	Pests, diseases, alien invasive species	-2	0	0	0
	Markets, trade and the private sector	2	0	0	0
	Policies	2	1	1	1
	Population growth and urbanization	2	-1	-1	-1
	Changing economic, socio-political, and cultural factors	2	-2	-2	-2

Production Systems	**Drivers**	**Effect of drivers on sector biodiversity for food and agriculture** (2, 1, 0,-1, -2, NK, NA)			
Code or name		PGR	FGR	AnGR	AqGR
	Advancements and innovations in science and technology	2	0	0	0
	Other				
Rainfed Crop	Changes in land and water use and management	-1	-1	-1	-1
	Pollution and external inputs	-1	-1	-1	-1
	Over-exploitation and overharvesting	0	0	0	0
	Climate change	-1	-1	-1	-1
	Natural disasters	-1	-1	-1	-1
	Pests, diseases, alien invasive species	-1	0	0	0
	Markets, trade and the private sector	2	0	0	0
	Policies	NA	NA	NA	NA
	Population growth and urbanization	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	-1	-1	-1	-1
	Advancements and innovations in science and technology	NA	NA	NA	NA
	Other				
Mixed	Changes in land and water use and management	-2	-2	-2	-2
	Pollution and external inputs	-2	-2	-2	-2
	Over-exploitation and overharvesting	-2	-2	-2	-2
	Climate change	-1	-1	-1	-1
	Natural disasters	-1	-1	-1	-1
	Pests, diseases, alien invasive species	-1	-1	-1	-1
	Markets, trade and the private sector	NA	NA	NA	NA
	Policies	NA	NA	NA	NA
	Population growth and urbanization	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	1	1	1	1
	Advancements and innovations in science and technology	1	1	1	1
	Other				

***Note**: strongly positive (2), positive (1), negative (-1), and strongly negative effect (-2), or no effect at all (0), NA: not applicable*

c. Effects of drivers of change on ecosystem services

Table 5. Major drivers and their effect on ecosystem services in production systems

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Natural regenerated forests:	Changes in land and water use and management	-2	-2	-2	-2	-2	-2	-2	-1
	Pollution and external inputs	-2	-1	-2	-2	-2	-2	-2	-1
	Over-exploitation and overharvesting	-2	-2	-2	-2	-2	-2	-2	-2
	Climate change	-1	-1	-1	-2	-1	-2	-1	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	NA	NA	NA	NA	NA	NA	NA	NA
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	1	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other	NK	NK	NK	NK	NK	NK	NK	NK

***Note**: strongly increasing (2), increasing (1), stable (0), decreasing (-1) or strongly decreasing (-2)*
NA: Not applicable

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Planted forests:	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	-1	-1	-1	-1	-1	-1	-1	-1
	Over-exploitation and overharvesting	-1	-1	-1	-1	-1	-1	-1	-1
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Livestock grassland based systems:	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	NA	-1	-2	-2	-2	-2	-2	-1
	Over-exploitation and overharvesting	NA	-2	-2	-2	-2	-2	-2	-2
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Livestock landless based systems:	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	NA	-1	-1	-1	-1	-1	-1	-1
	Over-exploitation and overharvesting	NA	-1	-1	-1	-1	-1	-1	-1
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Self recruiting capture fishiers	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	NA	NA	NA	NA	NA	NA	NA	NA
	Over-exploitation and overharvesting	NA	-2	-2	-2	-2	-2	-2	-2
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Non fed aquaculture	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	0	0	0	0	0	0	0	0
	Over-exploitation and overharvesting	0	0	-0	0	0	0	0	0
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Culture base fisheries and fed aquaculture:	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	-2	-1	-2	-2	-2	-2	-2	-1
	Over-exploitation and overharvesting	-2	-2	-2	-2	-2	-2	-2	-2
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2

	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Irrigated rice	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	-2	-1	-2	-2	-2	-2	-2	-1
	Over-exploitation and overharvesting	-2	-2	-2	-2	-2	-2	-2	-2
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2

	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Irrigated crops	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	-2	-1	-2	-2	-2	-2	-2	-1
	Over-exploitation and overharvesting	-2	-2	-2	-2	-2	-2	-2	-2
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2

	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2
	Other								

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Rainfed crops	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	-2	-1	-2	-2	-2	-2	-2	-1
	Over-exploitation and overharvesting	-1	-1	-1	-1	-1	-1	-1	-1
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	-2	-2	-2	-2	-2	-2	-2	-2
	Policies	2	2	2	2	2	2	2	2

	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2

Production systems	**Drivers**	**Effect of divers on ecosystem services** (2, 1, 0,-1, -2, NK, NA)							
Code or name		Pollination	Pest and disease regulation	Water purification and waste treatment	Natural hazard regulation	Nutrient cycling	Soil formation and protection	Water cycling	Production of oxygen/gas regulation
Mixed	Changes in land and water use and management	2	2	2	2	2	2	2	1
	Pollution and external inputs	-1	-1	-1	-1	-1	-1	-1	-1
	Over-exploitation and overharvesting	-1	-1	-1	-1	-1	-1	-1	-1
	Climate change	-2	-2	-2	-2	-2	-2	-2	-2
	Natural disasters	-2	-2	-2	-2	-2	-2	-2	-2
	Pests, diseases, alien invasive species	-2	-2	-2	-2	-2	-2	-2	-2
	Markets, trade and the private sector	1	1	1	1	1	1	1	1

	Policies	2	2	2	2	2	2	2	2
	Population growth and urbanization	-2	-2	-2	-2	-2	-2	-2	-2
	Changing economic, socio-political, and cultural factors	2	2	2	2	2	2	2	2
	Advancements and innovations in science and technology	2	2	2	2	2	2	2	2

Table 6. Drivers affecting available, knowledge and diversity of wild foods

Drivers	**Effect of drivers on sector biodiversity for food and agriculture** (2, 1, 0,-1, -2, NK, NA)		
	Available of wild foods	Knowledge of wild food	Diversity of wild food
Changes in land and water use and management	-2	-2	-2
Pollution and external inputs	-2	-2	-2
Over-exploitation and overharvesting	-2	-2	-2
Climate change	-1	-1	-1
Natural disasters	-1	-1	-1
Pests, diseases, alien invasive species	-1	-1	-1
Markets, trade and the private sector	-2	-2	-2
Policies	NA	NA	NA
Population growth and urbanization	-2	-2	-2
Changing economic, socio-political, and cultural factors	2	2	2
Advancements and innovations in science and technology	-1	-1	-1
Other			

Note: *strongly positive (2), positive (1), negative (-1), strongly negative (-2), no effect (0), not known (NK), or not applicable (NA) having both positive and negative effects*

d. The main driver affecting the availability, diversity and knowledge of wild foods,

❖ *Main drivers affecting availability and diversity of wild foods:*

- Policies are the main drivers influencing the availability, diversity and knowledge of wild foods.For example, policies of development and conservation of wild foods such as wild vegetable and aqutatic genetic resources like fish, shrimp and crabs from rivers, streams and seas have positive impacts on the availability of wild foods. The release of the list of precious species prohibited from export, together with the efforts of authorities in preventing wildlife exploitation and illegal trading has helped reduced the consumption of biological resources and reduced impacts on wildlife. Every year, the forestry and fishery sectorshave programs to returns breeding shrimp, fish, wildlife back to the sea or reservoirs and forests to promote the wild stock development. In order to sustainably manage the fishery, some coastal and marine areas were seasonally closed to fishing permission.
- Pollution and external inputs limit the availability of wild foods. The over-application of fertilizers and pesticides has killed freshwater genetic resources. In Vietnam, many species of crab, shrimp and fish in rice fields, rivers, lakes and streams have disappeared due to water pollution. High density aquaculture farming of *tra* and *basa* fish in the Mekong Delta is also causing pollution. Uneaten fish food and fish excretion is leading to organic pollution and high level of nutrientsis impacting on nearby ecosystems and aquatic communities. Similarly, marine genetic resourciisses are also under threats due to pollutants from industrial zones and human waste[11]. Pollution from agricultural activities is becoming increasingly environmentally

[11]MONRE, 2011

damaging with the sector consuming over 19,600 tons of fertilizers annually. The amount of fertilizer used has increased by 517% in the last 25 years, and it is estimated around 2/3 of the fertilizer is not absorbed by plants (Ministry of Natural Resources and Environment 2011) and enters groundwater, rivers and coastal waters. This has led to the depletion of many aquatic species.

- Overexploitation, overharvesting and destructive harvest manners also the main reason limiting the availability of wild foods. This can be seen clearly in the medical plant resources and fisheries. An increase in the consumption of fishery products, coupled with management inefficiencies has led to overfishing in many part of Vietnam resulting in a decline in fishery resources and severe degradation of inshore coral reefs. The populations of many high value marine species have severely declined, for instance, lobster (*Panulirus spp*.), abalone (*Haliotis spp*.), and scallops (*Chlamys spp*.). In addition, destructive fishing methods, such as fishing with poison and creating electric shocks to stun and kill fish, are widely used for fishing in both coastal and inland areas. Fishing practices using poison are reported to be severely threatening over 80% of the coral reefs of Vietnam.The use of electric fishing tools is resulting in the depletion of fisheries resources[6].

- Change in land and water use and management: while deforestation, fragmentation, modification of water regimes, forest degradation and land conversion for agriculture have negative impacts on the availability of wild food, ecosystem restoration provide habibats for survival of wild foods. For example, restoration of Xuan Thuy Ramsar (in Nam Dinh province) has contributed to providing habitats for many species including aquatic species, mangroves and birds.

❖ *Main driver affecting knowledge of wild foods*

- Policiesabout Intellectual Property Rights, Access and Benefit Sharing (ABS), documentation and conservation of indigenous knowledge of wild foods contribute to the maintenance and development of knowledge while policies causing the loss of biodiversity often lead to the loss of knowledge of wild foods.

- Some advancements and innovations in science and technology improve the knowledge of wild foods via deeper studies on the growth habits, chemical compositions and benefits of wild foods that can promote the development of wild foods. Therefore, the knowledge associated with them is also maintained and developed. Conversely, modern technology could displace traditional farming systems and the social, cultural and spiritual dimensions associated with them. Many knowledge systems of wild foods are built around wild food using and saving. This replacement could cause the loss of knowledge of wild food.

e. Effects of drivers of changes on traditional knowledge, gender and rural livelihoods

❖ *Drivers have had the most significant effect on the involvement of women in the maintenance and use of biodiversity for food and agriculture*

- Policies of government have a significant impact on the involvement of women in the maintenance and use of biodiversity for food and agriculture. Theycan help tostrengthen the role of women in this field via capacity building and greater participation. They give women more opportunities to participate in development activities, in training courses and natural resource protection. In particular, in technology transfer activities if women are prioritized they can gain more knowledge and learn new techniques in order to assist them to rationally and

sustainably develop the existing natural resources. For example, according to the Constitution and the 2003 Land Law, women have full rights decision-making in family activities and also in land use. In the land use, Vietnam National Report to UN Forum on Forests (UNFF) 518 certificate (Red Book) for agricultural or forest land allocated to households has both the names of the husband and the wife. Therefore, they have right to obtain loans (using the land use certificate as collateral). The gender equality situation in Vietnam today has improved. One of the important contributions are policies particularly, Vietnam joined The Convention on the Elimination of All Forms of Discrimination against women (CEDAW), issued laws on gender equality, marital and family law; and labor laws.

- Changing socio-political, cultural or religious factors: variation in the forces influencing decision-making of men and women. Culture has a significant impact on gender dimension in Vietnam, particularly in countrysides and remote regions. Vietnam is part of an Asian culture in which the patriarchal system is very popular. Therefore, there is inequality in the family division of labor. Due to social and cultural changes, especially the effects of Western culture, the role of women in their family of Vietnam has positively changed; women have more rights in decision making.

- Urbanization including shifts in proportion of urban and rural; change in urbanization trends, including different effects on men and women increases the role of women in the involvement of women in the maintenance and use of biodiversity for food and agriculture. Along with the structural changes from agricultural to commercial production and urbanization trends in many rural areas, women workers in rural Vietnam is also facing similar problems. While in many places the men engaged in non-agricultural activities has put the burden of work for women in agriculture. For the ethnic minority communities, labor contributions of women through the production nature of "self sufficiency" as growing fruit trees, collecting forest vegetable, roots and medical plants and these works are often considered to be "insignificant". A study on the role of male and female of Van Kieu ethnic minority people showed that Bru- Van Kieu women were in charge of all stages from seed selection, fertilization , harvesting of the crops and fruit crops, and livestock. They are also responsible for collecting forest products such as bamboo shoots, mushrooms, wild vegetables, firewood and rattan. Men are participating in logging, charcoal burning, hunting and the sale or exchange of products. This shows that urbanization has a significant effect on women's role in the maintenance and use of biodiversity for food and agriculture[12].

❖ *Drivers have had the most significant effect on the maintenance and use of traditional knowledge relating to biodiversity for food and agriculture*

- Policies and programs of the government have a vital role in the maintenance and use of traditional knowledge relating to biodiversity for food and agriculture. For example, policies to promote research, evaluation, documentation, conservation, building of intellectual property rights for traditional knowledge have a positive impact on the maintenance and development of traditional knowledge. In recent year, there has been also an increasing realization of the invaluable role of the indigenous knowledge systems and customary laws. Initiatives are also being taken by national governments to recognize indigenous knowledge systems and customary laws for the stated reasons. Increasingly, its effectiveness or success in conservation

[12] Le Kim Lan, 2005, Gender division of labor in the production of Bru Van Kieu minority ethnic people, D'Krong district, Quang Tri province

and sustainable utilization of biological resources are being acknowledged by national governments. However, there is still a large gap in understanding the modalities and mechanisms which will be necessary for indigenous knowledge and customary law to secure the central role in the sustainable management and use of natural resources in their lands and territories.

- The overharvest and overexploitation of natural resources has resulted in the loss of natural resources which are associated to indigenous knowledge. Therefore, the degradation of natural resources has led to the erosion of traditional knowledge. In fact, the overexploitation of genetic resources has been a serious problem in Vietnam that led to the huge degradation of biodiversity.

❖ *Drivers have had the most significant effect on the role of biodiversity for food and agriculture in improving food security and sustainability*

- Policies and programs of the government have the most significant effect on the role of biodiversity for food and agriculture in improving food security and sustainability: they help to raise public awareness about the role of biodiversity in sustainable development and livelihood improvement that helps to increase the role of biodiversity. Pilot policies and programs of biodiversity conservation through the utilization of biodiversity (such as agro-forestry and ecosystem payment services programs) in improvement of livelihoods of people living at buffer zones and near the PAs have brought benefits to them. This has positive effects on promotion of biodiversity role in improving food security and sustainability.

- In addition, policies and legal documents also help to control and prevent activities which generate negative impacts on biodiversity. Over the past few years, a number of studies and proposals have been completed on invasive alien species. Several publications addressing invasive alien species and their threats have been developed and disseminated. The agriculture and fishery sectors have approved examination procedures of imported alien species to review for potential "invasiveness" prior to large-scale production in Vietnam. Furthermore, the increasing trend in the illegal trading, including importation, of exotic species and their products has prompted the government to develop harsher penalties for smugglers (Ministry of Natural Resources and Environment 2014).

f. Identify countermeasures planners or in place to reduce adverse consequences of drivers on:

a) associated biodiversity, b) ecosystem services and c) wild foods. Provide any expected outcomes, lesson learned and best practices

The adverse consequences of drivers on associated biodiversity, ecosystem services and wild foods have been already clearly recorded in Vietnam. The government has implemented programs to reduce the adverse impacts.

Agro-forestry model as climate change adaptation model in many provinces: the model of agro-forestry as climate change adaptation model is defined based on results of group discussion for local people, consultants and agriculture officers at different levels. The general model reflects the adaptation and support to each other among cropping systems and cultivation techniques in various terrains of typical agriculture system of the region. Agro-forestry helps to improve the ability of soil protection such as decrease in erosion through combination of multi-plants and multi-floors. In addition, the crop residues are returned back to soil as well as annually fallen-objects have been very good effect in soil

improvement. The combination of several plant species has created structure of multi-floors, so the irrigation was decreased somewhat. It has to irrigate 4 – 5 times if it is monoculture. On the contrary, it needs to irrigate 2 -3 times with the intercropped model. The multi-floors and green fences have reduced water evaporation and maintained humidity for long time. Combination of several cultivars has reduced even not to use pesticide, so it has not caused air pollution. In addition, suitable using of organic and inorganic fertilizer has not only enhanced soil nutrition but reduced the harmful minerals in water. For example, the use of Cuba acacia as a supporting tree for pepper has limited deforestation for supporting stake. Cuba acacia trees, which planted as the green fence, are the effective wind-guard ones. The green fence is not only the source provides the fallen-objects to improve soil but also protects for the whole system.

Example of agroforestry models:

- Coffee – Pepper – Annual crop in Hoa Thuan Commune, Buonmathuot City, Dak Lak Province
- Agroforestry Model: Cashew – Bean – Maize in Easo Commune, Eakar District, Daklak Province
- Agroforestry Landscape Model: Natural and plantation forests – Industry trees, annual crop and husbandry in Cu Pui Commune, Krong bong District, Dak Lak Province
- Agroforestry Landscape Model: Natural and plantation forests – tea, paddy in Khuon Village, Phuc Xuan Commune, Thai Nguyen City
- Agroforestry Model: Plantation – Fruit trees – Annual crop – Husbandry in Bac Thanh Village, Quyet Thang Commune, Thai nguyen City
- Agro-forestry Landscape Model – Forest Garden. Lac Hoa Village, Lac Tanh Commune, Tanh Linh District, Binh Thuan Province
- Agroforestry Model – VAC: Garden – Fishpond – Pigsty in Binh Duc Village, Binh Nham Commune, Thuan An District, Binh Duong Province

Application of IPM (Integrated Pest Management), IPC (Integrated Pest Control), IWM (Integrated Weed Management) and ICM (Integrated Crop Management) in agricultural production in Vietnam has been enhanced. They help to reduce the amount of chemicals and protect the beneficial enermies such as frogs, snakes, birds, bees, ladybugs, spiders…This contributes to a sustainable agricultural development.

Many landscape protected areaswhich are important for agriculture have been established such as Wetlands and Marine Protected Areas. These areas have high diversity of plant, fish, …

CHAPTER III. THE STATE AND TREND OF BIODIVERSITY FOR FOOD AND AGRICULTURE

6. The overall state, trends and state of conservation of diversity of forest, aquatic, animal or plant genetic resources in your country

a. The main characteristics of biodiversity for food and agriculture

The diverse geographical conditions of Vietnam result in high variation in climate, soil and topography, and thus, a wide range of ecosystems, each of which has its own flora and fauna. It covers the terrestrial, marine, and other aquatic environments and their interrelatedness. The biodiversity of Vietnam is found in its ecosystem diversity, species diversity and genetic diversity

- **Ecosystem diversity**

In general, ecosystem can be divided into 3 types including terrestrial ecosystem, wetland ecosystem and marine and coastal ecosystems.

Terrestrial ecosystem

The terrestrial ecosystems can be divided into forest, grassland, savanna, arid land, urban, agriculture and karst limestone. Of these, forests, especially natural forests with a tropical climatic condition have the richest species diversity. Forests are the habitat of many rare wildlife species, with high economic and scientific value. The agricultural ecosystems and urban ecosystems have poorer speciescomposition.

Terrestrial wetland ecosystem

Wetland ecosystems are diverse including natural lakes, reservoirs, ponds, marshes, rice fields and water bodies such as streams, rivers and canals. In particular, mountains, streams and marshes are highly diverse with many new species discovered.

Coastal and marine ecosystem

Vietnam has about 20 typical marine ecosystems of 9 natural areas with different marine biodiversity (Figure 3). The coastal ecosystems such as mangroves, lagoons, seas, sea coves, coral reefs, sea grass and the areas around the coastal islands and offshore islands have high biodiversity that is very sensitive to environmental changes. In particular, coral reefs and sea-grass beds are considered the most typically important ecosystem due to their biodiversity and the highest conservation value. Two ecosystems are closely related and reciprocity to create important food chains in marine and coastal areas of Vietnam (MONRE, 2011).

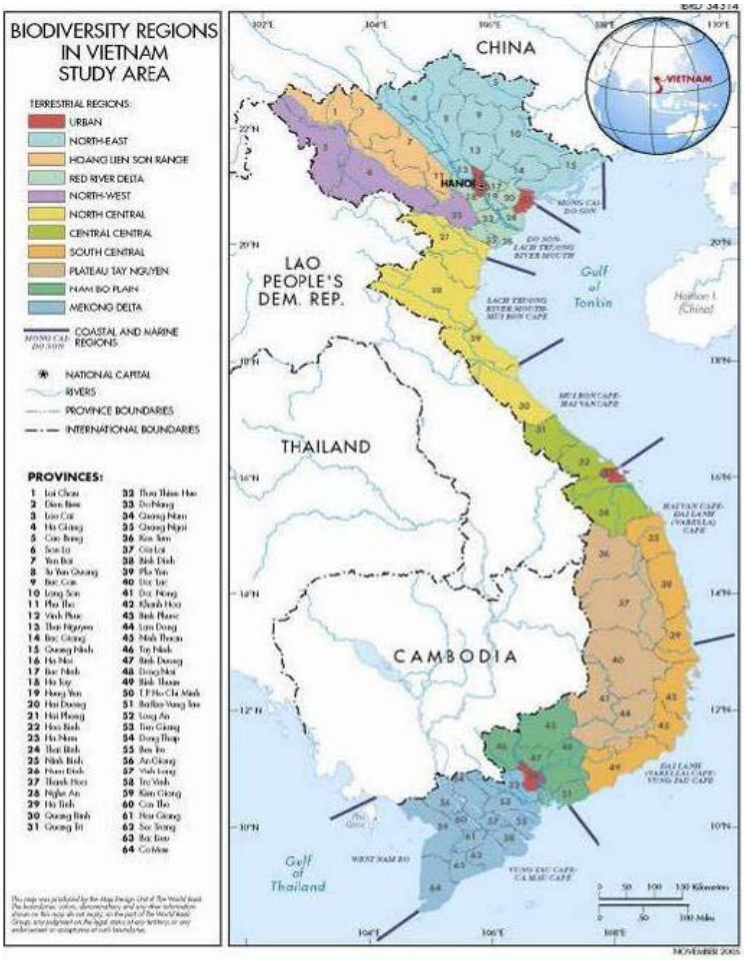

Figure 3. The biodiversity regions in Vietnam (Source: State report on biodiverisity, MONRE, 2011**)**

- **Species diversity**

Terrestrial flora: Vietnam's diverse array of ecosystems is made up of a similar richness of species According to the survey data by 2011, there were about 13,766 species of flora (except microalgae). Of these, there are 2,393 species of non-vascular plants and 11,373 species of vascular plants.

Terrestrial fauna: It has been listed and identified 10,300 speciesof fauna including 307 nematode species (Nematoda), 161 species of helminth parasites in cattle, 200 species of earthworms (Oligochaeta), 150 tick species (Acartia), 113 species of beetles (Collembola), over 7,700 species of insects (Insecta), 317 species of reptiles (Reptilia), 167 species of amphibians (Amphibia), 840 bird species (Avecs) , 312 mammal species and subspecies (Mammalia).

Microorganisms: have listed and identified 7,500 species, including more than 2,800 plant pathogen species, 1,500 human and animal pathogen species and over 700 species of beneficial microorganisms.

Freshwater genetic resources: have listed and identified 1,438 species belonging to 259 genera and microalgae 9 branches; over 800 species of invertebrates; 1,028 species of freshwater fish.

Marine genetic resources: According to known statistic, Viet Nam has detected 11,000 species in the waters. In particular, there are about 6,300 species of zoo-benthic, 2,500 fish species with over 100 fish species having high economical value; 653 species of seaweed; 657 species of zooplankton; 537

phytoplankton species; 94 mangrove plant species; 225 species of marine shrimp; 14 species of sea grass; 15 species of sea snakes; 25 species of marine mammals; 5 species of sea turtles (MONRE, 2011).

- ***Genetic diversity***

✓ *Crops*:

Vietnam is considered as one of the world's eight Vavilov "Centers of Origin" for domesticated plants because of the intensive use and management of plants throughout history in the various agricultural landscapes. There are over 700 plant species (belonging to 79 families) grown for food, medicine and construction (Nguyen Thi Ngoc Hue, 2000). Vietnam is the zone of origin or belongs to the region of origin of crop species such as rice, taro and local onion and a variety of endemic fruit crops.

Vietnam has exploited and used the following crop species: Starchy food crops (39 species), non-starchy food crops (95 species), fruit crops (104 species), vegetables (55 species), oil crops (44 species), fiber crops (16 species), beverage manufacturing plants(12 species), spice crops (39 species), aromatic crops (19 species) and cover crops for bare hill re-greening (29 species).

Crop wild relatives (CWR) are also diverse in Vietnam. The genetic resources of rice are the best known and the most significant of all domestic crops in Vietnam. The application of new molecular techniques has shown that Vietnam's rice plants have special characteristics and are among the most diverse in the world. Certain landraces of the fragrant Japonica rice are particularly important for breeding purposes[13].

Figure 4. The diversity of bean and zeamay genetic resources

✓ *Livestock:*

Vietnam is a country with abundant livestock genetic resources, among which 46 local breeds are known (Viet Ly, 1998). The characteristics of indigenous breeds are highly resistant to diseases, efficient for utilization of poor quality feed, tasty meat and good adaptability to various environments.There are about 14 species of animals and birds in Vietnam including 20 pig breeds (14 indigenous breeds), 21 beef breeds (5 indigenous breeds), 27 chicken breeds (16 indigenous breeds), 10 duck breeds (5

[13]*Luu Ngoc Trinh, 1999, Vietnam Environment and Life. National Politics Publishing House. Hanoi (2004)*

landraces), 7 muscovy ducks (3 indigenous breeds), 5 goose breeds (two indigenous breeds), 5 goat breeds (two indigenous breeds), 3 buffalo breeds (two indigenous breed), 1 sheep breed, 4 rabbit breeds (two indigenous breeds), 3 horses (2 landraces), 2 crocodile landraces, deers, and two imported ostrich breeds.

The density of local breeds in Vietnam is 1.52 breed per km^2 which is much higher than the world average figure that is only 0.098 breed per km^2. Vietnam is also known as a country with abundant precious livestock breeds such as Dong Cao chicken (Hung Yen province),To chicken (Thai Binh province), Ri chicken, Black chicken, Meo chicken, I Mong Cai pig, I Nam Dinh pig, Cap Nach pig and hundreds of imported animal breeds that helps to enhance the diversity of livestock genetic resources in Vietnam.

- ✓ *Insect and microorganisms:*

About 10,000 insect species have been indentified in Vietnam with 1000 species considered as pests and more than 1000 species as natural enemies of pests such as prey species (ladybugs, beetles, mantis, yellow-eyed bugs, hoverflies, prey bug species, large spiders, prey small spider species), the parasite: the Apanteles, the red eye bees parasites of insect eggs, black bees parasites of insect eggs and the parasitic flies) and microorganisms pathogenic to insects (the parasitic fungi infects insects), bacteria pathogenic to insects, ... Five indigenous bee species are raised in Vietnam including *Apis cerana, Apis dorsata, Apis laboraosa, Apis florea, Apis andreniformis* and one imported species *Apis melifera*.

Vietnam is located in the tropical monsoon region so it has a very diverse microorganism species including 5 main groups: bacteria, actinomycetes, filamentous fungi, yeasts and viruses. A collection of agricultural microorganisms with nearly 1000 species is conserved and exploited in Vietnam Academy of Agricultural Sciences, Institute of Biotechnology, Centre for Science and Technology, Veterinary Institute, Institute of Experimental Biology, Hanoi National University.Microorganism genetic resources in Vietnam are collected from soil, water, leaves, plant sap, from seawater, marine sediments, from the phytoplankton, from traditional fermented products such as soy sauce, sour rolls, sour fermented shrimp and many other sources. Microorganism genetic resources of Vietnam are specific to tropical climate including microorganism strains from traditional fermented foods such as sour fermented meat rolls, soy sauce, Hue sour fermented shrimp, pickles or strains having highly biological activities isolated from seawater, tropical forests and barren hills. The strains isolated from traditional fermented product are capable of producing some aromatic substances, proteins and especially enzymes for unique flavor of the product[14].

Nitrogen fixation bacteria: *Rhizobium spp.* và *Bradyrhizobium spp. Azotobacter spp.*, *Clostridium pasteurianum*...

Bacteria used in food industry: *Acetobacter aceti* (venigar), *Acetobacter xylinum* (Coconut jelly), *Brevibacterium spp.* (Glutamate, lizin…), *Lactobacillus spp.* (Yogurt), *Leuconostoc dextranicum* (dextran)…

Bacteria used in biopesticide: *Bacillus thuringiengis*

Yeast: *Saccharomycopsis* and *Saccharomyces*. Other genus: *Candida, Geotrichum,Kluyveromyces, Pichia,Hansenulla, Lipomyces, Phaffia, Rhodotorula, Bullera, Debaryomyces*…

[14]Nguyen Thi Ngoc Hue, 2010, The importance of agro-biodiversity and crop diversity conservation in agricultural production

Mycetocyte: Isolated from soil and organic materials: *Eurotium, Blakeslea, Choanephora, mucor, Rhizopus, Pilobolus, Syncephalastrum, Acrodictys, Acrogenspora, Alternaria, Angulimaya, Aureobasidium, Bahusandhica, Balanium, Beltraniella, Bispora, Botryotrichum, Catenularia, Cercospora, Chaetochalarra, Choloridium, Cladosporium, Curvularia, Codinaea, Cordana, Cylindrotrichum,Dactylaria,Dendryphiella, Dendryphion, Dictyosporium, Diplococcium, Drechslera, Embellisia, Echinobotryum, Exosporium, Fusariella, Gilmaniella, Gliocephalotrichum, Gliomastix, Gonatobotryum, Gonytrichum, Haplographium, Helicoon, Helmithosporium, Heterosporium, Humicola,Idriella, Lacellinopsis, Leptographium, Monocillium, Monodictys, Murogenella, Neta, Nigrospora, Periconia, Phialophora, Pithomyces, Pleurophgragmium, Pleurothecium, Scolecobasidium, Septonema, Stachybotris, Stemphylium, Thermomyces, Torula, Trichocladium, Ulocladium,Veronaea, Xenosporium, Acremonium, Amblyosporium, Arthrobotrys, Aspergillus, Beauverria, Botrytis, Cephalosporium, Chalara, Chlamydomyces, Chromelosporium, Circinotrichum, Cylindrocarpon,Helicosporium, Mammaria, Metarhizium, Monilia, Mycogone, Paecilomyces, Penicillifer, Penicillium, Sagenomella,Scopulariopsis, Spicellum, Sporotrichum, Sporothrix, Trichoderma, Trichothecium, Tritirachium, Verticillium, Ascotricha, Diplodia, Didymobotryum, Doratomyces, Heterocephalum, Epicoccum, Nyctalospora, Fusarium, Myrothecium,Volutella, Ozonium,Rhizotocnia*…

Other genus: *Arthrinium, Clonostachys, Cunninghamella, Gliocladium, Gongronella, Helicomyces, Mauginiella, Rhinocladiella, Althrographis, Briosia, Mariannaea, Scytalidium. Septomyrothecium, Wiesneriomyces, Conioscypha, Endophragmia, Eladia,Stibella, Nodulisporium, Memnomiella, Conidiocarpus, Phialemonium, Beltrania, Beltraniella, Campyrospora, Gongronella, Isthmolongispora, Tripospermum, Nodulisporium, Phomopsis, Zakatoshia*.

- ✓ *Forest flora:*

Vietnam forest flora is rich and diverse. However, until now there has not been detailed statistics about composition of plant species. According to Nguyen Nghia Thin (1997), there are about 11,373 species of 2524 genera; 378 families of 7 branches of the forest flora in Vietnam. On average, each family has 6.67 generas and 30 species and each genera has 4.5 species on average. The botanists predict that if there is a meticulous survey about the components of Vietnam forest flora, the species number can be up to 15,000[15]. The forest ecosystems of Vietnam are very diverse with many different types of forests, swamps and rivers providing habitats for approximately 10 % of the global total number of birds and animals. Many species of animals and plants are considered to be unique in Vietnam.

[15] Nguyen Hoang Nghia, 2012, Strategy of conservation, exploitation and use of forest plant genetic resources, Vietnamese Academy of Forest Sciences

Table 7. Timber species with high economic value

Species (Local name)	Scientific name	Family
Go do	*Afzelia xylocarpa* Craib	*Leguminosae*
Tram huong	*Aquilaria crassna* Pierre	*Thymeleaceae*
Nghien	*Burretiodendron tonkinense* Kost	*Tiliaceae*
To moc	*Caesalpinia sappan* L.	*Leguminoasae*
Bach xanh	*Calocedrus macrolepis* Kurz	*Cupressaceae*
Vu huong	*Cinnamomum balansae* H.Lec	*Lauraceae*
Re huong	*Cinnamomum panthenoxylon* Meissn	*Lauraceae*
Lat hoa	*Chukrasia tabularis* A.Juss	*Meliaceae*
Hoang dan	*Cupressus torulosa* Don	*Cupressaceae*
Hong tung	*Dacrydium pierrei* Hickel	*Podocarpaceae*
Trac day	*Dalbergia annamensis* Chev.	*Leguminosae*
Cam lai BR	*Dalbergia bariensis* Pierre	*Leguminosae*
Trac	*Dalbergia cochinchinensis* Pierre	*Leguminosae*
Cam lai vu	*Dalbergia mammosa* Pierre	*Leguminosae*
Sua	*Dalbergia tonkinensis* Prain	*Leguminosae*
Xoay	*Dialium cochinchinensis* Pierre	*Leguminosae*
Mun	*Diospyros mun* Lecomte	*Ebenaceae*
Dau cat	*Dipterocarpus chartaceus* Seem	*Dipterocarpaceae*
Dau dot tim	*Dipterocarpus grandiflorus* Blco	*Dipterocarpaceae*
Vang trung	*Endospermum chinense* Benth	*Euphorbiaceae*
Lim xanh	*Erythrophloeum fordii* Oliv.	*Leguminosae*
Trai Nam Bo	*Fagraea fragrans* Roxb.	*Loganiaceae*
Po mu	*Fokienia hodginsii* Henry et Thomas	*Cupressaceae*
Sang dao	*Hopea ferrea* Pierre	*Dipterocarpaceae*
Sao xanh	*Hopea helferi* (Dyer) Brandis	*Dipterocarpaceae*
Kien kien	*Hopea pierrei* Hance	*Dipterocarpaceae*
Du sam	*Keteleeria evelyniana* Mast	*Pinaceae*
Sen mat	*Madhuca pasquieri* Lam	*Sapotaceae*
Vang tam	*Manglietia fordiana* Oliv.	*Magnoliaceae*
Dinh	*Markhamia stipulata* Seem	*Bignoliaceae*
Son huyet	*Melanorrhoea laccifera* Pierre	*Anacardiaceae*
Son dao	*Melanorrhoea usitata* Wall	*Anacardiaceae*

Rang rang mit	*Ormosia balansae* Drake	*Leguminosae*
Cho chi	*Parashorea chinensis* Hsie	*Dipterocarpaceae*
Cho den	*Parashorea stellata* Kurz	*Dipterocarpaceae*
Kim giao	*Podocarpus fleuryi* Hickel	*Podocarpaceae*
Bach tung	*Podocarpus imbricatus* Blume	*Podocarpaceae*
Thong tre	*Podocarpus neriifolius* Don	*Podocarpaceae*
Kim giao nam	*Podocarpus wallichianus* Presel	*Podocarpaceae*
Giang huong	*Pterocarpus macrocarpus* Kurz	*Leguminosae*
Hong quang	*Rhodoleia championii* Hook f.	*Rhodoleiaceae*
Gu mat	*Sindora siamensis* var.siamensis Teysm ex Miq	*Leguminosae*
Do giay	*Wikstroemia balansae* Drake	*Thymeleaceae*
Cam xe	*Xylia xylocarpa* Taub	*Leguminosae*

- ✓ *Aquatic species:*

So far, about 11,000 aquatic species living in more than 20 typical ecosystems have been discovered in the coastal and marine areas of Vietnam. They belong to the 9 marine biodiversity regions; in total species were detected there are about 6,000 species of benthic species; 2,038 grass species (including 100 species having economic value); 653 algae species, 657 zooplankton species, 537 phytoplankton species, 94 mangrove plant species, 225 species of brine shrimp, 14 species of seaweed, 15 species of sea snakes, 12 species of marine mammals, 5 sea turtles species and 43 species of water birds. Freshwater fish species are about 1027[8].

Table 8: Fish group: Fish species are raised in Vietnam

Scientific name	Engish name	Local name
Epinephelus tauvina (Forskal, 1775)	Greasy grouper	Cá song mỡ, cá song gầu
Epinephelus bleekeri (Vaillant, 1878)	Duskytail grouper / Bleekeri grouper	Cá song Bơlêkơri, Cá song dẹt
Lates calcarifer (Bloch, 1790)	Sea bass, Barramudi	Cá vược, cá chẽm
Lutjanus erythropterus (Bloch, 1790)	Crimson snapper / Redfin snapper	Cá hồng đỏ, cá hồng
Lutjanus argentimaculatus (Forskal, 1775)	Mangrover red snapper	Cá hồng bạc, cá hồng ánh bạc
Rachycentron canadum (Linnaeus, 1766)	Black kingfish, Cobia	Cá giò, cá bớp biển
Bostrichthys sinensis (Lacepede, 1801)	Four-eyed sleeper	Cá bống bớp, cá bớp
Mugil cephalus (Linnaeus, 1758)	Gray mullet, Flathead mullet, Sea mullet	Cá đối mực, cá đối

Sparus latus (Houttuyn, 1782)	Yellowfin seabream	Cá tráp vàng
Seriola dumerili (Risso, 1810)	Greater amberjack, Yellowtail	Cá cam, cá bò biển
Chanos chanos (Forskal, 1775)	Milkfish	Cá măng, cá măng biển
Oreochomis niloticus (Linnaeus, 1758)	Nile tilapia	Cá rô phi vằn
Oreochromis mossambicus (Pepers, 1852)	Mozambique tilapia	Cá rô phi
Sciaenops ocellatus (Linnaeus, 1766)	Red drum	Cá đù đỏ Mỹ, cá hồng đỏ Mỹ
Anguilla marmorata (Quoy & Gaimard, 1824)	Gaint mottled eel	Cá chình cẩm thạch, Cá chình bông

Table 9: Imported fish species are be raised in Vietnam

Scientific name	Engish name	Local name
Epinephelus akaara (Temminck & Schlegel, 1842)	Hong Kong grouper, Redspotted grouper	Cá song chấm đỏ Cá mú chấm đỏ
Epinephelus fuscoguttatus(Forskal, 1775)	Brown-marbled grouper	Cá song hoa nâu
Psammoperca waigiensis (Cuvier, 1828)	Waigieu seaperch	Cá vược mõm nhọn
Cromileptes altivelis (Valenciennes, 1828)	Humpback grouper, Barramundi cod	Cá mú dẹt Cá mú chuột
Eleutheronema tetradactylum (Shaw, 1804)	Fourfinger threadfin	Cá nhụ 4 râu. Cá nhụ. Cá gộc
Sparus macrocephalus (Bleeker, 1854)	Black porgy	Cá tráp đen
Siganus guttatus (Bloch, 1787)	Orange-spotted spinefoot, Golden rabbitfish	Cá dìa công. Cá dìa chấm
Anguilla anguilla (Linnaeus, 1758)	European eel	Cá trình Châu Âu
Hippocampus kuda (Bleeker, 1852)	Sea horse, Spotted seahorse, Yellow seahorse	Cá ngựa đen

Seaweed group

Table 10: Species are grown in Vietnam

Scientific name	Engish name	Local name
Gracilaria asiatica.	Seaweed.	Rong câu chỉ vàng
Gracilaria heteroclada (Zhang et Xia)	Seaweed.	Rong câu cước
Gracilaria tenuistipitata	Seaweed.	Rong câu chỉ

(Zhang et Xia) *G. tenuistipitata* (var.liui Zhang et Xia).		Rong câu sợi mảnh
Kappaphycus alvarezii (Doty) Doty.	Seaweed.	Rong sụn

Table 11: *Imported seaweed species can be grown Vietnam*

Tên khoa học	**Tên Tiếng Anh**	**Tên tiếng việt**
Betaphycus gelatinum (Esper) Doty ex Silva.	Seaweed.	Rong hồng vân
Gracilaria lemaneiformis (Bory) Greville.	Seaweed.	Rong câu thừng
Gracilar bangmeiana (Zhang et Abbott)	Seaweed.	Rong câu bành mai
Gracilaria eucheumoides (Harvey)	Seaweed.	Rong câu chân vịt
Sargassum spp.	Seaweed.	Rong mơ

Table 12: Crustacean group: Species are raised in Vietnam

Scientific name	**Engish name**	**Local name**
Penaeus monodon (Fabricius, 1798)	Tiger shrimp, Giant tiger prawn	Tôm sú Tôm cỏ
Penaeus orientalis (Kishinouye)	White shrimp.	Tôm nương. Tôm đuôi xanh. Tôm râu dài. Tôm lớt
Penaeus merguiensis (deMan, 1888)	White shrimp.	Tôm he, tôm bạc, tôm bạc thẻ, Tôm lớt, Tôm he mùa
Penaeus japonicus (Bate, 1888)	Japanese shrimp.	Tôm hải quân Tôm he Nhật
Meatapenaeus ensis Haan, 1850)	Greasy-back shrimp	Tôm rảo Tôm đất
Penaeus indicus H. Milne(Edwards, 1837)	Indian white prawn	Tôm he Ấn Độ
Macro brachium rosenbergii (de Man, 1879)	Giant prawn	Tôm càng xanh
Lipopenaeus vannamei / Penaeus vannamei (Bone, 1931)	White shrimp	Tôm chân trắng. Tôm bạc Thái Bình Dương. Tôm bạc Tây châu Mỹ
Panulirus ornatus (Fabricus 1798).	Yellow ringspiny lobster.	Tôm hùm bông Tôm hùm sao
Panulirus Homarus	Scalloped spiny lobster.	Tôm hùm đá

(Linnaeus, 1758)		Tôm hùm xanh
Panulirus longipes (A.Milne Edwards, 1868).	Purplish brown spiny lobster.	Tôm hùm đỏ Tôm hùm gấm
Panulirus stimpsoni (Holthuis, 1963)	Chinese spiny lobster.	Tôm hùm sỏi Tôm hùm mốc
Scylla paramamosain (Estampado 1949)	Mud crab	Cua biển Cua bùn
Postunus pelagicus (Linnaeus, 1766)	Green crab	Ghẹ xanh Ghẹ hoa

Table 13: Molluscous group: Species are raised in Vietnam

Scientific name	Engish name	Local name
Tên khoa học	Tên Tiếng Anh	Tên tiếng việt
Pteria martensii.	Pearl oyster	Trai trắng Trai ngọc mã thị
Pinctada maxima (Jameson, 1901)	Golden lip pearl oyster / Yellow lip pearl oyster	Trai ngọc môi vàng
Chlamys senatoria nobilis (Reeve, 1852)	Noble scallop	Điệp quạt
Anadara subcrenata.	Suberenata ark	Sò lông
Arca gralossa (Linné)	Blood cockle, Arca cuneata reeve	Sò huyết, sò trứng, sò tròn
Tegillarca nodifera (V.Martens, 1860).	Blood cockle, Ark-shell	Sod nodi, sò dài
Meretrix lyrate (Sowerby, 1851).	Lyrate asiatic, Hard clam.	Nghêu bến tre
Paphia undulata (Born, 1778)	Undulating venus	Nghêu lụa
Meretrix meretrix (LinnĐ, 1758)	Asiatic hard clam	Ngao dầu. Ngao vạng
Crasostrea rivularis (Gould, 1861)	Oyster	Hầu cửa sông
Perna viridis (Linné, 1758).	Green mussel	Vẹm cỏ xanh
Babylonia areolata (Link, 1807)	Areolata	Ốc hương

Table 14: Molluscous group: Imported speices can be raised in Vietnam

Scientific name	Engish name	Local name
Haliotis asinina (Linné, 1758)	Donkey's Ear Abalone.	Bào ngư vành tai
Haliotis diversicolor (Reeve, 1846)	Ear abalon.	Bào ngư chín lỗ Cửa khổng
Haliotis ovina (Gmelin, 1791)	Oval abalone / Sheep ear shell	Bào ngư bầu dục
Logigo formosana (Sasaki, 1929)	Squid	Mực ống
Sepia tigris (Sasaki)	Squid	Mực nang da hổ
Pinna strangei.		Bàn mai nứa
Luthlaria philippinarum.	Offer Clam	Tu hài
Lucina Philippinarum	Clam	Ngán
Tridacna squamosa (Lamark, 1819)	Scaled clam / Frilled clam	Ngao tai tượng

Table 15: Other aquatic species are grown in Vietnam:

Scientific name	Engish name	Local name
Caretta caretta (Linnaeus, 1758).	Loggerhead turtle.	Rùa Quản Đồng. Đú
Eretmochelys imbriacata (Linnaues, 1766)	Hawsbill turtle.	Đồi mồi
Lepidochelys Olivacea (Eschscholtz, 1829).	Olive Ridle turtle	Vích
Chelonia mydas (Linnaues, 1755)	Green turtle	Đồi mồi dứa. Tráng bông
Dermochelys coriacea (Vandelli, 1761).	Leatherback turtle.	Rùa da
Diadema Setosum (Leske, 1778)	Black sea urchin.	Cầu gai đen Nhum đen
Tripneustes Gratilla (Linnaeus, 1758)	Edible sea urchin	Cầu gai sọ dừa Nhum sọ
Heterocentrotus Mammillatus (Linnaeus, 1758)	Slate pencil urchin	Cầu gai đá Nhum đá
Actinopyga echinites (Jaeger, 1833)	Redfish	Hải sâm mít Đồn hạt mít
Actinopyga Mauritiana (Quoy & Gaimard, 1833)	Surf red fish, White soled fish	Đồn đột dừa Hải sâm mít hoa
Holothuria / Halodeima	Lolly fish	Hải sâm đen

Scientific name	Engish name	Local name
(Atra Jaege, 1833)		Đồn đột đen
Holothuria /Leucospilota (Brandt, 1835)		Hải sâm đen mềm
Holothuria / Metriatyla (Scabra Jaeger, 1833)	Sand fish	Hải sâm trắng Đồn đột cát
Microthele Nobilis(Selenka, 1867)	Black teatfish	Hải sâm vú Đồn đột vú
Thelenota ananas (Jaeger, 1833)	Prickly red fish	Hải sâm lựu Đồn đột lựu
Astropecten spp. *Pentagonaster* spp.	Sea stars	Sao biển
Tachypleus tridentatus (Leach)	King crab	Sam Cua móng ngựa

Agro-ecological zones:

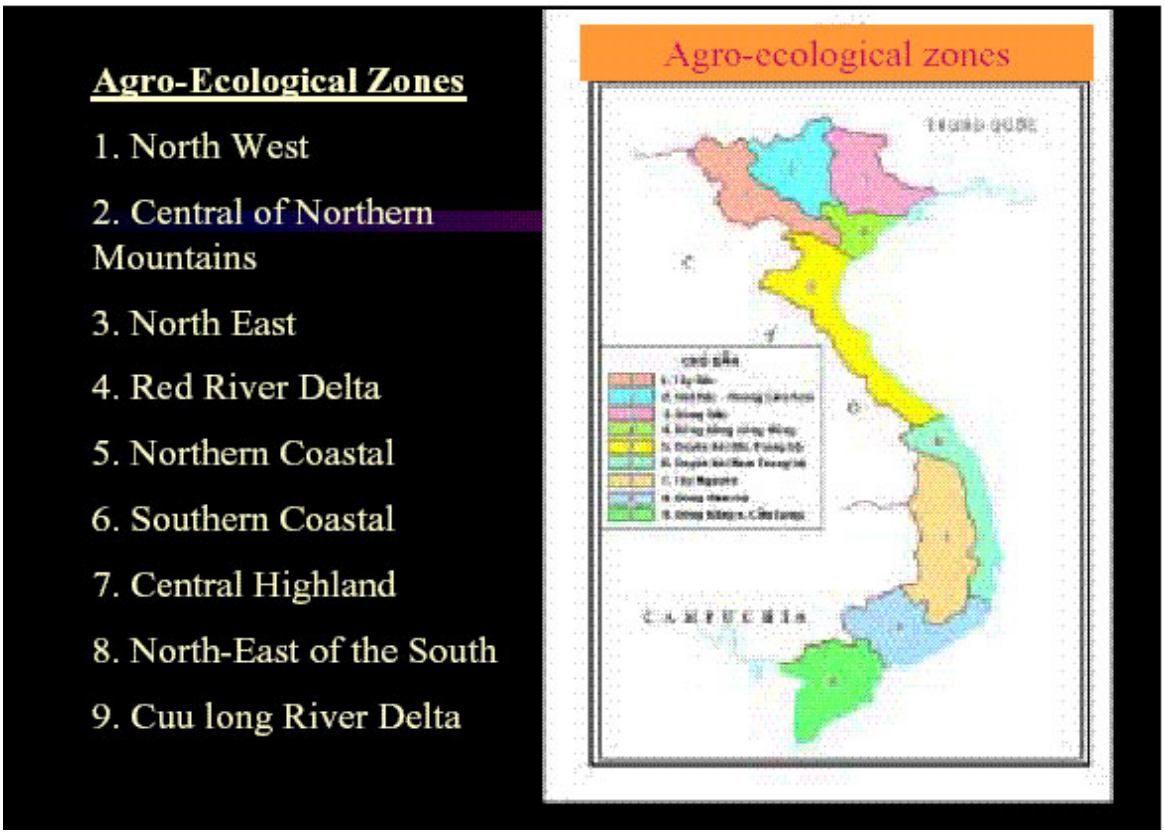

***Figure** 5. The nine agro-ecological zones in Vietnam*[16]

[16] http://www.fao.org/ag/agp/AGPC/doc/Counprof/vietnam/agromap.htm

There are 9 major agro-ecological zones in Vietnam (see Figure 4), determined by topography, soils and climate, with the distribution from the North to the South. In agriculture, the ecosystems are clearly divided into: Wetland ecosystems (including rivers, streams, canals, lakes, wetlands and rice paddies);Path at edge of fields (including roadside); Area having trees and forest (including small forest fragments located among fields; Homegardens; The highlands are cultivated or fallow (including annual and perennial plants)[8].

b. The trend of biodiversity for food and agriculture

✓ *Terrestrial forest*

Forest cover is increasing. However, this is mainly due to an increase in planted forests, which has a lower value in terms of species diversity. In addition, the area of natural forests with higher-level biodiversity values has declined. Yet, natural forests are increasingly fragmented and degraded. Over two-thirds of Vietnam'snatural forests are considered poor or regenerating. Forest loss and degradation are major reasons for desertification and land impoverishment, creating a wide range of negative impacts and challengessuch as more serious flooding and drought. Rapid conversion of wetlands continues; remaining areas are also under intensive use and development pressure.

Table 16. Changes in forest area and forest coverage in Vietnam (2004-2012)

Year	Forest area (1000 ha)			Coverage (%)
	Natural forest	Planted forest	Total	
2004	10,088,3	2,218,6	12,306,9	36.7
2006	10,177,7	2,486,2	12,663,9	38,2
2009	10,339,3	2,919,5	13,258,8	39,1
2010	10,304,8	3,083,3	13,388,1	39,5
2012	10,423,8	3,438,2	13,862	40,7

Source: *Forest status to 31 December, 2012*, *General statistic office, 2014*

✓ *Inland water ecosystem*

- River ecosystem increasingly fragmented due to the construction of dams and reservoirs*:* The construction of a series of dams and reservoirs on the river mainstreams for hydropower has cleaved a number of rivers into a series of layers. In addition to the loss of forests in the valleys and on the riverbanks, these hydropower constructions act as migration barriers to between rivers and the sea of many commercially valuable fish species. In addition, the operation of hydropower reservoirs has had negative impacts on downstream habitats, in particular estuaries and coastal ecosystems.
- Increasing eutrophication: due to Vietnam's rapid industrialization and urbanization, the amount of waste and sewage with high levels of nitrogen and phosphorus is increasing. In some cases, this is resulting in eutrophication of rivers and lakes and leading to the degradation of aquatic ecosystems with resulting impacts on biodiversity. In addition, aquaculture, in particular the high intensity catfish farming in the Mekong Delta, contributes to the eutrophication of areas where aquaculture is practiced.
- Decline in population of endangered, rare and precious species: aquatic species, particularly endangered, rare and precious species, are being threatened by the pressure of exploitation, infrastructure construction on rivers such as hydroelectric dams, irrigation, river ports, and

illegal mineral exploitation. Each of these activities is leading to the degradation of river ecosystems, and disturbing the spawning grounds and habitats of many aquatic species[17].

- ✓ *Marine and coastal ecosystems*

A consequence of the current and planned harvesting and production pressure on marine and coastal ecosystems, the coastal ecosystem's biological resources and its ecosystem service functions are currently considered to be over-exploited. The continuous decline in quality of natural habitats including the inter-tidal areas, coral reefs, sea grass, as well as decline in coverage of coral reefs and sea grass is pointing towards "coastal desertification" in the future.

Mangrove habitats:According to 2012 statistics, 56% of the total area of mangroves in Vietnam is considered as "planted mangroves" with a very low diversity of species. Mangrove degradation is clearly shown through the rapid decline in both the area and quality of forests. In 1943, the country had more than 408,500 ha of mangroves. In 1990, the area of mangroves was about 255,000 ha, declining to 209,741 ha in 2006 (Vietnam Environment Protection Agency 2006) and 140,000 ha in 2010. By the end of 2012, only 131,520 ha of mangrove forests remained (General Statistics Office, 2013).

Status of agricultural genetic resources

Over the past 10 years (from the time of the Vietnam Red Book was first published), state the number of endangered animals, plants in the production systems and in the wild of Vietnam has made significant changes.

- ✓ *Crop genetic resources:*

Native varieties are being pushed out by the new ones. The introduction of new high productivity agricultural varieties, especially hybrids, has caused a reduction in the planted area and genetic diversity of indigenous varieties. More than 80 percent of native crop varieties have been lost through various forms of modernization. For example, 80% of traditional rice varieties, 50% of local zeamay and bean cultivars, 90% of tea and fibre crop varieties, and 70% of local fruit species cannot be found in the nature. Similar trends are also found in the natural enemies of insects and diseases due to pollution[8].

Table 17*. List of endangered precious and rare crop varieties*

Local name	**Scientific name**
Chiêm đá Quảng Ninh	*Oryza sativa*
Dự Nghểu Hòa Bình	*Oryza sativa*
Lúa Chăm Biển	*Oryza sativa*
Hom mùa Hải Phòng	*Oryza sativa*
Tẻ tép	*Oryza sativa*
Giống Cút	*Oryza sativa*
Chiêm Cườm	*Oryza sativa*
Nếp hạt mây	*Oryza sativa*

[17]The fifth country's report on biodiversity, MONRE, 2014

Local name	Scientific name
Chiêm Bầu	*Oryza sativa*
Tẻ Trắng Hà Chua Cay	*Zea mays*
Mắc Phứa Hom (Yellow taro)	*Colocasia esculenta*
Lạc Trắng Vân Kiều	*Arachis hypogaea*
Đậu Tương Hạt Đen	*Glycine max*
Đậu Nho Nhe Hạt Đen	*Vigna umbellata*
Nhãn Hạt Trắng	*Dimocarpus longan*

Source: *Decree 160/2013/ND-CP on the criteria for identification and management of endangered, rare and precious species prioritized for protection*[18]

- ✓ *Livestock genetic resources:*

With the agricultural and economic development, the human need for animal production and consumption of higher quality product is increasing and this requires better and more productive animals. Numerous commercial animal breeds have been introduced into Vietnam in the last few decades. These breeds enriched the farms animal genetic resources, contributed to the improvement of animal production and diversified the animal products. Due to the lack of management in breeding there was no conservation strategy in the last decades, the importation of new exotic breeds also led to the extinction of many indigenous breeds and many others are decreasing rapidly in number because their performance, food conversion efficiency or lean meat percentage are much lower than that of imported breeds[19]. Some animal breeds are believed to be disappearing at the rate of about 10 percent per year.

Table 18. List of Vietnam livestock breeds and their status

Species	Breeds	Status	In the project	Mode of use
Cattle	Yellow	Decreasing		Purebred, crossed
	U Riu	Endangered	x	Purebred, crossed
	Hmong	Mass production	x	Purebred, crossed
	Phu Yen	Mass production		Purebred
Buffalo	Small	Mass production		Purebred
	Big	Mass production		Purebred
Horse	White	Endangered	x	Purebred
	Color	Increased		Purebred
Pig	Black I	Loss	x	Purebred, crossed
	Rough I	Extremely dangered		Purebred
	Mong Cai	Mass production	x	Purebred, crossed
	Ba Xuyen	Decreasing	x	Purebred, crossed

[18] Decree 160/2013/ND-CP on the criteria for identification and management of endangered, rare and precious species prioritized for protection

[19] The Vietnam National Country report on Animal Genetic Resources

Species	Breeds	Status	In the project	Mode of use
	Thuoc Nhieu	Mass production		Purebred, crossed
	Nghe An Meo	Decreasing	x	Purebred
	Tay Nguyen Soc	Decreasing	x	Purebred
	Muong Khuong	Mass production	x	Purebred, crossed
	Quang Tri Mini	Decreasing	x	Purebred
	Son Vi	Loss		
Chicken	Ri	Decreasing		Purebred, crossed
	Te	Extremely dangered	x	Purebred
	Mia	Mass production	x	Purebred, crossed
	Ho	Decreasing	x	Purebred
	Dong Tao	Increased	x	Purebred, crossed
	Tau Vang	Mass production	x	Purebred, crossed
	Dwarf	Mass production		Purebred
	Oke	Decreasing	x	Purebred
	H'Mong Brown	Decreasing	x	Purebred
	H'Mong White	Decreasing	x	Purebred
	H'Mong Black	Decreasing	x	Purebred
	Van Phu	Loss		Purebred
	Tre	Decreasing	x	Purebred
	Choi (fighting)	Decreasing		Purebred
Duck	Bau Qui	Decreasing	x	Purebred
	Bau ben	Decreasing	x	Purebred
	Co	Decreasing	x	Purebred
	Ki Lua	Decreasing	x	Purebred
	Moc	Decreasing	x	Purebred
Muscovy duck	Ngan	Decreasing	x	Purebred
Goose	De	Decreasing	x	Purebred
	Co	Decreasing	x	Purebred
	Lion	Decreasing	x	Purebred
Rabbit	Grey	Decreasing	x	Purebred
	Black	Decreasing	x	Purebred, crossed
Goat	Small	Decreasing	x	Purebred, crossed
	Bach Thao	Decreasing	x	Purebred, crossed
Sheep	Phan Rang	Decreasing	x	Purebred
Pigeon	Vietnam	Decreasing	x	Purebred

Source: *Summary on Vietnam Livestock Genetic Resources Conservation, National Institute of Animal Husbandry,Hoang Van Tieu, Le Viet Ly, Vo Van Su and Le Minh Sat, 2001.*

- ✓ *Forest flora resources:*

Forest plant genetic resources have been under threat of erosion due to overexploitation, especially the species having high values for medicine, construction, cosmetic and ornamental. For example, species are used for medical purposes in the wild such as Ngoc Linh ginseng (*Panax vietnamensis*), red pine (*Taxus wallichiana*), Wild Pingpien ginseng *(Panax stipuleanatus*), Wintergreen Barberry (*Berberis julianae*), Stephania species (*Stephania* spp.), White Pinyin (*Disporopsis longifolia*) and Solomonseal Rhizome (*Polygonatum kingianum*). Some species for essential oils and pharmaceuticals, have been hunted down aggressively as: Selasian wood (*Cinnamomum parthenoxylon*), and *Cinnamomum balansae*. The species for precious timber with high economic value in the market (sold by kg) are *Delbergia torulosa, D. cochinchinesis, Dalbergia Oliveri, Diospyros spp.* and *Pterocarpus macrocarpus.* The endemic species are limitedly distributed such as *Taiwania cryptomerioides, Xanthocyparis vietnamensis, Abies delavayi ver .Fansipanensis, Glyptostrobus pensilis* and *Cupressus torulosa.* Some fine wood species used in construction and furniture are seriously exploited that will lead to extinction in the wild, such as *Erythrophleum fordii, Fokienia hodginsii, (Markhamia stipulata), Afzelia xylocarpa, Sindora siamensis, Sindora torulosa and Garcinia fagraeoides*. Also, the species having beautiful flowers, ornamental value and endemic are being destructively exploited in the nature such as the *Paphiopedilum* spp., *Cycas* spp. and *Dendrobium nobile*[20].

Table 19. The threat level of some forest plant species according to IUCN category 2001

Local name	Scientific name	Family	IUCN Category
Sơn huyết	*Melanorrhoea laccifera* Pierre	*Anacardiaceae*	VU A1a,d+2d
Sơn đào	*Melanorrhoea usitata* Wall	*Anacardiaceae*	VU B1+2abcde
Thiết đinh	*Markhamia stipulata* Seem	*Bignoniaceae*	VU B1+2e
Trai lý	*Garcinia fagraeoides* A. Chev.	*Clusiaceae*	NT
Tung	*Tetrameles nudiflora* R.Br.	*Datiscaceae*	VU A1cd
Mun	*Diospyros mun* A. Chev. ex Lecomte	*Ebenaceae*	CR A1cd
Vạng trứng	*Endospermum chinense* Benth.	*Euphorbiaceae*	VU A1cd
Dẻ đỏ	*Lithocarpus ducampii* A. Chev.	*Fagaceae*	NT
Chò đãi	*Annamocarya sinensis* (Dode) J.Leroy	*Juglandaceae*	EN B1+2cde
Mạy chấu	*Carya tonkinensis* Lecomte	*Juglandaceae*	VU A1acd+2d
Vù hương	*Cinnamomum balansae* Lecomte	*Lauraceae*	VU A1c
Xá xị	*Cinnamomum glaucescens* Drury	*Lauraceae*	CR A1acd
Re hương	*Cinnamumum parthenoxylum* Meisn	*Lauraceae*	CR A1acd
Kháo vàng	*Machilus odoratissima* Nees	*Lauraceae*	NT
Gõ đỏ, cà te	*Afzelia xylocarpa* (Kurz) Craib	*Leguminosae*	EN A1cd
Trắc dây	*Dalbergia annamensis* A.Chev.	*Leguminosae*	EN A1cd
Cẩm lai Bà Rịa	*Dalbergia bariensis* Pierre	*Leguminosae*	EN A1cd
Trắc nghệ	*Dalbergia cochinchinensis* Pierre	*Leguminosae*	VU A1cd
Sưa	*Dalbergia tonkinensis* Prain	*Leguminosae*	EN C
Xoay	*Dialium cochinchinensis* Pierre	*Leguminosae*	VU A1cd
Lim xanh	*Erythrophloeum fordii* Oliv.	*Leguminosae*	EN A1cd
Ràng ràng mít	*Ormosia balansae* Drake	*Leguminosae*	NT
Gụ mật	*Sindora siamensis* Teysm. ex Miq	*Leguminosae*	EN A1acd

[20]Investigation and assessment of the conservation status of endangered rare forest plant species in the list of decree 32/2006/ ND-CP, MARD, 2010

Local name	Scientific name	Family	IUCN Category
Gụ biển	*Sindora siamensis* var. *maritima*	*Leguminosae*	VU A1cd
Gụ lau	*Sindora tonkinensis* A. Chev.	*Leguminosae*	EN A1acd+2d
Giáng hương	*Pterocarpus macrocarpus* Kurz	*Leguminosae*	EN A1acd
Căm xe	*Xylia xylocarpa* (Roxb) Taub.	*Leguminosae*	VU A1cd
Trai Nam Bộ	*Fagraea fragrans* Roxb.	*Loganiaceae*	VU A1cd
Mỡ Hải Nam	*Manglietia hainanensis* Dandy	*Magnoliaceae*	VU A1cd
Lát hoa	*Chukrasia tabularis* A. Juss	*Meliaceae*	VU A1acd+2d
Chò nước	*Plantanus kerrii* Gagnep.	*Plantanceae*	VU B1+2e
Trúc vuông	*Chimonobambusa quadrangularis* Mak	*Poaceae*	CR B2ab
Trúc đen	*Phyllostachys nigra* Munro	*Poaceae*	EN B1a
Trúc hóa long	*Phyllostachys aurea* Carr. ex A. et C.Riv	*Poaceae*	CR B2ab
Hồng quang	*Rhodoleia championii* Hook	*Rhodoleiaceae*	VU A1cd
Sến mật	*Madhuca pasquieri* H.J.Lam	*Sapotaceae*	EN A1acd
Trầm hương	*Aquilaria crassna* Pierre ex Lecomte	*Thymeleaceae*	EN A1cd B1+2
Dó giấy	*Wikstroemia balansae* (Drake) Gilg.	*Thymeleaceae*	VU A1cd
Nghiến	*Burretiodendron tonkinense* Kost	*Tiliaceae*	EN A1ad+2cd

Sources: Strategy for conservation, exploitation and utilization of forest plant resources, Nguyen Hoang Nghia, 2012

- ✓ *Aquatic genetic resources*

For the freshwater fish species in the Red Data Book of Vietnam in 1992 with over 33 species in total 500 species of known freshwater fish species, however, this number was up to 36 species in the Red Data Book 2007. Specially, significant changes are increasing threatened levels of freshwater fish after 10 years. While 33 species of freshwater fish were in the Red Data Book 1992 at level EN (Endangered) and VU (vulnerable), three of 36 species in the Red Data Book 2007 were considered extinct in the wild (EW) includingspecies of *Procypris merus*, *Anguilla japonica*and *Cyprinus multitaeniata*. Some species used to be ranked at level VU also were moved to level EU such as *Clupanodon*, *Tenualosa, and Catlocarpio*. In general, the extent of threatened freshwater fish in the past 10 years has increased remarkedly.

The number of marine fish species in the Red Data Book 2007 (53 species) increased significantly compared with the period of 1992s (37 species). Of these, endangered and vulnerable species were 20 and 28 respectively while these in 1992 were only 3 and 5 species respectively. In addition, in this period, three species were ranked at CR level including*Epinephelus andulatostriatus, Plectorhynchus Gibus* and *Bostrichthys sinensis*. The endangered species group(*Alopias*, *Stegostoma*, *Rhincodon*, *Cephaloscylliufish* and *Hippocampus*),havinga high economic value are being insensitively exploited. In the Red Book of 1992, this group had just been put at the level R (Rare). Notably, many fish species of *Chaetodontidae* and *Labridae* families in coral reefs previously were not threatened,however, in the Red Data Book 2004, they wereput at VU level due to increased poaching in recent times.

The number of freshwater invertebrate species in the Red Book is not large. In 1992, the species in the Red book was 23 while in 2007 it decreased to 19 species belonging to mainly two groups of shellfish and snails. Of these, 2 species in 2007 Red Book at CRlevel were *Gibbosula crassa*with very narrow distribution in Ky Cung and Bang rivers and *Protunio messageri*, an endemic species to Vietnam, at EN level. Particularly, brown shell clams (*Chamberlania hainesiana*) might have become extinct. In general,

freshwater invertebrate species have low economic value, except some species such as *Sinohyriopsis cummingii* are artificial breeding, so the threat is not great.

Different from freshwater invertebrates, there are a greater number of marine invertebrate species in the Red Data Book and these figures increase continuously. The 1992 Red Book listed 40 species including 7 species at EN level, 12 species VU level. In the Red Book 2007, the number of marine invertebrates was up to 61 species, including six species at CR level and 10 at EN level. 15 coral specieswas also found in this book with 3 species ranked EN (*Juncella gemmacea, Seriatopora hystrix and Stylophora pistilata*). These coral species are often exploited for decorative purpose. The highest number in the 2007 Red Book was sea snail species (27 species) with some of them at highly threatened levels. Of these, six species were classified as critically endangered (CR) including *Haliotis diversicolor*, *Trochus niloticus,Turbo marmoratus*, *Cypraea argus* and *Nautilus pompilus*. These snail and clam species, living near the coastal areas with beautiful colors and shapes, are objective to exploit for decorative purpose. About 11 marine shellfish species werelisted in the 2007 Red Book, of which *Palinurellus gunalachi*, *Panulirus homarus* and*Panulirus longipes*species were classified at EN level. Some lobster species arebeing artificially breeding and raised due to high economic value[21].

7. *Conservation of endangered, rare and precious species and genetic resources for food and agriculture*

Vietnam is strongly committed to the conservation of its biodiversity for food and agriculture in the face of various challenges. This commitment includes the maintenance and continued development of a widespread protected area (PAs) network of National Parks, Nature Reserves, Cultural and Historical sites*, in-situ*, *ex-situ* conservation of rare endangered crop and animal genetic resources.

Conservation of endangered, rare and precious species and their habitats is mainly being conducted within the national system of *in-situ* and *ex-situ* conservation. Currently, there is a network of focal agencies and 68 separate departments/units under 6 ministries involved in implementing the mission and objectives of the program on Plant, Animal and Microorganisms Genetic Resources Conservation.

- A national network of plant genetic resource conservation has been established and coordinated by Plant Resources Centre (PRC) with 24 official members nationwide
- The National Institute of Animal Sciences (NIAS) has 28 agencies working in animal genetic resources conservation.
- The Forestry Institution is a national clue of forest plant genetic conservation with 13 official members throughout the country
- The Research Institute for Aquaculture No I, the Research Institute for Aquaculture No II and The Research Institute for Aquaculture No III are responsible for conservation of aquatic genetic resources
- VNU Institution of Microbiology and Biotechnology is responsible for conservation of microorganism genetic resources which are significant in economic development and research.

[21]Ministry of Agricultural and Rural Development, 2011, Program of conservation and development of aquatic genetic resources to 2020

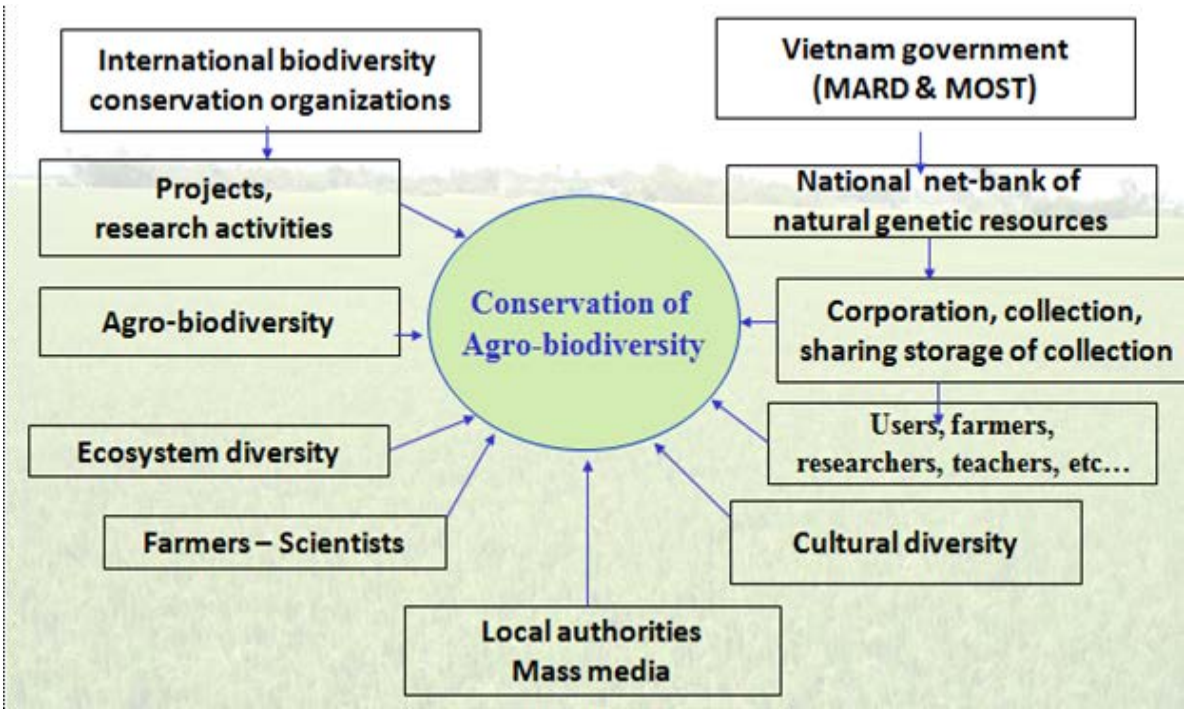

*Figure 6.Agro-biodiversity conservation system in Vietnam (*Source*: The importance of agro-biodiversity and crop diversity conservation in agricultural production, Nguyen Thi Ngoc Hue, 2010)*

a. Conservation of crop genetic resources:

Until 2014, more than 26,000 plant genetic accessions of over 200 plant species including food crops, fruit trees, medical plants and some other plant species are preserved by *ex-situ*, *in-vitro* and DNA conservation. Simultaneously, *in-situ* conservation is being developed for industrial trees and fruit trees which are rare, precious and endemic to some specific regions in Vietnam.

***Table 20**. List of crop genetic resources being conserved in the national genebank*

Crops	**Accession number**	**Conservation method**
Cereals	11,975	*Ex-situ*, ADN
Vegetable, Herbs, Fungi	4,110	*Ex-situ*, In-Vitro
Fruit trees, Industrial Trees and Mulberry	4,277	*Ex-situ, In –situ*, ADN
Tuber plants	2,282	*Ex-situ*, In-vitro
Beans and peas	3,092	*Ex-situ*
Flower plants	230	*Ex-situ*, in-vitro
Crops for soil fertility and fodder	123	*Ex-situ*
Others	13	*Ex-situ*
Total	**26,102**	

Sources: Report on conservation status of crop genetic resources, Plant Resources Center, 2014

b. Conservation status of livestock genetic resources

- *Survey of animal husbandry genetic resources*: 70 % of local animal races have been surveyed. FAO standards are used for race classification as per levels of usage and deterioration. New genetic resources have been found by surveys such as Udauriu cattle, H'Mong cattle, Mini pig and H'mong chicken.

- *In-situ conservation*:

Secure races in pressing danger, facing extinction: Rehabilitation and in-situ conservation of I Pig race in Thanhhoa, Ho Chicken in the Red river delta, Oxen in Nghe An, White Horse inThai Nguyen, Te Chicken in Lao Cai, Yenbai, and Bau Ben Ducks in Hoa Binh.

- Maintain races in risky situations: Dong Tao chicken, Bau Quy ducks.

-Maintain races decreasing in quantity: Three races of Pigs, one of Oxen, one of Goats, two of Rabbits, one of Horsesfive of Chickens, two of Ducks, and one of Geese.

-Creating new products having both high productivity and high quality by crossbreeding between exotic and indigenous breeds (for example, Dong Tao x Tam Hoang chicken, Mia x Kabir chicken, Co X Bau duck and Mong Cai x Landrace pig...).

-Establish information system on animal husbandry diversity is given in protection network, including a Web page.

- *Ex-situ conservation*:

-Ex-situ conservation is done at research institutions and at animal raising units for races in extremely risky situation and in need of urgent use. The work has been applied to one race of Pigs, six of Chickens and three of Ducks.

-In-vitro preservation of genetic materials: Semen, oocytes, embryos, somatic cells.

-The genomic DNA samples and somatic cells of 32 nativeanimal and poultry breeds were preserved.

-Animal Molecular Genetic Lab. for genetic study has beenestablished and start studying on DNA polymorphisms[22].

c. *Conservation of forest plant genetic resources*

Forestry Science Institute of Vietnam has collected and conserved forest plant species (origin/or mother plant), including many endemic rare species.

- *In-situ conservation*

Among the special-use forests, many of them were established with the aim to protect the survival of rare endangered species such as: Ba Be National Park to conserve the species of *Calocedrus macrolepis*, *Manglietia conifera*; Ben En National Park to protect *Calocedrus macrolepis* species; Hoang Lien National Park to conserve medicinal plants and *Fokienia hodginsii* species; National Park Pu Mat for protecting *Cunninghamia konishii* species and *Fokienia hodginsii* species; Earal and Trap KSo Protected Areas to conserve *Glyptostrobus pensilis* species and York Don National Park to conserve species of

[22] Le Thi Thuy, Nguyen Dang Vang, Hoang Kim Giao; Farm animal genetic genetic resources and their conservation in Vietnam, National Institute of Animal Husbandry, Vietnam

Dipterocarpaceae family[23].In general, these plants are relatively well preserved in these protected areas and special use forests. However, the illegal exploitation of these species still happens in some places, particularly for some species with high economic values such as *Dalbergia tonkinensis, Panax bipinnatifidus, Panax stipuleanatus, Panax vietnamensis and Afzelia xylocarpa*.

- *On farm conservation:*

Some forest plant species has been put into cultivation for hundreds of years as Star Anise (*Illicium verum*) in Lang Son province; Cinnamon (*Cinnamomum cassia*) in Yen Bai, Thanh Hoa, Quang Nam and Quang Ngai provinces; Trung Khanh Chestnut (*Castanea mollissima*) and Moso Bamboo (*Phyllostachys pubescens*) in Cao Bang; tea-oil Camellia (*Camellia oleifera*) in the north; Rough Giant Bamboo (*Dendrocalamus barbatus*) in Thanh Hoa, Hoa Binh and Phu Tho provinces (Nguyen Hoang Nghia, 2012).

Table 21. On farm conservation of some forest species

Species	Area
Star anise (*Illicium verum*)	Lang Son
Cinnamon (*Cinnamomum cassia*)	Yen Bai, Quang Nam, Quang Ngai
Trùng Khánh Chestnut (*Castanea mollissima*)	Cao Bang
Tea-oil Camellia (*Camellia oleifera*)	Lang Son, Quang Ninh
Moso Bamboo (*Phyllostachys pubescens*)	Cao Bang
Rough Giant Bamboo (*Dendrocalamus barbatus*)	Thanh Hoa, Hoa Binh, Phu Tho

- *Ex-situ conservation:*

For forest species, this method is often applicable to those under high risk of extinction and threats, particularly rare species in the wild. Species can be stored in gene banks, natural museums, or they can be move to more suitable locations. Vietnam has built a network of botanical garden, forest stands and medicinal plant garden to conserve rare endangered species. Some native species are successfully brought into cultivation. *Ex-situ* conservation has contributed significantly to the conservation of plant species has been extinct in the wild.

Experimental forests

Experimental forests consist of wood gardens, botanical gardens, forest plant collection garden and forest stands for forest flora genetic conversation. According to the current classification system, experimental forests are put under the system of special-use forests. A survey statistic of 3 forest forms in 2006 showed that Vietnam had 17 experimental forests with total area of 8,516 ha. Some typical experimental forests such as: Trang Bom wood garden (Thong Nhat district, Dong Nai province) with 155 plant species, Thao Cam Vien botanical garden with 100 species of plants, wood garden of Lang Hanh forest experiment station, Mang Lin wood garden and Bach Thao botanical garden with various rare precious wood trees.

Medical plant garden

Currently, several medical plant gardens have been established. In addition, there is a system of medical plant gardens of households who are working in the field of traditional medicine. This system is also a place for preservation and development of some valuable plant species. Some example of medical plant gardens are: Sapa medical plant garden: 63 species (*Berberis julianae*, *Coptis chinensis, Panax*

[23] MARD, 2010, Investigation and assessment of the conservation status of endangered rare forest plant species in the list of Decree 32/2006/ND-CP

bipinnatifidus and *Panax stipuleanatus)*; Tam Dao medical plant garden: 175 species; Van Dien medical plant garden: 294 species; Tam Dao medical plant garden: 175 species; Van Dien medical plant garden: 294 species; Ha Noi Medical University: 134 species; the medical garden of Vietnam Military Medical University: 95 species; Da Lat Medical Plant Center: 88 species; Vietnam Ginseng Center: 6 species (including Ngoc Linh ginseng).

Table 22. Some collection gardens of wood trees and bamboos

Location	Species number	Area
Cau Hai, Phu Tho	230 wood species and 100 bamboo species	40 ha
Trang Bom, Dong Nai	280 wood species	8 ha
Bau Bang, Binh Duong	260 wood species	5 ha
Lang Hanh, Lam Dong	20 precious wood species	10 ha
Mang Linh, Lam Dong	30 precious wood species	10 ha
Cuc Phuong National Park	200 wood species and *Cycas balansae*	100 ha

d. Conservation of aquatic species:

- *In-situ* conservation:

In conservation of marine genetic resources, Vietnam has only three marine protected areas (MPAs) established over 10 years ago including Hon Mun MPA in Nha Trang Bay, the first MPA Vietnam founded in 2001, Cham Island MPA established in 2003 and Phu Quoc MPA established in 2007. The two arms of the sanctuary Hon Mun, Nha Trang and Cu Lao Cham have been established with the support of Denmark Global Environment Facility and the World Bank through ODA projects and part of Vietnam government (Nguyen Huu Ninh, 2014).

- *Ex-situ* conservation:

The project "Preservation and storage of aquatic genetic resources and freshwater fisheries breeds" has conserved 75 varieties of 63 species (some lines of *Oreochromis niloticus* species including Thailand, Israel, China, Taiwan, GIFT lines and green tilapia *Oreochromis aureus* species including Israel, Taiwan and China lines). Annually, new fish genetic resources are collected, added and developed. The cryopreservation techniques of aquatic animal sperm have been also applied since 1999, for example, some fish species such as *Cyprinus carpio, Ctenopharyngodon idellus*, *Labeo rohita*, *Cirrhinus mrigala*, catfish (*Pangasius hypophthalmus*), *Barbodes gonionotus*, *Pangasius bocourti* and a number of marine fish species such as grouper and cobia species.

e. *Conservation of microorganism genetic resources*:

Vietnam Type Culture Collection (VTCC) under Vietnam National University Institute of Microorganism and Biotechnology was established in 1996. VTCC has conserved the cultures of microorganisms such as bacteria, fungi, yeast and streptomyces which have high values for food, medical and cosmetic industry such as probiotics and enzymes. About 9000 of microorganism strains are preserved deep frozen, liquid nitro and freeze dried conditions[24].

Microorganisms for agriculture: In the genebank of microbial resources for agriculture of the Soils and Fertilizer Research Institute currently has 580 bacteria strains, 54 strains of antinomycetes, 12 yeast

[24]Vietnam National University, Institute of Microbiology and Biotechnology, 2014
http://imbt.vnu.edu.vn/en/ptn_vn_btg_vsv

strains 12 and 18 strains of filamentous fungi. These strains are stored at a good condition for stable biological activity and high viability. Annually, new microbial strains with symbiotic nitrogen fixation, cellulose resolution, heat and low pH tolerance, inhibition of pathogenic fungi of plant rhizosphere and silicate resolution activities are isolated.

Edigible mushroom: Currently, the group of edible mushrooms has been described, evaluated in terms of morphological and agronomical characteristics with a total of 124 accessions. The characteristics of each strain are already detail evaluatedthe growth and adaptation of the strains. However, the detailed evaluation of genetic resources of edible mushrooms has not been done much.

Microorganism resources for veterinary: Microbial genetic resources for veterinary are wide. Many strains for manufacturing vaccines and reference strains were longstanding the veterinary industry however, they have never been documented and clarified the origins. The conservation is mostly carried out spontaneously depending on the requirements of each study purpose. Consequently, many species have been lost irretrievably. For example, before 2000, Hanoi Medical University preserved about 4,000 strains of pathogenic microorganisms and the Institute of Hygiene and Epidemiology well preserved 4,000 microorganisms, but so far as the management is not paid enough attention, the above genetic resources have been lost or infected that cannot be recovered.

8. *Changes have been detected in Vietnam for the different production systems over the last 10 years in components of associated biodiversity*

Table 23. Trends in the state of components of associated biodiversity within production systems

Production system	**Trends in last 10 years (2,1,0,-1,-2, NK, NA)**			
	Micro-organisms	Invertebrates	Vertebrates	Plants
Crop production systems	NK	-2	-2	-1
Forest production systems	NK	-1	-2	-1
Aquatic production systems	NK	-1	-2	-1
Livestock production systems	NK	NK	NA	NK

Note: *indicate if trends are strongly increasing (2), increasing (1), stable (0), decreasing (-1) or strongly decreasing (-2) in Table 14. If no information is available, indicate not known (NK). If not applicable, (NA)*

9. *The changes or trends in diversity recorded in Table 23*

In general, there is a decrease in both the number and diversity of invertebrates, vertebrates and plants in the all production systems. In recent decades, an ever-increasing human population and related intensive farming practices – including a far greater dependence on chemical pesticide and fertilizer applications – are exerting growing pressure on living aquatic resources. Many of the aquatic species that colonize rice fields come from inland water sources, such as rivers and lakes. However, chemicals, agricultural runoff, sedimentation and other forms of pollution also may accumulate in rice fields and cause environmental damage and the loss of plant and animal species that cannot survive in the deteriorating conditions. In addition, habitat loss through land development activities, the destruction of

fish breeding grounds and illegal and destructive fishing methods, such as electro-fishing or chemical poisoning, further threaten aquatic ecosystems and the people who depend on them (Aquatic THE SITUATION biodiversity in rice fields). Fishes, crustaceans (shrimp and crabs), amphibians (frogs, toads and ... lizards and turtles), molluscs (snails), plants and insects supplement the rice diet have decreased significantly.

10. Ex -situ conservation or management activities or programs for associated biodiversity for food and agriculture

Table 24. *Ex situ conservation or management activities or programs for associated biodiversity for food and agriculture*

Components of associated biodiversity	**Organisms, species and sub-species (where available) conserved**	**Size of collection**	**Conservation condition**	**Objective (s)**	**Characterization and evaluation status**
Microorganisms	**Actinomycetes**: *Acrocarpospora sp., Actinokineospora diospyrosa, Actinomadura nitritigenes, Actinomadura nitrigensis, Actinoplanes sp., Actinoplanes arizonaensis, Actinoplanes aurantiacus, Actinoplanes auranticolor, Actinoplanes brasiliensis, Actinoplanes campanulatus, Actinoplanes capillaceus, Actinoplanes deccanensis, Actinoplanes ferrugineus, Actinoplanes humudus, Actinoplanes minutisporangius, Actinoplanes philippinensis, Actinoplanes regularis, Actinoplanes sarveparensis, Actinoplanes utahensis, Asanoa siamensis,Catellatospora bangladeshensis, Cellulomonas sp., Couchioplanes sp., Dactylosporangium aurantiacum, Herbidospora sp., Isoptericola sp., Kineococcus like, Kineosporia aurantiaca, Kitasatospora putterlickiae, Krasilnikovia cinnamomea, Kribbella sp., Microbispora corallina, Microbispora rosea, Micromonospora carbonacea, Mycobacterium sp., Nocardia lijiangensis, Nonomuraea roseola*	Culture collection	Strains of microorganisms will be stored in the form of freeze-dried ampoules or cryopreserved (-80°C or -130°C) and/or on agra. Deposition of microorganisms would be made by filling up the accession form and sending with two tubes of active culture (for each strain) to the collection. Accession number and two lyophilized tubes of the culture will be	Providing services in the fields of applied microbiology and biotechnology in the form of short- or long-term projects that are carried out on a confidential basis. Organizing training courses to students and researchers who wish to learn knowledge and techniques in working with microorganisms Preservation of important microorganisms	NK

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation condition	Objective (s)	Characterization and evaluation status
	Fungi: *Alternaria chartatum Preuss, Arthrinium phaeospermum, Aspergillus awamori, Beauveria bassiana, Blakeslea trispora, Ceratosporella lamdasepta, Cercophora terricola, Circinella sp., Cladosporium, Cunninghamella sp., Currvularia lunata, Cylindrocladiella sp., Doratomyces stemonitis, Emericella nidulans, Eupenicillium ochrosalmoneum, Eurotium amstelodami, Fusadium oxysporum, Fusarium proliferatum, Gongronella butleri, Graphium penicillioides, Humicola sp., Idriella lunata.*		sent to the depositor after preservation for quality checking (viability and authentication)		
	Yeast: *Ambrosiozyma playtypodis, Ashbya gossypii, Asterotremella humicola, Athroascus javanensis, Aureobasidium sp., Bullera cuulongensis, Candida albicans, Clavispora lusitaniae, Crebrothecium ashbyii, Cryptococcus dejecticola, Debaryomyces hansenii, Endomyces decipiens, Filobasidium capsuligenum, Geotrichum candidum, Hannaella luteolus, Hanseniaspora thailandica, Hansenula anomala, Hyphypichia burtonii, Issatchenkia orientalis, Jaminaea angkoriensis.*				

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation condition	Objective (s)	Characterization and evaluation status
	Edible mushroom: *Pleurotus florida, Pleurotus ostreatus, Pleurotus eryngii, Pleurotus ostreatus , Pleurotus eryngii, Pleurotus ostreatus, Pleurotus eryngii, Pleurotus sapious, Pleurotus corrnucopiae, Pleurotus eryngii ferula, Pleurotus ostreatus colombinus, Pleurotus pulmonarious, Pleurotus sajocaju, Pleurotus geestezanus, Pleurotus cystidiosus, Pleurotus ostreatus, Pleurotus sajor, Ganoderma lucidum, Agaricus bisporus, Agaricus blazei, Lentinus edodes, Auricularia polytricha, Auricularia auricular, Auricularia judae, Volvariela volvacea, Flammulina velutipes, Stropharia rugosa, Pholiota nameko, Coprinus comatus, Tremella fuciformic,Tremella auratiabla, Clitocybe maxima, Agrocybe aegerita, Hypsizygus marmoreus, Pleu rotus nebrodensis, Hericium erinaceus, Pleurotus citrinopileatus, Pleurotus sdimoneo- straminine, Tricholoma lobayense, Dictyophora duplicate, Pleurotus ferulae, Ganoderma lucidum, Hypsizygus marmoreus, Hypsizygus tessulatas, Ganoderma spp, Tricholoma spp, Lentinula edodes,Trametes versicolor*				
	Bacteria: *Acinetobacter radioresistens, Aerococcus urinaeequi, Agrobacterium tumefaciens, Arthrobacter globiformis, Aureobacterium testaceum, Azospirillium brasilence, Bacillus mycoides, Bradyrhizobium japonicum, Brevibacillus brevis, Brevibacterium iodinum, Burkholderia stabilis, Cellulomonas flavigenna, Citrobacter freundii, Cobetia marina, Comamonas,Corynebacterium crenatum, Curtobacterium citreum, Delftia lacustris, Enhydrobacter aerosaccus, Enterococcus faecalis, Halobacillus litoralis*				
Invertebrates	Insect: (see Table 17)				
Vertebrates	U ax head beef, Hmong beef		Genetic specimen (sperm)		Initial characterization, detailed
	Mong Cai pig breed	20 samples	Embryos, cells, DNA		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation condition	Objective (s)	Characterization and evaluation status
	I pig	12 samples	Embryos, cells, DNA		characterization, and evaluation of genetic characteristics
	Nghe An pig	8 samples	Embryos, cells, DNA		
	Ho Chicken	25 samples	Embryos, cells, DNA		
	Mia Chicken	35 samples	Embryos, cells, DNA		
	Ri Chicken	20 samples	Embryos, cells, DNA		
	Dong Tao Chicken	15 samples	Embryos, cells, DNA		
	Ac Chicken (*Gallus gallus domesticus brisson)*	20 samples	Embryos, cells, DNA		
	Zebu *(Bos taurus indicus)*	20 samples	Embryos, cells, DNA		
	Coc Cow	15 samples	Embryos, cells, DNA		
	Deers *(Cervus nippon)*	18 samples	Embryos, cells, DNA		
	Buffalos, Cows, Goats, Pigs and Chickens	7275 samples	Raised		
	*Cyprinus carpio*Linnaeus	379 samples	Raised and *In vitro*		
	Hypophthalmichthys molitrix	200 samples	Raised		
	Oreochromis aureus	180 samples	Raised		
	Oreochromis niloticus	200 samples	Raised		
	Ctenopharyngodon idellus	200 samples	Raised		
	Cyprinus carpio	168 samples	Raised, and *In vitro*		
	Sinilabeo lemassoni	150 samples	Raised, and *In vitro*		
	Spinibarbus hollandi	130 samples	Raised		
	Bagarius yarrelli	100 samples	Raised		
	Mastacembelus armatus	80 samples	Raised		
	Probarbus jullieni	78 samples	Raised		
	Pangasius sanitwongsei	6 samples	Raised		
	Cyprinus carpio	430 samples	Raised		
	Clarias macrocephalus	90 samples	Raised		
	Notopterus chitala	120 samples	Raised		
	Pangasiuslarnaudii	74 samples	Raised		
	Epinephelus malabaricus	40 samples	Raised		
	Epinephelus bleekeri	43 samples	Raised		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation condition	Objective (s)	Characterization and evaluation status
	Epinephelus lanceolatus	3 samples	Raised		
	Plectropomus leopardos	44 samples	Raised		
	Epinephelus fuscoguttatus	30 samples	Raised		
	Ranina ranina	100 samples	Raised		
Plants	**Forest trees***: Illicium verum, Cinnamomum cassia, Castanea mollissima, Camellia oleifera, Phyllostachys pubescens, Dendrocalamus barbatus, Calocedrus macrolepis, Fokienia hodginnsii, Taxus wallichiana, Pinus dalatensis, Erythrophleum fordii, Dalbergia cochinchinensis, Dipterocarpus grandiflorus, Hopea pierrei, Cupressus torulosa, Glyptostrobus pensilis, Pinus krempfii, Pinus kwangtungensis, Taxus chinensis, Keteleeria davidiana, Dacrydium pierrei, Podocarpus Imbricatus, Podocarpus neriifolius, Dialium cochinchinensis, Ormosia balansae, Sindora siamensis, Afzelia xylocarpa, Dalbergia cochinchinensis, Dalbergia oliveri, Pterocarpus pedatus, Xylia xylocarpa, Dipterocarpus retusus, Parashorea chinensis, Dipterocarpus baudii, Dipterocarpus artocarpifolius, Dipterocarpus dyeri, Shorea siamensis , Hopea pierrei, Hopea ferrea, Hopea reticulate, Vatica odorata, Hopea cordata, Shorea falcate, Shorea roxburghii, Dipterocarpus condoensis, Scaphium macropodium, Diospyros mun, Melanorrhoea laccifera, Melanorrhoea usitata, Markhamia stipulate, Garcinia fagraeoides, Cinnamomum balansae, Cinnamomum parthenoxylon Meissn, Cinnamomum parthenoxylon, Maglolia baviensis, Chukrasia tabularis, Rhodoleia championii, Michelia mediocris, Terminalia nigrovenulosa, Chimonobambusa quadrangularis, Phyllostachys aurea, Phyllostachys nigra, Ampelocalamus*		Preserved in protected areas, botanical gardens genebanks, in-vitro		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation condition	Objective (s)	Characterization and evaluation status
	Crops: *Oryza sativa, Sorghum bicolor, Setaria italic, Eleusine coracana, Panicum miliaceum, Triticum aestivum, Hordeum vulgare, Coix lacryma-jobi, Fagopyrum esculentum, Vigna unguiculata subp. Sesquipedalis, Phaseolus vulgaris, Pisum sativum, Vigna grabescens, Clitoria teanatea, Canavalia gladiate, Phaseolus lunatus,* *Mucuna cochinchinensis, Vigna umbellate, Vicia faba, Psophocarpus tetragonolobus, Glycine max, Cajanus cajan, Lablab purpureus, Vigna radiate, Vigna grabescens, Vigna angularis, Pachyrrhizus erosus, Vigna unguiculata var. Unguiculata, Helianthus annuus, Arachis hypogae L., Sesamum indicum, Perilla frutescens var. crispa, Abelmoschus esculentus, Lagenaria sinceraria* *Cucurbita sp., Benincasia hispida, Solanum melongena, Lycopersicon esculentum, Lycopersicon sp., Daucus carota L., Brassica oleracea var. capitata, Brassica sp.,Raphanus sativus, Chrysanthemum coronarium, Sinapis alba, Cucumis sativus, Citrull lanatus, Ocimum basilicum L., Mentha arvensis, Capsicum sp., Perilla frutescens , Celosia argentea, Coriandrum sativum, Basella alba, Mormodica charantia, Luffa cylindrical, Trichosanthes cucumerina, Luffa acutangula, Corchorus olitorius, Hibiscus sabdariffa, Lactuca sativa var. Amarathus sp., Brassica oleracea L. var. botrytis L., Brassica oleracea (D.C.) Pasq. var. caulorapa D.C., Anethum graveolens, Lactuca sativa var. capitata, Allium sp., Elsholtzia ciliate, Petroselium crispum, Cucumis melo , Apium graveolens, Gossypium hisrutum, Colocasia esculenta, Manihot esculenta, Xanthosoma sp., Colocasia esculenta, Dioscorea esculenta, Dioscorea alata, Dioscorea sp., Impomoea batatas, Pueraria thomsoni, Canna edulis, Maranta arundinaceae, Amorphophallus sp., Alpinia sp., Curcuma sp., Zingiber sp., Alocasia sp., Colocasia indica,*		In seed banks, Field banks, In vitro and DNA banks		

Table 25. *List of insect species conserved and developed for agricultural production (Ex situ conservation)*

Local name	**Scientific name**	**Conservation purpose**
Ong mắt đỏ	*Trichogramma chinolis* Ishii; *Trichogramma evanescens*Westw.	Enemy of Lepidoptera
Ong kí sinh kén đơn trắng	*Costesia plutellae*Kurdjumov	Enemy of *Plutella xylostella* species
Ong ký sinh kén trắng	*Apanteles* sp.	Enemy of Aphididae- Homoptera
Ong kí sinh sâu khoang	*Microgaster russata* Haliday	Enemy of Spodoptera litura species
Ong ký sinh rệp	*Diaeretiella rapae* M'Intosh	Enemy of Aphididae- Homoptera
Ong ký sinh ruồi đục lá rau họ Agromyzidae	*Encarsia formosa, Dacnusa sibirica, Opium pallipes,* và *Diglyphus isaea*.	Enemy of Agromyzidae family
Bọ rùa hai mảng đỏ	*Lemnia biplagiata* Swartz	Enemy of Aphididae- Homoptera, and Lepidoptera
Bọ rùa sáu vằn đen	*Menochilus sexmaculatus* Fabricius	Enemy of Aphididae-Homoptera, and Lepidoptera
Bọ rùa đỏ Nhật Bản	*Propylea japonica* Thunberg	Enemy of Aphididae- Homoptera, and Lepidoptera
Bọ rùa chữ nhân	*Coccinella transversalis* Fabricius	Enemy of Aphididae Homoptera, and Lepidoptera
Bọ rùa đỏ	*Micraslis discolor* Fabricius	Enemy of Aphididae Homoptera, and Lepidoptera
Bọ rùa 10 chấm	*Harmonia octomaculata*	Enemy of Aphididae Homoptera, and Lepidoptera
Bọ rùa vàng	*Leis axyridis* Pallas	Enemy of Aphididae Homoptera, and Lepidoptera
Bọ rùa Hốp man	*Scymnus hoffmanni* Weise	Enemy of Aphididae Homoptera, and Lepidoptera
Bọ rùa 18 chấm	*Harmonia axyridis* Pallas	Enemy of Aphididae Homoptera, and Lepidoptera
Bọ rùa 13 chấm	*Synonycha grandis* Thunberg	Enemy of Aphididae Homoptera, and Lepidoptera
Bọ cánh cộc 3 khoang	*Paederus fuscipes* Curtis	Enemy of Lepidoptera
Bọ cánh cộc đen	*Philonthus* sp.	Enemy of Lepidoptera
Ruồi ăn rệp	*Ischiodon scutellaris*	Enemy of Aphididae
Bọ đuôi kìm	*Euborellia annulipes* Lucas *Chelisoches variegates* *Chelisoches morio*	Enemy of Brontispa longissima
Bọ đuôi kìm nâu	*Labidura sp.*	Enemy of Lepidoptera and Coleoptera
Bọ đuôi kìm đen	*Euborellia stali* Dollrr	Enemy of Lepidoptera and Coleoptera
Bọ mắt vàng	*Chrysopa sp.*	Enemy of Aphididae (particularly Pseducoccus)

Local name	Scientific name	Conservation purpose
Bọ chân chạy viền trắng	*Chlaenius circumdatus* Brulle	Enemy of Lepidoptera
Bọ chân chạy đuôi 2 chấm trắng	*Chlaenius bioculatus* Chaudoir	Enemy of Lepidoptera
Bọ chân chạy đen nhỏ cổ dài	*Adacantha metallica (Fairmaira)*	Enemy of Lepidoptera
Bọ chân chạy đen	*Stenolophus quinquepustulatus* Wied	Enemy of Lepidoptera
Chân chạy	*Acupalpus* sp.	
Hổ trùng 8 chấm trắng	*Cicindela tranbaicalica* Most	
Bọ xít cổ ngỗng đỏ	*Sycalus falleni*	Enemy of Lepidoptera
Bọ xít cổ ngỗng đen	*Sycalus croceovittatus*	Enemy of Lepidoptera
Bọ xít nâu	*Coelioxys fuscipennis*	Enemy of Lepidoptera
Bọ xít nâu viền trắng	*Andrallus spinidens* Fabricius	Enemy of Lepidoptera
Bọ xít hoa gai vai nhọn	*Cantheconidae furcellata*	Enemy of Lepidoptera
Bọ xít nâu nhỏ	*Orius sauteri* Poppius *Orius minutes* Linnaeus	Enemy of Lepidoptera
Chuồn chuồn kim xanh	*Agriocnemis femina* (Brauer)	
Nhện linh miêu	*Oxyopes javanus* Thorell	Enemy of Aphididae, moth and caterpillar of Scirpophaga incertulas
Nhện sói	*Lycosa pseudoannulata* B.et.str.	Enemy of Aphididae, Enemy of Lepidoptera
Nhện nhảy	*Bianor hottingchichi* Schenkel	Enemy of Aphididae, Enemy of Lepidoptera
Nhện lưới tròn	*Agriope* sp.	Enemy of Aphididae, Enemy of Lepidoptera
Nhện chân dài	*Tetragnatha javana* Thorell	Enemy of Aphididae, Enemy of Lepidoptera

Table 26. *List of rare precious aquatic species conserved at Institute of Oceanography (Nha Trang, Khanh Hoa)*

Local name	**Scientific name**	**Threat level (IUCN category)**	**Accession number**	**Conservation method**	**Purpose of conservation**
Vertebrate					
Bò biển	*Dugong dugon* (Muller, 1776)	CR	**1**	Preserved in chemicals	Research and visiting
Hải cẩu đốm	*Phoca largha* (Pallas, 1811)	NA	2	Dried type specimen and raised at the museum	Research and visiting
Đồi mồi	*Eretmochelys imbricata* (Linnaeus, 1766)	EN	9	Dried type specimens and raised at the museum	Research and visiting
Tráng bông	*Chelonia mydas* (Linnaeus, 1758)	EN	6	Dried type specimens and raised at the museum	Research and visiting
Vích	*Lepidochelys olivacea* (Eschscholtz, 1829)	EN	1	Dried type specimens	Research
Đú	*Caretta caretta* (Lineaus, 1909)	CR	1	Dried type specimens	Research
Rùa da	*Dernochelys coriacea* (Linnaeus, 1766)	CR	1	Dried type specimens	Research
Cá nhám nhu mì	*Stegostoma fasciatum* (Hermann, 1783)	R	4	Dried type specimens	Research
Cá Nhám đuôi dài	*Alopias pelagicus* Nakamura , 1935	EN	1	Dried type specimens	Research
Cá Nhám voi	*Rhincodon typus* Smith, 1828	EN	2	Dried type specimens	Research
Cá Mặt trăng đuôi nhọn	*Masturus lanceolatus* (Lienard, 1840)	EN	1	Dried type specimens	Research
Cá Mặt trăng đuôi tròn	*Mola mola* (Linnaeus, 1758)	EN	2	Dried type specimens and preserved in chemicals	Research
Cá mập vây đen	*Carcharhinus melanopterus* (Quoy & Gaimard, 1824)	EN	8	Raised at the museum	Research and visiting
Cá mập Mã lai	*Triaenodon obesus* (Rüppell, 1837)		4	Raised at the museum	Research and visiting
Cá giống mõm tròn	*Rhina ancylostoma* Bloch & Schneider, 1801	T	1	Dried type specimens	Research and visiting

Local name	Scientific name	Threat level (IUCN category)	Accession number	Conservation method	Purpose of conservation
Cá chình bông	*Gymnothorax favagineus* Bloch & Schneider, 1801		14	Raised at the musem	Research and visiting
Cá chình thiên long	*Rhinomuraena quaesita* Garman, 1888		2	Specimens preserved in chemicals	Research
Cá ngựa gai	*Hippocampus histrix* Kaup, 1856	VU	2	Specimens preserved in chemicals	Research
Cá ngựa lớn	*Hippocampus kuda* Bleeker, 1852	V	5	Raised at the museum	Research and visiting
Cá ngựa Nhật	*Hippocampus japonicus* Kaup, 1856	R	3	Specimens preserved in chemicals	Research and visiting
Cá ngựa thân trắng	*Hippocampus kellogggi* Jordan & Snyder, 1902	VU	8	Raised at the museum	Research and visiting
Cá bò xanh hoa đỏ	*Oxymonacanthus logirostris* (Bloch & Schneider, 1801)	R	1	Raised at the museum	Research and visiting
Cá khoang cổ	*Amphiprion frenatus* Brevort, 1856		15	Specimens preserved in chemicals and raised at the museum	Research and visiting
Cá khoang cổ	*Amphiprion ocellaris* Cuvier, 1830		60	Specimens preserved in chemicals and raised at the museum	Research and visiting
Cá khoang cổ	*Amphiprion clarkii* (Bennett, 1830)		14	Specimens preserved in chemicals and raised at the museum	Research and visiting
Cá chim hoàng đế	Pomacanthus imperator (Bloch, 1787)	VU	2	Raised at the museum	Research and visiting
Cá chim xanh nắp mang tròn	Pugoplites diacanthus (Boddaert, 1772)	VU	1	Specimens preserved in chemicals	Research
Cá bàng chài đầu đen	Thalassoma lunare (Linnaeus, 1758)	VU	1	Specimens preserved in chemicals	Research

Local name	Scientific name	Threat level (IUCN category)	Accession number	Conservation method	Purpose of conservation
Không xương sống	**Invertebrates**				Research
Hải sâm vú đen	*Holothuria (Microthele) nobilis* (Selenka, 1867)	EN	1	Specimens preserved in chemicals	Research
Hải sâm mít	*Actinopyga echinites* (Jaeger, 1883)	VU	1	Specimens preserved in chemicals	Research
Đồn độ dừa	Actinopyga mauritiana (Qouy & Gaimard, 1833)	VU		Specimens preserved in chemicals	Research
Hải sâm lựu	*Thelenota ananas* (Jaeger, 1833)	EN	2	Specimens preserved in chemicals	Research
San hô trúc	*Isis hipputis* Linnaeus, 1758	R	1	Dried type specimens	Research
Tôm hùm đá	Panulira homarus (Linnaeus, 1758)	EN	7	Raised at the museum	Research
Tôm hùm bông	Panulirus ornatus (Fabrivus, 1798)	VU	2	Dried type specimens	Research
Tôm hùn sen	*Panulirus versicolor* (Latreille, 1804)	VU	1	Dried type specimens	Research
Tôm vỗ dẹp trắng	Thenus orientalis (Linnaeus, 1758)	VU	1	Specimens preserved in chemicals	Research
Cua huỳnh đế	*Ranina ranina* (Linnaeus, 1758)	VU	2	Specimens preserved in chemicals	Research
Ốc đụn đực	*Trochus pyramis* Born, (1778)	EN	11	Dried type specimens	Research
Ốc đụn cái	*Tectus niloticus* (Linnaeus, 1767)	EN	5	Dried type specimens	Research
Ốc xà cừ	*Turbo marmoratus* Linnaeus 1758	EN	2	Dried type specimens	Research
Ốc tù và	*Charonia tritonis* (Linnaeus, 1758)	VU	2	Dried type specimens	Research
Ốc kim khôi	*Cassis cornuta* (Linnaeus, 1758)	VU	2	Dried type specimens	Research
Trai tai tượng khổng lồ	*Tridacna gigas* (Linnaeus, 1758)	R	1	Dried type specimens	Research
Trai tai bồ	*Tridacna squamosa* Lamarck, 1819		1	Dried type specimens	Research
Trai tai nghé	*Tridacna crocea* Lamarck, 1819		1	Dried type specimens	Research

Local name	Scientific name	Threat level (IUCN category)	Accession number	Conservation method	Purpose of conservation
Bào ngư vành tai	*Haliotis asinina* (Linnaeus, 1758)	VU	3	Dried type specimens	Research
Bào ngư 9 lỗ	*Haliotis diversicolor* Reeve, 1846	CR	5	Dried type specimens	Research
Bào ngư bầu dục	*Haliotis ovina* Gmelin, 1791	VU	5	Dried type specimens	Research
Ốc sứ	*Cypraea testudinaria* Linnaeus, 1758	VU	5	Dried type specimens	Research
Ốc sứ mắt trĩ	*Cypraea argus* Linnaeus, 1758	CR	5	Dried type specimens	Research
Ốc sứ bản đồ	*Cypraea mappa* Linnaeus, 1758	VU	3	Dried type specimens	Research
Trai ngọc môi đen	*Pinctada margaritifera* (Linnaeus, 1758)	VU	3	Dried type specimens	Research
Trai ngọc môi vàng	*Pinctada maxim*a (Jameson, 1901)	VU	3	Dried type specimens	Research
Trai ngọc nữ	*Pteria penguin* (Roding, 1798)	VU	3	Dried type specimens	Research
Trai bàn mai	*Atrina vexillum* (Born, 1798)	EN	2	Dried type specimens	Research
Tu hài	*Lutraria rhynchaena* Jonas, 1844	EN	2	Dried type specimens	Research
Ốc anh vũ	*Nautilus pompilius* Linnaeus, 1758	CR	2	Dried type specimens	Research
Mực nang vân hổ	*Sepia (tigris) pharaonis* Ehrenberg, 1831	VU	2	Dried type specimens	Research

Sources: *Institute of Oceanography, 2014*

11. In-situ conservation and management activities or programs in Vietnam that support the maintenance of associated biodiversity

Table 27. In- situ conservation or management activities or programs for associated biodiversity for food and agriculture

Components of associated biodiversity	**Organisms, species and sub-species (where available) conserved**	**Site name and location**	**Production system(s) involved (code or name**	**Conservation objective (s)**	**Specific actions that secure associated biodiversity or ecosystem services**
Microorganisms	NK	NK	NK	NK	NK
Invertebrates	***Aquatic species**: Haliotis sp., Trochus sp., Nerita sp., Turbo sp., Ovula sp.Pinctada sp., Pteria sp.,(Mytilus sp., Asaphis sp. Anomalocardia sp., Loligo sp., Sepia sp., Panulirus sp.,Tachypleus sp., Holothuria sp.,Cephalopholis sp., Epinephelus sp., Euthynuus sp., Hypnea sp., Caulerpa sp., Acasta sulcata., Armatobalanus allium., Balanus Amphitrite., Chinochthamalus scutelliformis., Chirona amaryllis., Chthamalus malayensis., Hiroa stubbingsi., Ibla cumingi., Lepas anatifera.,Megabalanus ajax, Megabalanus tintinnabulum., Nobia conjugatum., N. grandis, Octolasmis warwicki,Pollicipes mitella, Savignium crenatum, S. milleporum, Tesseropora alba, Tetraclita japonica, T. squamosa,Tetraclitella costata., Lepas anserifera, L. pectinata, Acasta japonica,Archiacasta tenuivalvata, Balanus condakovi, Solidobalanus socialis and Tetrachthamalus Sinensis* **Insect species:** NK		Conserved in the protected areas, marine protected areas		

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name	Conservation objective (s)	Specific actions that secure associated biodiversity or ecosystem services
Vertebrates	**Aquatic species**: *Proteracanthus sarissophorus*, *Cheilinus undulates,*		- In the protected areas,		
Plants	**Forest plant species***: Calocedrus macrolepis, C. rupestris, Fokienia hodginsii, Taxus wallichiana, Pinus dalatensis, Dalbergia cochinchinensis, Dipterocarpus grandiflorus, Dialium cochinchinensis, Cupressus torulosa, Hopea pierrei, P. krempfii, Pinus kwangtungensis, Taxus chinensis,Keteeleria evelyniana, Dacrydium pierrei, Podocarpus Imbricatus, Podocarpus neriifolius, Dialium cochinchinensis, Ormosia balansae , Sindora siamensis, Afzelia xylocarpa, Dalbergia cochinchinensis, Dalbergia bariensis, Pterocarpus macrocarpus, Xylia xylocarpa, Dipterocarpus retusus, Parashorea chinensis H.Wang, Dipterocarpus baudii, Dipterocarpus artocarpifolius, Dipterocarpus dyeri, Shorea siamensis,Hopea pierrei Hance, Xanthophyllum colubrinum, Hopea reticulate, Vatica odorata, Vatica mangachapoi, Vatica tonkinensis, Hopea cordata, Shorea falcate, Shorea roxburghii, Dipterocarpus condoensis, Scaphium macropodium, Diospyros mun, Melanorrhea laccifera, Melanorrhoea usitata, Markhamia stipulate,Garcinia fagraeoides, Cinnamomum parthenoxylon, Cinnamomum*				

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Site name and location	Production system(s) involved (code or name	Conservation objective (s)	Specific actions that secure associated biodiversity or ecosystem services
	parthenoxylon,Maglolia baviensis, Chukrasia tabularis, Rhodoleia championii, Michelia mediocris,Terminalia nigrovenulosa, Chimonobambusa quadrangularis, Phyllostachys aurea, Phyllostachys nigra , Ampelocalamus sp., Illicium verum, Cinnamomum cassia, Castanea mollissima, Phyllostachys pubescens, Camellia oleifera, Dendrocalamus barbatus				
	Crops: *Saccharum officinarum, Saccharum spontaneum, Saccharum sinense, Erianthus arundinaceus, Miscanthus sp, Sclerostachya, Saccharum robustum,Camellia sinensis, a variety of flower species including species of Orchids and other, fodder species, plant species for improvement of soil nutrient, species of Mulberry, coffee species, species of industrial crops, fruit species: citrus, pomelo, dragon, lemon, pineapple, star fruit, Lucuma caimito, Punica granatum, Syzyum spp., banana, litchi, longan, mango, kaki (Japanese persimmon), avocado, guava, peach, kiwi, pear, plum*				

12. Activities undertaken in Vietnam to maintain traditional knowledge of associated biodiversity

The Convention on Biological Diversity (CBD) recognizes the value of the 'knowledge, innovations and practices of indigenous and local communities' for the conservation and sustainable use of biological diversity. However, this knowledge is under increasing threat, from intellectual property regimes and other processes which undermine traditional livelihoods based on natural resource management.The role of indigenous knowledge has just been recognized in recent years by some research institutions and NGOs in Vietnam. But many obstacles such as environmental degradation, lack of sound policy and economical development make the preservation and promotion of IK become difficult.

Regarding documentation and dissemination, not many studies on Indigenous Knowledge System (IKS) have been done in Vietnam. Up to now, there are only two main official publications on IKS including Indigenous Knowledge of the Vietnam Uplanders in Agriculture and Natural Resources Management and the Role of Customary Law in Rural Sustainable Development. In addition, lack of IK resources centre or fragmented information and the absence of an academic institute on IK issues are obstacles. The IK studies have just been collecting works and published in the national language instead of conducting comprehensive research and publishing in ethnic minority group languages. Furthermore, IK contents have not been integrated in the curriculum of formal education system. In the area of institution, although the role of IKS has been recognized and mentioned in Directive 36 – Environmental Protection Task by the Communist Party and government legislation, it still lacks an action framework to utilize it in the socio-economic development. To date, Vietnam does not have a national IKS development strategy[25].

a. Preserving indigenous knowledge, innovations and practices

The Institute of Ecology and Biological Resources (IEBR), the National Institute of Medicinal Materials, Ha Noi University of Pharmacy, and the Institute of Social Sciences have conducted research on anthropological botany over many years. They have investigated, assessed, conserved and assisted in further development of indigenous knowledge of mountainous ethnic communities related to natural resource protection and utilization. As a result, hundreds of medicinal plants and traditional family-based remedies have been collected from Dao, Nung, Tay, and Hmong ethnic minority populations in mountainous areas in Vietnam. Some traditional practices such as protecting the holy forests and holy watersheds (home to many species of flora andfauna) are maintained and developed by local authorities. Several traditional festivals like *Cau ngu* (praying for fish) in coastal communities are still organized every year.

b. Best practices:

An interesting example regarding the role of IK in conserving natural resources comes from a village in North West Mountain Region of Vietnam. Thai ritual management of natural resources - a model of community based forest management[26]. The ritual and worldview of the Thai ethnic minority group in the village named Ban Banh of Muong Luan in Dien Bien Dong District of Lai Chau province promotes a social mechanism that helps them maintain an ecological balance in resource management. Their beliefs in spirit and magic power have been the basis of setting up their customary laws to manage the natural resources, which is directly related to the spiritual life of all local Thai people. It is also under management and monitoring by a local management board and local leaders. Based on the belief that their management of "sacred" forest of local people's ancestors are "living" in the forest, local rules have been created for the sake of stability in the local people's lives, and the forest must be well looked after and protected. Because this forest is the common property of the community, encroachment into it is forbidden. With their traditional

[25] Tran Chi Trung, Le Xuan Quynh, Vu Van Hieu (2007) The Role of Indigenous Knowledge in Sustainable Development: A Case Study of The Vietnam Mountain Regions

[26]Indigenous Knowledge and Customary-based Regulations in Managing Community Forest by the Thai Ethnic Group in Vietnam's Northern Mountain Region

knowledge, the Thai villagers know how, when, and what they should collect from the forest. Only dried branches and fallen trees are collected and the profits from selling these go into a common community fund. Moreover, harming the forest means damaging the safety and tranquility of all villagers. They believe that encroaching into the scared forest not only disturbs the lives of villagers' ancestors but also means offending "spirit", who will react by kidnapping the souls of the offender and, may be, other villagers; as a consequence, this person and some others could become insane or die. Thus, any villager who gets caught breaking the laws not only suffers himself/herself from the anger, but the offender must also give a buffalo and pay other expenses to the sick person(s)'family(s) in the village to offer to the spirit to release them from the sickness. If any one dies in this period the offender must leave the village to live elsewhere. With these rules which form the Thai ritual beliefs, the sacred forest in the Lai Chau has been maintained very well. The system and methods for effectively managing and developing the community forest in Ban Banh has become a model of "real "community-based forest management in Lai Chau Province[27].

The second practice is the application of agro-forestry models. This can improve the incomes of local community and ensures sustainable use of land in accordance with sustainable forest management such as:Model of growing cinnamon with rice, corn, cassava of Dao ethic minority people in Yen Bai, Quang Ninh, ethnic minorities in Quang Nam, the model of cinnamon grown under the forest canopy or in gaps in the forest of K'Ho ethnic minority people in Quang Nam and Quang Ngai province, the model of bamboo combined with corn and upland rice in the first 2 years of bamboo growth period of Muong ethnic minority people in Thanh Hoa province, the model of growing tea under forest canopy of Bodhi, Pine and Acacia plants in the Northern mountainous provinces, the model of growing pineapple under the forest canopy and the model of growing cardamom under the forest canopy of ethnic minorities in Yen Bai province

c. Lesson learned:

The success of community forest management and development in Ban Banh is due to the following factors:

- Setting up the community forest in Ban Banh and managing it communally is appropriate to Thai custom, in which forest is considered the common property of the whole community. Community members join hands and are responsible for observing their local law. The village chief and the village elders' council are highly prestigious and play the most important roles in ensuring the interests of the whole community are protected.
- The community rules are set up by the villagers themselves. They initiated and committed themselves to participate in all processes of creating their own effective regulation. The motivation of the Thai villagers for doing this stems from their desire to preserve their traditional culture and lifestyle, which are threatened partly by losing forest.
- The rules are developed based on Thai indigenous knowledge of local forest flora and biodiversity, so that they can help to prevent human disturbance of the development of vegetation in the critical period of the year and overexploitation of forest resources. As a consequence, the forest is being sustainably managed and biodiversity is protected.
- Strong community leadership has contributed to the successful implementation of the community regulations. It is indicated in the ways community leaders have worked together, which convinced local authorities and state agencies to accept the rules and community forest management before they were acknowledged by the state[17].

13. Gender dimensions with respect to the maintenance of and knowledge about associated biodiversity

Role of men and women in conservation and development of IK

[27] Pham Tuong Vi, Tran Chi Trung (2004) Indigenous Knowledge and Customary-based Regulations in Managing Community Forest by the Thai Ethnic Group in Vietnam's Northern Mountain Region

Many factors affect IK such as gender, age, education, access to and transfer of information.There is a common result for all ethnic groups when they are surveyed, women are evaluated as having a good memory, dexterity in jobs that require meticulous and they also have good understandings of the natural conditions of crops and wild plants. Commonly, when a man was asked, the final answers were always got from the woman sitting next to him.

In the ethnic minority groups, so far the division of labor is based on age and gender. Men often do the heavy work and women often do the lighter work such as childcare and domestic work. Men might know more about the land, and wood kinds for making houses and the behavior of wild animals while women have their own strength of observations of the nature to predict the weather, the biological features of the tubers /wild fruit /vegetable and forest insects. Furthermore, women often have higher ability to cope with hunger cases. In addition, women of Hmong, Thai and Kho Mu ethnic people also have invaluable knowledge of weaving, embroiling and brocade. Most patterns on women's dresses reflect the natural world (Son et al., 2009).

In the field of medicine and pharmacy, women also know more about herbs that can be used for treatment of common diseases of people and animals. For some ethnic minority groups, such as H'mong, Dao and San Diu, the finding and processing of herbal medicines seems to be the main task of women. Therefore, the encouragement of women participationin biodiversity conservation and the activities of responding to climate change is very important in order to ensure the success[28].

Another servey in a village of Black Thai ethic people in Son La province showed that the villagers could identify hundreds of natural plants having economic and medicinal values. This experience is passed from mothers to daughters or daughters in law. Therefore, Thai women know the use of these plants more than men, especially plants for medical and food purpose. Thai women are an important factor in the economic development of their family. However, their role in management and use of natural resources has not been properly evaluated[29].

Research on women's participation in some activities (2006-2010) showed that: Women take over 50% of forestry activities; Women's role in the development of production, processing and consumption (45%); exploitation of non-timber products (70%), plantation (57%), nursery (70%); Dissemination of forestry policies and laws(10%); Participation in forestry extension activities and training (20%); Forest Protection and Management (20%); and Management and staffing at department and sub-department level (15%)[30].

Research conducted by Nguyen Thi Ngoc Hue (1999) showed that in agricultural activities, women were responsible for looking after seedlings and cattles. Women themselves maintained seed for the next season. Other activities were shared between men and women. Most common knowledge of medicinal plants resides with women[31].

The study on the role of Thai ethnic women in the utilization of natural vegetation showed that exploitation, process of natural vegetation species were entirely responsibility of women. Men only partially involved in the harvesting of medicinal plants and some other plants[32].

Table 28. *Gender dimension in the utilization of natural vegetation of Thai people*

[28]Mai Thanh Son, Le Dinh Phung, Le Duc Thinh (2011), Climate change: effects, response ability and some policy related issues (Study on minority ethnic people in Nothern mountainous areas)

[29]Cam Thi Tu Lan (…), Indegenous knowledge of Thai ethnic minority women in Nothern mountainous area in agriculture and management of natural resources

[30] Nguyen Tuong Van (2013), Workshop on gender mainstreaming in national forestry policy, Vietnam Administration of Forestry (VNFOREST), MARD

[31] Nguyen Thi Ngoc Hue (1999), Gender dimensions in biodiversity management and food security: policy and programme strategies for Asia, FAO Regional technical consultation

[32]Cam Thi Tu Lan, Hoang Quang Huy, Vu Van Thuan and Tran Thi Sen (2004), Indigenous Knowledge of Thai ethnic in agriculture and management of natural resources

TT	Activities	Labor division (%)	
		Women	Men
1	**Medical plants**		
	Planting	100	-
	Harvesting	90	10
	Processing	100	-
	Selling	100	-
2	**Gathering bamboo shoot**	70	30
3	**Harvesting vegetable and fodder**	80	20

14. Wild food species known to be harvested, hunted, captured or gathered for food in Vietnam.

(Indicate in or around which production system the species is present and harvested, and the change in state of the species over the last 10 year)

Table 29. Wild species used for food in Vietnam

Wild food	Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Differences within species identified and characterized (Y/N)	Source of information
Wild plants for fruit	Quả vả (Fig)	*Ficus auriculata*	Forest and many other ecosystems		http://www.iebr.ac.vn/database/HNTQ/957.pdf (Bay et al., 2013)
	Quả ngái	*Ficus hispida*	Forest		
	Sung	*Ficus racemosa*	Forest, homegardens and other ecosystems		
	Quýt gai	*Atalantia buxifolia*	Forest		
	Quyt	*Citrus reticulate*	Forest		
	Cơm rượu	*Glycosmis pentaphylla*	Crop fields		
	Nhãn rừng	*Dimocarpus fumatus subsp. Indochinensis*	Forest		
	Vải rừng	*Nephelium cuspidatum var. bassacense*	Forest		
	Vải guốc	*Xerospermum noronhianum*	Forest		
	Trám đen	*Canarium tramdenum*	Forest and homegarden		
	Trám trắng	*Canarium album*	Forest and homegarden		
	Trám chim	*Canarium tonkinense*	Forest and homegarden		
	Cọ bắc bộ	*Livistona tonkinensis*	Forest and homegarden		
	Mâm xôi	*Rubus alcaefolius*	Forest and crop fields		
	Ngấy trâu	*Rubus leucanthus*	Forest and homegarden		
	Ngấy lá hồng	*Rubus rosaefolius*	Forest and homegarden		
	Đào bánh xe	*Rhaphiolepis indica*	Forest		
	Cà ổi ấn độ	*Castanopsis indica*	Forest		
	Cà ổi lá đa	*Castanopsis tesselata*	Forest		
	Cà ổi bắc bộ	*Castanopsis tonkinensis*	Forest and homegarden		
	Cà ổi gai	*Castanopsis triluboides*	Forest and homegarden		
	Sồi đá	*Lithocarpus corneus*	Forest		
	Giẻ quả vát	*Lithocarpus truncates*	Forest		

Wild food	Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Differences within species identified and characterized (Y/N)	Source of information
	Sấu	*Dracontomelon duperreanum*	Forest and homegarden		
	Dâu da xoan	*Allospondias lakonensis*	Forest and homegarden		
	Me rừng	*Phyllanthus emblica*	Forest		
	Thị	*Diospyros decandra*	Forest and homegarden		
	Cườm thị	*Diospyros malabarica*	Forest and homegarden		
	Tai chua	*Garcinia cova*	Forest and homegarden		
	Dọc	*Garcinia multiflora*	Forest and homegarden		
	Bứa nhuộm	*Garcinia tinctoria*	Forest and homegarden		
	Sổ bà	*Dillenia indica*	Forest		
	Hồng quân	*Flacourtia rukam*	Forest		
	Chuối rừng	*Musa acuminate*	Forest		
Wild plants used as vegetable	Rau sắng	*Melientha suavis*	Forest		http://hodinhhai.blogspot.com/2014/04/rau-bo-khai.html (Assessed on 13 Oct, 2014) http://vi.wikipedia.org/wiki/Rau_d%E1%BB%9Bn
	Bò khai	*Erythropalum scandens*	Forest		
	Rau dớn	*Diplazium esculentum*	Forest		
	Rau bợ	*Marsilea quadrifolia*	Crop field		
	Cây quang	*Alangium barbatum*			
	Rau dệu	*Alternanthera sessilis*	Crop field and homegarden		
	Dền gai	*Amaranthus spinosus*	Crop field and homegarden		
	Dền cơm	*Amaranthus lividus*	Crop field and homegarden		
	Càng cua	*Peperomia pellucida*	Crop field and homegarden		
	Hu lá hẹp	*Trema angustifolia*	Forest and foothill		
	Hu đay	*Trema orientalis*	Forest and foothill		
	Đỏ ngọn	*Cratoxylum pruniflorum*	Forest and foothill		
	Vầu ngọt	*Indosasa crassiflora*	Forest		
	Vầu đắng	*Indosasa sinica*	Forest		
	Giang	*Ampelocalamus patellaris*	Forest		
	Cây bướm trắng	*Bauhinia viridescens*	Forest		http://www.pgrvietnam.org.vn/UserFiles/File/Bao
	Dưa mông	*Cucumis sativus L*	Forest		
	Xoài	*Mangifera indica*	Forest		

Wild food	Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Differences within species identified and characterized (Y/N)	Source of information
	Quao núi	*Stereospermum colais*	Forest		%20cao%20Khoa%20hoc/Dac%20diem%20nong%20sinh%20hoc%20cay%20Buom%20trang.pdf (Hue et al., 2014) http://iebr.ac.vn/database/HNTQ/964.pdf
	Điều nhuộm	*Bixa orellana*	Forest		
	Lim xanh	*Erythrophleum fordii*	Forest		
	Bồ kết	*Gleditsia australis*	Forest		
	Chiêu liêu ổi	*Terminalia corticosa*	Forest		
	Côm xanh	*Elaeocarpus varunus*	Forest		
	Chòi mòi chua	*Antidesma acidum*	Forest		
	Thẩu tấu	*Aporosa dioica*	Forest		
	Rù rì	*Homonoia riparia*	Forest		
	Cẩm lai	*Dalbergia oliveri*	Forest		
	Căm xe	*Xylia xylocarpa*	Forest		
	Gối hạc	*Leea indica*	Forest		
	Dướng	*Broussonetia papyrifera*	Forest		
	Cơm nguội đào	*Ardisia insularis*	Forest		
	Nhàu núi	*Morinda citrifolia*	Forest		
	Bưởi	*Citrus grandis*	Forest		
	Sầu đâu	*Brucea javanica*	Forest		
	Song voi	*Plectocomiopsis geminiflora*	Forest		
	Thổ phục linh	*Smilax glabra*	Forest		
	Sa nhân quả có mỏ	*Amomum muricarpum*	Forest		
	Giả sa nhân	*Hornstedtia sanhan*	Forest		
	Địa liền	*Kaempferia galangal*	Forest		
Plants for starch	Củ ráy	*Alocasia macrorrhizos*	Forest and homegarden		
	Khoai tầng vàng	*Colocasia esculenta*	Forest		
	Củ cái	*Dioscorea alata*	Forest		
	Củ mài	*Dioscorea persimilis*	Forest and homegarden		
	Hoàng tinh bột	*Maranta arundinacea*	Forest and homegarden		
	Búng báng	*Arenga pinnata*	Forest		
	Khoai tây	*Solanum tuberosum*	Forest		
Aquatic resources	Ca tra dầu	*Pangasianodon gigas*	River		
	Cá đuối bông	*Dasyatis laosensis*	River		

Wild food	Species (local name)	Species (scientific name)	Production systems or other environments in which present and harvested	Differences within species identified and characterized (Y/N)	Source of information
	Cá đuối mỏ chim	*Himantura oxyrhynchus*	River		
	Cá mập mũi cưa	*Pristis zijsron*	River		
	Cá trà sóc	*Probarbus jullieni*	River		
	Cá cháy lào	*Tenualosa thibaudeaui*	River		
	Cá mập trắng	*Carcharhinus leucas*	River		
	Cá cườm Đông dương	*Chitala blanci*	River		
	Cá bống đỏ bi cô	*Redigobius bikolanus*	River		
	Cá vồ cờ	*Pangasius sanitwongsei*	River		
	Cá rô đồng	*Anabas testudineus*	River, lake, pond, paddy rice fields, and swamp		http://thatsonchaudoc.com/banviet2/LuongThuTrung/HoiKy/CachGoiTenVaiLoaiCaVungNuocNgot.htm
	Cá diếc	*Carassius auratus*	River, lake, swamp, paddy rice field		
	Cá quả	*Channa micropeltes*	River, swamp, pond		
	Cá nhái	*Exocoetus volitans*	Sea		
	Cá chốt giấy	*Hemibagrus planiceps*	River		
	Cá trê vàng	*Clarias macrocephalus*	River, lake, pond, rice field and swamp		
	Cá trê trắng	*Clarias batrachus*	Pond, lake, river, stream and river basin		
	Cá Linh	*Danio dangila*	Rice field, river		
	Cá he nghệ	*Barbonymus schwanenfeldii*	Sea		
	Cá bống mú	*Gobio gobio*	River, lake, pond		
	Cá thát lát	*Notopterus notopterus*	River		
	Cá trèn bầu,	*Ompok bimaculatus*	River		
	Cá bụng,	*Phallostethus cuulong*	River		
	Cá sặc rằn	*Trichogaster pectoralis*	River, pond		
	And many marine fish species				

Note: (strongly increasing (2), increasing (1), stable (0), decreasing (-1), or strongly decreasing (-2), or not known (NK)).

15. Wild food species for which there is evidence of a significant threat of extinction or of the loss of a number of important populations in Vietnam (following the IUCN Red List Categories And Criteria 19)

Table 30. Main threats to wild food species identified as at risk.

Wild food species (scientific name)	Degree of threat	Main threat (indicate)	References or resources of information
Callerya speciosa (Champ. ex Benth.) Schot (Cát sâm)	**VU** A1a,c,d	Overexploaitation	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (assessed on 10/10/2014) 2.http://tapchi.vnu.edu.vn/upload/2014/04/1334/4.pdf
Panax vietnamense Ha & Grushv. (sâm Ngọc Linh)	**EN** A1a,c,d, B1+2b,c,e	Specific habitat, overexploitation	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (Assessed on 10/10/2014) *2*.http://125.235.3.98/dspace/bitstream/123456789/9994/1/317-331_TC%20Cong%20nghe%20Sinh%20hoc_2011_T.%209_%20So%203.pdf *3*.http://tapchi.vnu.edu.vn/tn_4_07/b9.pdf
Melientha suavis Pierre (rau sắng)	**VU** B1+2e	Overexploitation	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (Assessed 10/10/2014) 2.http://voer.edu.vn/pdf/8b6e8807/1
Balanophora laxiflora Hemsl. (Nấm đất)	**EN** B1+2b,c,e	Overexploitation	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.tamdaonp.com.vn/index.php/dong-thuc-vat/thuc-vat/10.html (10/10/2014)
Oryza rufipogon Griff. (Lúa trời)	**VU** A2c, B1+2c	Habitat loss	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.thanhnien.com.vn/pages/20100827/lua-ma-ky-an.aspx (10/10/2014)
Lithocarpus vestitus (Hickel & A. Camus) A. Camus (Dẻ cau lông trắng)	**EN** A1c,d	Overexploitation, habitat loss	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2. www.iebr.ac.vn/database/HNTQ/525.pdf 3.www.awsassets.panda.org/downloads/hcvf_toolkit_of_vietnam_vn.pdf
Arborophila david Delacour, 1927 (Gà so cổ hung)	**EN** B1 +2b, c,d,e C1+2a	Destroyed habitat, excessively hunted	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.vncreatures.net/chitiet.php?page=1&loai=1&ID=5710

Wild food species (scientific name)	Degree of threat	Main threat (indicate)	References or resources of information
			(10/10/2014) 3. http://cattiennationalpark.vn/print.aspx?nid=185 (10/10/2014)
Clupanodon thrissa (Linnaeus, 1758*)* (Cá mòi cờ hoa)	**EN** A1a,d B1+2a,b,c	Illegally overexploitation	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.vncreatures.net/chitiet.php?page=2&loai=1&ID=5108 (10/10/2014) 3.http://www.rimf.org.vn/bantin/tapchi_newsdetail.asp?TapChiID=30&muctin_id=2&news_id=1843 (10/10/2014)
Haliotis diversicolor Reeve, 1846 (Bào ngư chín lỗ)	**CR** A1a,c,d	Overexploitation, poisoned, habitat loss	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.vncreatures.net/chitiet.php?page=6&loai=1&ID=6174 (10/10/2014)
Lophura edwardsi (Oustalet, 1896) (Gà lôi lam mào trắng)	**EN** B1+ 2b,c,d,e C1+2a	Overexploitation, habitat loss	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html(10/10/2014) 2.*www.*hueuni.edu.vn/hueuni/issue_file/49_16.pdf *3.*http://www.vncreatures.net/chitiet.php?page=1&loai=1&ID=5705*(10/10/2014)*
Lophura hatinhensis (Vo Quy, Đo Ngoc Quang, 1975) (Gà lôi lam đuôi trắng)	**EN** B1 + 2b,c, d,e C1 + 2a	Excessively hunted, destroyed habitat	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.vncreatures.net/chitiet.php?page=1&loai=1&ID=5707 (10/10/2014)
Lophura imperialis (Delacour et Jabouille, 1924) (Gà lôi lam mào đen)	**CR** A1b,c,d B1+ 2c,e C2a.	Overexploitation, habitat loss	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.vncreatures.net/chitiet.php?page=1&loai=1&ID=5706 (10/10/2014)
Tragopan temminckii (Gray, 1831) (Gà lôi tía)	**CR** A1a,c,d C2a	Narrowed habitat, overexploitation	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.vncreatures.net/chitiet.php?page=1&loai=1&ID=5709 (10/10/2014)
*Panulirus homarus (*Linnaeus, 1758)	**EN** A1c,d	Polluted and	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html

Wild food species (scientific name)	Degree of threat	Main threat (indicate)	References or resources of information
(Tôm hùm đá)	B2b+3d	poisoned habitat, overexploitation	(10/10/2014) 2.*www*.tailieuso.udn.vn/bitstream/TTHL_125/4987/2/Tomtat.pdf 3.http://www.vncreatures.net/chitiet.php?page=3&loai=1&ID=5825 (10/10/2014)
Panulirus longipes (A.M.Edwards, 1868) (Tôm hùm đỏ)	**EN** A1c,d B2b +3d	Habitat loss, overexploitation	1.http://www.biodivn.com/p/danh-luc-o-viet-nam-phan-thuc-vat.html (10/10/2014) 2.http://www.vncreatures.net/chitiet.php?page=3&loai=1&ID=5826 (10/10/2014)
Pangasianodon gigas (cá tra dầu)	**CR**	Overexploitation, pollution and habitat loss	http://www.mrcmekong.org/assets/Publications/technical/Tec_paper10_vn.pdf (13/10/2014)
Dasyatis laosensis	**VU**	Overexploitation and habitat loss	http://www.iucnredlist.org/details/39407/0 (assessed 15 December 2014)
Himantura oxyrhynchus	**VU**	Overexploitation and habitat loss	http://www.iucnredlist.org/details/44185/0 (assessed 15 December 2014)
Probarbus jullieni	**EN**	Overexploitation	http://nbc.org.vn/chi-tiet-bai-viet/572/ca-tra-soc.html
Tenualosa thibaudeaui (Cá cháy)	**VU**	Overexploitation and habitat loss	http://www.tinvasong.com/?articleId=33007

16. Ex-situ conservation or management activities or programmes established in Vietnam for wild food species

Table 31. Ex situ conservation or management activities or programmes for wild food species

Components of associated biodiversity	Organisms, species and sub-species (where available) conserved	Size of collection	Conservation condition	Objective (s)	Characterization and evaluation status
Microorganisms	**NK**	NK	NK	NK	NK
Invertebrates					
Vertebrates					

Table 32. Ex situ conservation of wild vegetable germplasm collected from different agro-ecological regions at Plant Resources Center (Until 12/2010)

Agro-ecological regions	Number of accessions	Number of species	Representative species	Characterization and evaluation status
Northwest region	1635	53	*Ficus callosa* Willd.	Detailed evalutation of agro-morphological characteristics
Northeast region	919	57	*Erythropalum scandens*	
Red River Delta	848	51	*Meliantha suarvis*	
Central North	533	37	*Gynura procumbens* L.	
Central South	77	29	*Centella asiatica* L.	
Highlands	332	50	*Bihaunia viridescens* Desv	
Southeast	162	42	*Peperomia pelluciada* Konth	
Mekong delta	139	30	*Moringa oleifera* L.	

Table 33. Ex situ conservation of fish species

STT	Species	Origin	Launch time	Conservation location
A	**Fresh water resources**			
1	Cá chép hồ Lắk *Cyprinus carpio*	Dak Lak province	2005	Lam Dong province
2	Cá trê vàng *Clarias macrocephalus*	Lam Dong province	2005	Lam Dong province
3	Cá còm *Notopterus chitala*	Cat Tien province	2005	Lam Dong province
B	**Blackish water resources**			
4	Cá song da báo *Plectropomus leopardus*	Khanh Hoa province	2005	Nha Trang, Khanh Hoa
5	Cá mú cọp *Epinephelus fuscoguttatus*	Khanh Hoa province	2005	Nha Trang, Khanh Hoa
6	Cá măng *Chanos chanos*(Forsskal, 1775)	Khanh Hoa province	2005	Nha Trang, Khanh Hoa
7	Cá chẽm trắng *Lates calcarifer* (Bloch, 1790)	Khanh Hoa province	2005	Nha Trang, Khanh Hoa
8	Cá cam khế *Caranx melampygus* (Cuvier, 1883)	Binh Thuan province	2010	Binh Thuan province
9	Cá cam *Seriola dumerili* (Risso, 1810)	Binh Thuan province	2010	Binh Thuan province
10	Cá chìa vôi *Proteracanthus sarissophorus*	Coastal Southern provinces	2006	Vung Tau
11	Cá mó đầu khum *Cheilinus undulates*	Coastal Nothern provinces	2007	Vung Tau
12	Cua hoàng đế *Ranina ranina*	Khanh Hoa and Binh Thuan provinces	2009	Nha Trang, Khanh Hoa
13	Hải sâm vú *Holothuria nobilis*	Khanh Hoa and Binh Thuan provinces	2011	Nha Trang, Khanh Hoa

Source: Research Institution of Aquaculture III, 2014

http://aquagenria3.com/news/20121220014317-danh-muc-nguon-gen.html

17. In-situ conservation and management activities or programmes established in Vietnam that supports maintenance of wild food species

Table 34. In-situ conservation or management activities or programmes for wild food species.

Wild food species conserved (scientific name)	**Site name and location**	**Size and environment**	**Conservation objective (s)**	**Actions taken**
Sargassum quinhon (rong mơ quy Nhơn)	Coastal area of middle Vietnam			Establishment of PAs
Hydropuntia eucheumoides (Rong Câu chân vịt)	Coastal area of middle Vietnam			
Kappaphycus cottonii (Rong Kỳ lân)	Coastal area of middle Vietnam			
Clupanodon thrissa, Tenualosa thibaudeaui, Sinilabeo lemassoni, Bagarius bagarius, Hemibagrus guttatus, Semilabeo notabilis	Middle stream of Red river and lower section of Da river			

Table 35. On- farm conservation of some indigenous vegetables at Bavi Ecological Tourist Company (BAVIECO) (until 30/9/ 2014)

Local name	**Scientific name**	**Size**	**Utilization part**
1.Tai voi (Xích đồng nam)	*Clerodendrrum japonicum* Sweet	100 plants	Leaves
2. Bướm xanh (Móng bò xanh)	*Bauhinia viridescens* Desv.	50 plants	Leaves, young fruits
3. Cây Báng (Da chai, Gừa)	*Ficus callosa* Willd.	50 plants	Yong leaves, fruits
4.1. Tai sóc D1 (Chùm ngây) 4.2. Rau Tai sóc dạng 2	*Moringa oleifera* Lamk.	50 plants 3 plants	Young leaves, fruits
5. Rau Lưỡi hổ (Bồ công anh VN)	*Lactuca indica* L.	50 m^2	Leaves
6. Rau sau sau/ Thau	*Liquidambar formosana* Hance	10 m^2	Shoots, young leaves
7. Rau ngót rừng	*Sauropus androgynus* L.	500 m^2	Leaves
8. Rau càng cua (Đơn kim)	*Bindens pilosa* L.	200 m^2	Leaves
9. Rau chua đỏ	*Hibiscus sabdariffa* L.	30 m^2	Leaves.
10. Rau mơ rừng	*Paederia foetida* L.	30 m^2	Leaves
11. Bướm Trắng (Móng bò trắng)	*Bauhinia aculata*	10 plants	Flowers
12. Măng củ	*Bamboos multiplex*L.	500 m^2	Young shoots
13. Xương sông	*Blumia lanceolaria* Druce	30 plants	Leaves
14. Bưởi bung	*Toddalia tonkinensis* Guill	30 plants	Leaves
15. Rau lang đồi	*Ipomea batatas* L.	200 m^2	Leaves
16. Rau rút rừng (*Họ Trinh nữ)*		20 plants	Young shoots, leaves
17. Bò Khai	*Erythropalum scandens* Blume	10 plants	Young leaves
18. Rau muống đồi	*Ipomea aquatica* Forsk	200 m^2	Leaves
19. Đậu khế (Đậu rồng)	*Psophocarpus tetregonolobus* L.	200 m^2	Leaves
20. Rau Sắng	*Meliantha suavis* Piere	5 plants	Leaves
21. Rau xương chua	*Hibiscus surattensis* L.	10 plants	Leaves
22. Rau Vách núi (lốt rừng)	*Piper lolot* C. DC	50 m^2	Leaves
23. Cây cánh gà	*Strophioblachia fimbricalyx* Boerl	50 plants	Leaves
24. Rau cải mán	*Brassica juncea* L.	200 m^2	Leaves
25. Mướp rừng (lặc lày)	*Trichosanthes anguina* L.	100 m^2	Fruits

Source: *Report of 5 year conservation of some indigenous vegetable (2010-2014), Vu Quang Huy, Hoang Dinh Phi, Do Thi Hoa, Le Thi Thuy, Nguyen Thi Ngoc Hue (2014*

18. Natural or human-made disaster(s) that has had a significant effect on biodiversity for food and agriculture and/or on ecosystem services in the past 10 years

Table 36. Natural and human disasters that has had a significant effect on biodiversity for food and agriculture and/or on ecosystem services in the past 10 years

Disaster description	Production system(s) affected (code or name)	Effect on overall biodiversity for food and agriculture	Effect on ecosystem services
Oil spills	Aquaculture and fishery production	-1	-1
Waste pollution	Crop production and aquaculture production	-2	-2
Deforestation and overexploitation of forest resources	Crop, aquaculture, livestock production system	-2	-2
Damming	Crop production, fishery production, livestock production	-1	-2
Forest fire	Forest production, crop production, livestock production	-2	-1
Salinization (seawater intrusion)	Crop production, aquaculture production	-1	-1
Typhoons	Crop, livestock, aquaculture, fishery production system	-1	-2
Flood and drought	Crop production, aquaculture and livestock production	-1	-1
Landslide	Crop production, livestock production	-1	-1

Note: significant increase (2), increase (1), no change (0), some loss (-1), significant loss (–2), or not known (NK).

19. A description of the effects of the disaster on the different components of biodiversity for food and agriculture and/or on the effects on ecosystem services, and references to the supporting documentation.

Disasters	Description	Year	Effects of disasters	References
Oil spill	Oil mixing with litter spilled into the coastal area of Quang Tri province.About 10 tons of oil washed up on shore,lumped and clinged to the rocks of the coastal commnunes of Vinh Linh and Con Co districts,	2011	Caused serious damage to the ecosystem and livelihoods of the local people.	https://www.jsps.go.jp/english/e-astrategy/date/07_asiahorcs_03_p2/session2/s2-09_Tran.pdf
	Oil spill at coastal area of Thua Thien Hue province. The oil spill extended over 40 km through the Phu Thuan, Phu Dien, Vinh Xuan, Vinh Thanh communes of Phu Vang district. Particularly, the coastal area of Phu Dien was heavily affected with the extent of the highly concentrated oil spill for more than 7 km. 3.5 tons of contaminated oil waste was collected.	2011	The tourism and aquaculture of this district was severely affected.	http://baodientu.chinhphu.vn/Hoat-dong-dia-phuong/Quang-Tri-lap-ke-hoach-ung-pho-su-co-tran-dau/185056.vgp (access day: October 2, 2014) http://baoquangngai.vn/channel/2031/201409/ung-pho-su-co-tran-dau-can-chu-dong-va-chuyen-nghiep-2339452/ (3/10/2014) http://vnn.vietnamnet.vn/xahoi/2009/01/821571/ (3/10/2014)
	Hoang Son South Cargo ship with 180 tons of FO oil and 40 tons of DO oil collided with coral reef near Ly Son island caused oil spill	2010	Resulted in pollution of a vast area of Eastsea	http://m.tin247.com/su_co_tran_dau_de_doa_vung_bien_mien_trung-1-21694373.html
	Two tankers of Vietnam Air Petrol Company Limited (VINAPCO) were broken, spilled about 100 tons of oil into Da Nang Bay. Primary assessed loss is more than 33 billion VND. Approximately 500 m^3 gasoline spill from two tanks were punctured a dike,	2008	This affected the coastal ecosystem of about 10 km^2	http://www.songthu.com.vn/linh-vuc-hoat-dong/ung-pho-su-co-tran-dau/cac-sctd-da-duoc-trung-tam-xu-ly-14.html (access day: October 2, 2014)

Disasters	Description	Year	Effects of disasters	References
	about 100m^3 has soaked into the ground and another 100m^3 leaking into the sea , creating a thin oil slick from the area of the incident to the Cu De estuaries around 10km^2.			
	'Mystery' oil spill during which has occurred along the coastline of 20 provinces/cities from the North to South of Vietnam(The oils were discovered from the North (Bach Long Vy Island in the Gulf of Tonkin) down to the South, Ca Mau Cape). Most of spilled oils are crude oil.	2007	The oil spill continuously affected the shoreline of more than 20 coastal provinces. It caused a serious damge for socio-economy environmental quality.	http://www.ioscproceedings.org/doi/pdf/10.7901/2169-3358-2008-1-65
	The collision between Ha Loc and Hai Xuan cargo ship near Quang Ngai sea, spilled 140 tons of diesel.	2007		1.
	Tanker KASCO MONROVIA collided with Cat Lai Jetty, Ho Chi Minh City, on Sai Gon River, spilled 518 tons of DO. Up to 1 million USD is being claimed for compensation	2005		2.
Damming	Son La hydropower startedoperation from 7th January, 2011 with 2400 MW in capacity	2011,	In terms of biodiversity protection, although many native species survive in the reservoir, an artificial habitat, the construction of the dam and subsequent reservoir will have changed and destroyed manynatural habitats causing many species (particularly those that	http://www.wraptoolkit.org/download/output-matrix/Son%20La%20Vietnam/IAP_Son_La_Final.pdf

Disasters	Description	Year	Effects of disasters	References
			require flowing water, or plants that cannot survive the large changes in water levels, and migratory species that cannot pass the dam) to be extirpated from the area.	
	2.Tuyen Quang hydropower works from 2008, with 342 MW	2008	Dam and reservoir by itself is unlikely to cause major loss of biodiversity, apart from unknown cave, and mollusc species. Pressures induced by the dam on hunting and collection and orchids etc, will threaten biodiversity in area. Loss of habitat and fragmentation of habitat also threatens biodiversity	
	Song Tranh 2 Hydropower project	2012	The plant construction has caused forest loss beyond the initial estimated area, and negative impacts on biodiversity. The impacts have not been mitigated properly, leading to risks to the local environment. According to the Environmental Impact Assessment 2006, the reservoir of Song Tranh 2 was planned to flood 2,446.9 hectare of land, including 1,042.1 hectare of agricultural land, 781 hectare of annual crops, 256.3 hectare of longterm trees, 5 hectare of aquaculture ponds, 81.14 hectare of natural forest and 734 hectare of production forest. To make the construction site for Song Tranh 2, 220 hectare of land was cleared, including 32 hectare of agricultural land and 133 hectare of forest39. In reality, 3,249 hectares of agricultural and forestry land were confiscated for the project	

Disasters	Description	Year	Effects of disasters	References
Deforestation, forest fire	About 808 ha of forest were cut down in 2013, 1164 ha in 2012, 2186 ha in 2011, 1057 ha in 2010, 1536 ha in 2009, 3172 ha in 2008, 1348 ha in 2007	2013, 2012, 2010, 2009, 2008, 2007	Contributing to the reduction of world biodiversitythrough the extinction of populations or species. Forest fires threat to forest biodiversity, endanger many species and destroy habitats of many creatures. Forest fires may lead to erosions, landslide and floods. For example, in Kontum province, damage caused by floods and landslides over the years is very large. Particularly, in 2009 the landslide caused the dealth of 51 people and the loss of more than 3000 billion VND. The reason for this was deforestation, this region was formerly covered by forest but in recent years, forests have been seriously cleared and reduced coverage; many slopes became vacant land, affecting the flow surface. Deforestation makes the soil not covered by foliage or roots of trees. Ground exposed to sunlight in the dry season will soon decline associated structures. When the rains, the strong water flow will easily lead to erosion and collapse a large area.	http://www.gso.gov.vn/default.aspx?tabid=390&idmid=3&ItemID=15255
	In 2013, there were total about 1156 ha of forest burnt, with about 475 ha in the Central Highland.	2013		http://www.unep.org/vitalforest/Report/VFG-18-Forests-and-fires.pdf http://www.fao.org/docrep/014/am254e/am254e00.pdf
	There are about 1325 ha of forest fired in 2012, whereas 597 ha were in North Central Coast and about 570 ha were in Northeast and Red River Delta	2012		
	In 2011, 1745 ha were fired with about 835 ha in Central Highland	2011		
	In 2010, there are total 6723 ha of forest demolished by fire, whereas 4085 ha were in Northeast and Red River Delta, 1200 ha were in North Central Coast and 1008 ha were in Mekong Delta.	2010		
	In 2009, about 1658 ha were burnt, whereas Northern account for 1124 ha.	2009		

Disasters	Description	Year	Effects of disasters	References
	In 2008, there were about 1550 ha of forest burnt with about 610 ha in the Northern and Southern Central Coast	2008		
	In 2007, there were about 5136 ha of forest fired, whereas Northwest and Northeast account for 3059 ha, Red River Delta accounts for about 979 ha.	2007		
	Typhoons: (strong typhoons)17/7/2010, Con Son typhoon landed into Northeast and Red River Delta causing the deaths of 12 people	2010	Typhoons sweep through area of agricultural production, threating and damaging crops and animals, breaking down and destroying infrastructures as well as engulfing ships. Strong typhoons usually cause flood and erosion that threat extremelyseriously to agricultural production. Negative effects, either direct or indirect of heavy rain and flood on agriculture are the damage to fragile plant organs like flowers and buds, soil erosion, water logging and conditions favorable to crop andlivestock pest development as well as on pollution andpollinators. In addition to the battering effects of winds, there is the additional damage caused by airborne sea salt which occurs within a few hundred meters of the coast. Winds which blow from the coastal seas spray a lot of salt oncoastal areas, making it impossible to growcrops sensitive to excessive salt.	http://www.baomoi.com/Nhung-con-bao-khung-khiep-tung-do-bo-vao-Viet-Nam/144/14828383.epi (day of access: October 2, 2014) http://www.ccfsc.gov.vn/KW6F2B34/CatId/G87DG9YUHH/Bao.aspx (8/10/2014
	26/9/2009, Ketsana land into Northern and Southern Central Coast and Cetral Highland	2009		
	30/9/2008, Mekkhala typhoon landed into North Central Coast	2008		
	3/10/2007, Lekima typhoon landed to the land of HaTinh and Quang Binh provinces causing strong winds and heavy rains as well as deaths of 37 people and disappearance of 24 people	2007		
	On October 1st 2006, super typhoon of Xangsane landed into Northern and Southern Central Coast of Vietnam before moving to Lao	2006		

Disasters	Description	Year	Effects of disasters	References
Sanilization:	According to statistic data in 2003, salinity soil was approximately 1 million ha, accounting for about 3% natural area. In 2013, there were about 1.77 million ha of salinity soil. Before 1980, every year during the dry season, agricultural areas in Mekong river delta were affected by salinity, amounting to 1.7 to 2.1 million ha out of 3.5 million ha. In the 1980's and 1990's, a number of projects were implemented to control salinity. Until 2006, salinity affects about 0.8 million ha every year.	2003	**Effects on different components:** Because of sea level rise and deep salt penetration into the interior part, the upstream culverts on the riverside will be unable supply fresh water for rice field and many regions will lack irrigational water In Vietnam, most of the coastline in the south that is located in wide and flat alluvial fan and bordered by tidal rivers fringed by wide mangrove swamps, has been eroded continuously at a rate of approximately 50 metres/year since the early twentieth century this massive erosion, mostly due to wave and current action, is attributable to the long-term impacts of human activities With aquaculture production system, seawater intrusion is an advantage. Salt content is about 7-8‰ suitable for shrimp production. Salt content is less than 1‰ suitable for rice production but more than 10‰, rice is easy to lose productivity	http://www.google.com.vn/url?q=http://www.hydrol-earth-syst-sci.net/10/743/2006/hess-10-743-2006.pdf&sa=U&ei=jOA0VJuPDNbe8AXotIKYAw&ved=0CBkQFjAB&usg=AFQjCNEeO6QyTp_9xTG-iZXpFIpSDcHb4g http://www.google.com.vn/url?q=http://www.imh.ac.vn/b_tintuc_sukien/bc_hoinghi_hoithao/L777-thumuccuoi/mlfolder.2005-12-29.1459843019/mlnews.2006-01-06.4046259778/13-58_MaiHanhNguyen.pdf/download&sa=U&ei=wOo0VJvzBNje8AWw_YBg&ved=0CD4QFjAI&usg=AFQjCNGfkBa1CTrO9JOm9tEdinR36ugscw http://www.iwem.gov.vn/?News&id=903&g_id=117 (8/10/2014) http://siteresources.worldbank.org/INTVIETNAM/Resources/MARDEng.pdf http://tapchivatuyentap.wru.edu.vn/Portals/10/So%2040/06-Nguyen%20Tuan%20Anh,%20Pham%20Tat%20Thang%20%20Anh%20huong%20cua%20xam%20nhap%20man%20den%20he%20thong%20Nam%20Thai%20Binh.pdf

Disasters	Description	Year	Effects of disasters	References
				http://www.fao.org/docrep/010/ag127e/ag127e09.htm http://www.google.com.vn/url?q=http://start.org/download/2013/ysc/day1/5-1nguyen.pdf&sa=U&ei=jOA0VJuPDNbe8AXotIKYAw&ved=0CEQQFjAJ&usg=AFQjCNHfHGGPMDylamLBH0riYhOSIc1CZw http://www.rfa.org/vietnamese/in_depth/soil-was-salinization-05312012064153.html (8/10/2014)
Floods	10/2013: flood in Central Coast provinces (affected by Nari storm)	2013	Floods cause damage to economic structuressuch as roads, dams and bridges, affect to agricultural products Flooding often has significant, deleterious effects on agricultural production, rangelands and forestry. The impacts can be wide ranging, both temporally and spatially. The following effects are often landslide and sediment transport, contamination and waterlogging. Crops, nurseries, pastures can be completely destroyed due to asphyxiation, if flood waters stay for a significant period of time. Flood water causes interruption to tillage, planting, crop management and harvesting. It also causes permanent damage to perennial crops, trees, livestock, building and machinery. Soil temperature reduction and	http://vtc.vn/nhin-lai-8-tran-lut-kinh-hoang-tai-viet-nam.2.456814.htm (7/10/2014) http://www.ccfsc.gov.vn/KW6F2B34/CatId/DB09387DF5/Lu-lut.aspx (7/10/2014) http://meteo.edu.vn/DATA/Books/Natural%20Disasters%20and%20Extreme%20Events%20in%20Agriculture/15.%20Degradation%20of%20Vegetation%20and%20Agricultural%20Productivity%20due%20to%20Natural%20Disasters%20and%20Land%20Use%20Strategies%20to%20Mitigate%20Their%20Impacts%20on%20Agriculture,%20Rangelands%20and%20Forestry.pdf
	9/2013: flood in Central Coast provinces (affected by Wutip storm)	2013		
	10/2011: flood in Central Coast provinces, especially in Quang Binh	2011		
	10/2010: flood in Ha Tinh province, especially in Huong Khe district	2010		
	11/2008: flood in Northern provinces	2008		
	11/2007: flood in Southern Central coast provinces	2007		

Disasters	Description	Year	Effects of disasters	References
	12/2006: flood in Quang Binh, Quang Tri, Hue	2006	retardation due to flood is harmful for agricultural production. Stagnant water due to flood could befavorable breeding ground for insects and diseases.	http://www.pnclink.org/pnc2011/english/ppt/Vu%20Ngoc%20CHAU.pdf
	11/2006: flood in Daklak	2006		
	10/2006: flood in Northwest provinces	2006		
	8/2006: flood in Northern to Southeast provinces	2006		

20. *The enhanced use of biodiversity for food and agriculture has contributed to improving livelihoods, food security and nutrition in the context of natural or human-made disasters.*

a. *Human disaster (Deforestation)*

One of the most serious human disasters in Vietnam is deforestation that has been resulted in many consequences such as landslide, the loss of soil fertile and floods. One of the best practices to deal with this is the application of agro-forestry systems (kinds of enhanced use of biodiversity) to improve livelihood for people living near forest borders. For example:

- **Traditional agro-forestry system**

*Fallow/ Innovated Shifting Cultivation System***:** This system regenerates the forest by using slash and burn cultivation. This long -standing form of agro-forestry overcame the negative effects of continuous shifting cultivation and it creates favorable conditions to restore soil nutrients.

*Forest and Terrace System***:** This system reduces soil erosion and takes the initiative in irrigation. It has an important role in preserving irrigation water and regulates the water supply to rice terraces, preventingof landslides and offering forest products.

*Traditional Home Garden***:** In the agro-forestry system, the home garden is traditional throughout the rural areas of Vietnam. The home garden system consists of perennial and annual crops, animal husbandry and aquaculture components. Furthermore, these components are combined to take advantages of soil productivity and surface spaces. This system also includes time consumption and household labor to produce food stuff and generate household income.

*Forest Garden***:** Forest gardens grow perennial and fruit trees that supply highly value products. Normally, the structure of forest gardens has a primary timber storey which is only one type of tree. Furthermore, there is a lower crop storey that is intercropped with the timber. Based on ecological conditions, traditional experience and custom, as well market demands of each region, farmers grow material trees or special trees such as Dien bamboos (tre dien) in Phu Tho, luong bamboo in Thanh Hoa and Hoa Binh, cinnamons in Yen Bai, Thanh Hoa and Quang Nam, Melaleucaplant in Phu Tho, Bollywood in Tay Nguyen provinces, cashews in the Mekong River delta, coconuts in Binh Dinh and anises in Lang Son. In addition, they plant other crops in the lower storey to take advantage of land and solar energysuch as food crops (rice, maize, cassava, bean…) and medicinal plants (gingers, saffron, lemongrasses…).

*Perennial Tree Garden***:** This system grows perennial trees intensively. Perennial trees with multiple purpose trees are largely grown to createshadow, windbreak and take advantages of other products. Households are located in the valleys which are near or far from the perennial tree garden, but they have favorable water and transportation condition for daily activities and trading. This system established under the form of farms or plantations to trade highly value products of perennial trees. The system's structure consists of high storey of trees to produce primary commodities such as coffee, cacao, pepper, rambutan, etc. Annual crops are often grown between tree row s in the early years to take advantages of the land and they reduce weeds. Ecological storey is grown to cover land, reduce surface flow, and regulate water to keep it moist for the main storey. This system is common throughout the southern provinces wherethey have expansive and fertile land that is suitable for perennial trees.

*Fruit Garden***:** This traditional land-use system is found next to residential land. It often comprises from 3 to 4 main storey's. The upper/top storey includes large and light preferred fruits such as durians, coconuts, mango, jackfruits, litchi and longan. The middle storey includes average and shading fruits such as mango, steens, dauda, sapotas, orange, mandarin, custard -apple, etc. The lower storey includes small and short, and shading fruits such as cacao. The bottom storey could include medicinal plants.

*Garden -Fish Pond – Livestock***:** This system is very common throughout Vietnam, from low lands to uplands. The average area of this system is about from 500 to 1,000 m2 per household, eve n up to

2,000 to 5,000 m2. The system's upper storey includes multi-purpose timber trees or fruit trees. The lower storey includes fruit trees, root crops or medicinal plants, and a small vegetable garden. Besidesfruit garden, this system also consists of livestock and fish pond.

Forest -Garden-Fish Pond – Livestock: In fact, this system is derived from the Garden -Fish Pond-Livestock system and has long been developed in some upland areas. This system combines forest, fruit tree garden, fish fond and livestock.

Forest-Cash Crops -Paddy Rice: This system is often established in relatively large upland areas. Natural or planted forests are located at the top of the hill. Irrigation system has been built to supply water for cash crops in terrace field and paddy fields in valleys.

Innovative Agro-forestry Systems

Alley Cropping: This type of cultivation method usestrees/crops are planted in contours inthe slope lands. This system includes hedgerows and cash crops that are grown between hedgerows. Normally, the distance between hedge rows is around one meter. Those hedgerows are comprised one to two timber trees or perennial bush rows and are periodically pruned to create sun light for cash crops. Hedgerows are grown by improved the soilfor the trees. These trees create favorable condition for better crops developing;offer soil organic elements due to decaying debris dropped from trees/ leaves dropping;and supply farms withtimber, firewood and other utilities. This agro-forestry practice is applied in slope land areas. This system, known asSALT1-SALT4 models is based on the proportion among the agricultural crops, perennial trees and livestock.The hedgerowsare grown incontours and the distance between these rows of trees varies on the slope hill. This model offers various advantages, for instance, reducing surface flow, supplying feed sources for livestock or humus to restore soil fertilizer. With this technology, after a couple of years, it will form natural storeys.

Green Fence/ Boundary Planting: This model is very popular in Vietnam's rural regions. Legume is grown to be used as fences, thus preventing buffalos from destroying farms, and establishing clear boundaries among different owners of that area.

Windbreaks and Shelterbelts: This system consists of timber and bush trees that are planted in alleys to protect soil from damaging winds and reduce wind erosion. The structure of shelterbelts and the distance among shelterbelts depends upon what trees/crops are planted such as agricultural crops, perennial trees, fruit trees. In Vietnam, windbreaks and shelterbelts are planted widely on fields, especially in Tay Nguyen and this system is mainly used for coffee.

Taungya: Taungya is applied in many forest projects in Vietnam. This technology is used to recover natural forests that were depleted. This system helps thefarmers reduce management costs, increase benefits and protect environment. However, this system also has disadvantage that is short cultivation period. Hence, farmers sought other similar land to continue cultivate when the forests have not closed their canopies. For example, in Son La Province the model intercrops swidden rice, maize and tecknonia granis in the first 2 or 3 year when forests have not closed. Their canopies yet, or in some places, for instance in Hoa Binh, farmers sow melia seed in parallel with cash crops in the beginning years when melia has not closed its canopy[33].

b. Natural disaster

In order to reduce the damages caused by typhoons in coastal areas of Vietnam the key adaptation strategies were to reduce vulnerability of the communities to risks storms through sound management of mangrove and to increase adaptive capacity of the community by providing alternative livelihoods. In Vietnam and elsewhere mangrove forests have been destroyed and degraded by unsustainable harvesting as well as by a myriad of coastal development projects including tourism and aquaculture. However, in light of recent extreme natural events and the risk of rising sea levels due to climate change {IPCC, 2007 #35} there is increased interest and motivation in

[33] http://www.cares.org.vn/webplus/attachments/228902ef2354149a1dd167530818b183-00.pdf
(Assessed 20 November 2014)

restoring mangrove forests for both livelihoods as well as for the disaster risk reduction benefits they provide. Mangroves can reduce the impacts of storms, sea level rise and big waves such as tsunamis.Their roots stabilize the soil, thereby decreasing erosion by wind and waves, and provide a physical barrier that slows down storm surges and tidal waves, thereby reducing their height and destructive power. Livelihood benefits from mangroves are numerous.The forest provides a nursery for young fish and crustaceans including shrimp and crabs, and a rich habitat for avariety of mollusks including oysters and mussels.These species play important roles within the ecosystem by decomposing organic matter or by supporting animals higher up in the food chain, including fish. Seafood is one of the great economic importancesand can significantly improve household income when sold on the market or for self consumption. Honey produced from mangrove flowers is another value that illustrates the broad and multiple benefits of mangroves.The trees themselves have tremendous value, both as fire wood and construction if sustainably harvested, and as critical carbon dioxide sinks. In addition mangroves are important as habitat for a wide variety of wildlife[34].

Experiences from Thai Binh and Nam Dinh provinces in 1996 and 1997 proved that mangroves planted by the Red Cross initially for environmental reasons constituted a good green wall to protect sea dykes against typhoon waves. This means no flooding of agriculture fields or settlements. Fishing boats can use mangroves as shelter during typhoons. The number of deaths fell. In 2003, two typhoons struck Northern Vietnam in July and August but only four people died, no rice fields were flooded and the impact of the typhoon rapidly weakened. Research published in 1997 by Japanese scientists demonstrated that a sea wave 1.5 m high is reduced to nearly zero after passing through a 1,500-m wide mangrove plantation. Mangroves are considered to offer effective protection for sea dykes during both typhoons and normal circumstances[35].

Widening the covering of upstream forests is a fundamental method of reducing the severity of floods. However, this requires a long period of time for its implementation. The forest system in upstream areas not only functions as a flood harmonizer but also has a beneficial effect on the environment and the ecological system. At present, forest cover is increasing thanks to forest planting and protection campaigns steered by the Vietnamese Government[36].

[34]Pauline Buffle, Nguyen Thi Yen, Morten Fauerby Thomsen (2011) Community-based MangroveReforestation and Management in Da Loc, Vietnam

[35]http://www.adrc.asia/publications/TDRM2005/TDRM_Good_Practices/PDF/PDF-2005e/Chapter3_3.1.1-1.pdf

[36]http://www.preventionweb.net/files/9055_TDRM05.pdf

27. Invasive alien species identified in Vietnam that have had a significant effect on biodiversity for food and agriculture in the past 10 years.

Table 37. Invasive alien species that have had a significant effect on biodiversity for food and agriculture in the past 10 years

Common name	Invasive alien species	Affected production system	Impacts on ecosystem	Contribution of Biodiversity to managing
Banana bunchy top virus	*Banana bunchy top virus* - BBTV	Crop production (banana)	Banana leaves grow abnormally, become yellow and wilt impacting on banana productivity	Aphid *Pentalonia nigronervosa* is main vector of transmission. It is necessary to control this aphid
'the plague'/the Black Death	*Yersinia pestis*	Livestock production	There are about 203 rodents and 14 rabbit species easy to be infected. This bacteria is acute disease but it can be prevented	Mouses are host and main vector. Thus, managing this bacteria is managing mouses
Cinnamon fungus	*Phytophthora cinnamoni*	Crop production	This fungi impacts on root system of crops, especially small root system causing wilt, ulcers and sometimes sudden death. This leads to decrease in productivity of crop.	Using resistant varieties
Bird flu	*Avian influenza virus*	Livestock production	This virus affects seriously to poultry production system. The outbreak of this virus in 2005 leaded to the death and destruction of more than 140 million of poultries.	
Golden apple snail	*Pomacea canaliculata*	Crop production, livestock production	This snail usually feeds young leaves of crops, some aquatic creature, impacting on crop production, especially rice fields. However, it is a rich resource of protein supplying for poultry production system.	Releasing ducks into the field before transplanting rice
Apple snails	*Pomacea bridgesii*	Crop production, livestock production, aquaculture production	Food of this snail is decomposed plants, food supplied for fish, sometimes young plants impacting negatively on crop and fish. Besides, eggs and young snail sometimes become food for ducks and fish.	Releasing ducks into the field and pond, or using black crap to collect eggs
Giant African snail	*Lissachatina (Achatina) fulica*	Crop production	This kind of snail can cause seriously impacts on crops in tropical and subtropical regions. With high	

Common name	Invasive alien species	Affected production system	Impacts on ecosystem	Contribution of Biodiversity to managing
			density, they can damage and destroy vegetation, leading to the reduction of crop productivity. Moreover, they are also vector of transmission.	
Redclaw crayfish/Blue lobster	*Cherax quadricarinatus*		They are omnivores, can survive in different environment. Their food involves in plants, animals, organic humus. Sometimes, they also feed each other when food resource is scarce. They are vectors of transmission including virus, bacteria and fungi	
Coconut leaf beetle	*Brontispa longissima*	Crop production (coconut trees)	This Coconut leaf beetle damages on agriculture region, planted forest and specially *Aecaceae* family. They usually feed on young coconut leaves. Coconut leaf beetle associating with another beetle and the lack of water in dry season will cause seriously loss in productivity of coconut. In recent years, this kind of beetle causes loss in 5.352 ha of coconut in Ben Tre province and 70% coconut tree in Tra Vinh province.	Using parasitic wasp *Asecodes hispinarum* as a natural enemy to control coconut beetles in low density.
Masson pine moth	*Dendrolimus punctatus*	Planted forest (Pine)	Pine caterpillars damage on pine forests. With high density, they can feed total leaves on plant and cause death by impacting on photosynthesis ability of plants. According to statistic data, in the first six months in 2011, there were about 14.354 ha of damaged pine.	Avoid mono-cropping, using intercropping with other plants such as *Vernicia Montana* or *Acacia auriculiformi.*
Mozambique Tilapia	*Oreochromis mossambicus*	Aquaculture production, fishery production	Black tilapia is recorded to be a dangerous invasive alien species competing food resources and feeding native aquatic species.	
Amazon sailfin catfish	*Pterygoplichthys pardalis*	Aquaculture production, fishery production	This specie can survive in various environment and wide range of temperature as well as pH. They usually feed algae, larva, eggs of fish and some other creatures. They cause dangerous alternation in food chain, compete food resources and habitat of native	

Common name	Invasive alien species	Affected production system	Impacts on ecosystem	Contribution of Biodiversity to managing
			aquatic species, leading to loss of aquaculture and fishery production.	
Suckermouth catfish	*Hypostomus punctatus*	Aquaculture production, fishery production	This specie can survive in various environments. They usually feed algae, organic humus and food supplied for fish. They cause dangerous alternation in food chain, compete food resources and habitat of native aquatic species. After released into environment, they can adapt and develop quickly. Once approaching with other fish, they will suck the mucus and cause death.	
Sharptooth catfish	*Clarias gariepinus*	Fishery and aquaculture production	This kind of catfish can survive in poor conditions. They are omnivores, feeding young fish, aquatic invertebrates and plants. Specially, they can hybridize with native catfish, impacting on traditional aquaculture production as well as leading to degradation of native genetic resources	
Mosquitofish	*Gambusia affinis*	Fishery and aquaculture production	Gambusia fish completes food resources and often attack and kill native fishes. Gambusia fish also are vectors transmitting parasitic helminthes to native fishes.	
Largemouth Black Bass	*Micropterus salmoides*	Fishery and aquaculture production	This fish is ferocious omnivores. They feed plankton, aquatic larva, shrimp and small fishes, sometimes, they also feed each other. Thus, this species affects negatively to aquatic creatures and biodiversity, especially native small fishes, leading to depletion or extinction.	
Red-eared slider turtle	*Trachemys scripta subsp.elegans*	Fishery and aquaculture production	This kind of turtles strongly competes in food resources, habitat and sunny space with native species. They threat endanger native species as well as are vectors transmitting roundworms to native	

Common name	Invasive alien species	Affected production system	Impacts on ecosystem	Contribution of Biodiversity to managing
			species.	
Cuban crocodile/Eichhornia crassipes	*Croccodylus rhombifer*		This crocodile species can easily hybridize with native crocodile species, therefore, leading to degradation of native species.	
Waterhyacinth	*Eichhornia crassipes*	Crop production, aquaculture production	Water hyacinth is widespread on freshwater wetland especially in standing water. It can survive in various habitats with wide range except frost and seawater. It covers the water surface, reducing the abundance of native floating plants and other aquatic organisms by reducing the availability of sun lights and soluble oxygen and competing for nutrients. It impacts negatively on environment and biodiversity, changes in ecosystem and invades in other animal and plant populations.	
Ageratum/Billygoat weed	*Ageratum conyzoides*	Crop production, naturally regenerated forest, planted forest	This weed is hard to be removed. It compete space as well as food resources of crops. This weed can fire easily; therefore it is a dangerous factor biodiversity of forest. However, it is a medicinal herb.	
Siam Weed	*Chromolaena odorata*	Crop production, naturally regenerated forest, planted forest	Siam weed forms dense stands competing sunlight and nutrients with crops and preventing establishment of other species. Thus, this weed impacts negatively on crop production. The leaves of this species are toxic because they contain high levels of nitrate, and if consumed by grazing animals may cause fatalities affecting to livestock production. In dry condition, it is a factor causing bush fire, affecting to biodiversity of forest.	
Crofton weed	*Ageratina*	Crop production,	This weed with high density will prevent the	

Common name	Invasive alien species	Affected production system	Impacts on ecosystem	Contribution of Biodiversity to managing
	adenophora	naturally regenerated forest, planted forest	establishment and regeneration of native crops. It causes loss in agriculture, forestry, natural regeneration, and it is a source of bush fires.	
Parthenium weed, Bitterweed	*Parthenium hysterophorus*	Crop production, naturally regenerated forest, planted forest	This weed will prevent the establishment and regeneration of native crops. It causes loss in agriculture, forestry, natural regeneration, and it is a source of bush fires.	
Climbing hempweed	*Mikania micrantha*	Crop production	This weed can spread quickly, be asexual reproduction. It damages to other crops by covering and competing nutrients and space. It also secretes inhibitors to prevent the growth and development of other crops.	
Giant sensitive plant	*Mimosa diplotricha*	Crop production, planted production, livestock grassland-based system	The mimosa compete nutrients and sunlight with other crops, preventing the establishment of other species leading to degradation of biodiversity. Mimosa plants with high density of thorns will prevent grazing.	
Catclaw mimosa/ Black mimosa	*Mimosa pigra*	Crop production, planted production, livestock grassland-based system	Giant Mimosa is one of the worst environmental weeds that easy to spread long distances in flood water and has the potential to spread through grass-lands, floodplain ecosystems and pastures, converting them into unproductive scrubland. The development of this species leads to loss in habitat of many bird and reptile species. It is a serious agricultural weed in Vietnam.	
White leadtree	*Leucaena leucocephala*	Crop production, planted	This species can establish population with high density endangering native forest and endemic	

Common name	Invasive alien species	Affected production system	Impacts on ecosystem	Contribution of Biodiversity to managing
		production, livestock grassland-based system	species. Besides, the growth of this species also prevents animals' movement.	
Big sage	*Lantana camara*	Crop production, planted production, livestock grassland-based system	This species is a dangerous weed in natural ecosystem and agro-ecosystem. It compete nutrients and sunlight with other species. In regenerated forest, it changes in ecological succession and degrade biodiversity. It also secretes phytoncide, inhibiting other species, endangering extinction of some native species.	
Broad leaved paper bark	*Melaleuca quinquenervia*		Quinquenervia threats the ecological succession in freshwater, changes chemical components in the soil, declines ability of decomposition… this species also degrade native species.	

Note: strong increase (2), increase (1), no effect (0), some loss (-1), significant loss (-2), or not known (NK).

28. The major gaps with respect to the state, trends and conservation of associated biodiversity (including wild resources for food) and ecosystem services:

a. The major gaps in information and knowledge

- In government agencies (MONRE, MARD and Misnistry of Science and Technology,…): data often generate from projects, scientific research,…In institutions, universities, and information centre: certain groups of animals (such as fishes and crustaceans) or plants (such as mangrove tree species and rice species) and in protected areas, most databases are in form of species list or composition. This means the available data is very fragmented and specific to some species which are selected for researching. The general figure and information is not available.
- Many of available data sets are mainly kept maintained by individuals, and are often not publicly accessible, only a limited portion of the information is available in an electronic format
- Lack of human resources and funding for activities related to collecting information and developing databases
- For most databases, information is not updated regularly due to low priority and/or insufficient funding; information content is limited, outdated, unstandardized and often unrevealed
- Lack of practical guideline or protocol on establishing biodiversity database and developing and implementing biodiversity (including BFA) information sharing
- Work relating to 'biodiversity" require high effort of coordination and cooperation among various stakeholders, which are still a weakness in Vietnam
- Inappropriate perception on data ownership is among the biggest barrier for information exchange and sharing in Vietnam
- Disparity of data formats makes it difficult to share data among biodiversity databases
- Poor data quality is a reason for not shared data and there is still a tendency to share data/information through personal contacts[37]

b. The main capacity or resources limitations

The quantity and quality of human resources for conservation of biodiversity in general and BFA in particularly remain limited.

Investment for biodiversity conservation is limited:

In recent years, investment for biodiversity conservation has increased in total budget and diversified in finding sources. However, the efficiency of investment is low. Funding for biodiversity conservation in Vietnam, especially ODA funding, has been considered high in comparison to that in other Southeast Asian developing countries (more than 20 millions USD in 2004-2005); but few projects were noticed successful. Moreover, with the economics being grown, ODA funding for Vietnam would be less committed in a near future.

Investment for biodiversity conservation is also insufficient, when little funding is allocated to management, strategic development and legislative formulation, capacity building, and public awareness raising as well as baseline biodiversity investigation. It is estimated that nearly 90% of biodiversity funding were spent for infrastructure construction and only 10% was directly spent for biodiversity conservation and management.Despite a slight increase in the State budget for biodiversity conservation, the effectiveness of investment is low due to approaches to use of the budget. Most of the funding from non-governmental organizations depends upon the short-term funding and projects.

c. The main policy and institutional constraints

[37] Phung Thu Thuy (2011), Biodiversity Conservation Agency, Viet Nam Environment Administration, Ministry of Natural Resources and Enviroment

Since 1995, Vietnam's Government and its Ministries have released legal documents related to biodiversity conservation and management. Some contents are prescribed in different documents in respective to different specific areas; therefore they are found overlapping, inconsistent or even conflicted. Ministry of Agriculture and Rural Development (MARD) is responsible for managing special use forests (forest ecosystems) and marine protected areas (marine ecosystems) while MONRE is responsible for establishing and managing wetland protected areas (wetland ecosystems). However, these ecosystems always co-existin protected areas. For instance, Xuan Thuy National Park (NamDinh province) includes all three ecosystems: forest, marine and wetland ecosystems. Because of this overlapping, it is necessary to have an appropriate mechanism to unitedly manage biodiversity and protected areas in the country.

Besides, several important contents are not legislated such as genetic access and benefit sharing, biodiversity exploitation and utilization. The inaction of the Biodiversity Law is an opportunity to fill those gaps. To enforce this law, a wide range of under-law documents needs to be prepared and approved by the Government to guide its implementation. This is a heavy task for the national management agencies for biodiversity in Vietnam.

State management system for biodiversity conservation less powerful

The Government decided MONRE to act as the national focal point for CBD implementation in Vietnam. This ministry is responsible for developing and facilitating the implementation of the NBAP; and coordinating all CBD related activities in Vietnam. Particularly, after the Biodiversity Law approved, MONRE is officially assigned to help the Government on the united state management of biodiversity inVietnam. Authorized by MONRE, the newly-established Department of BiodiversityConservation is responsible for consulting MONRE to deliver biodiversity management tasks. However, this department is required adequate investment to enable them to do the assignment.

Planning for sustainable biodiversity development at provincial, regional and national levels is still weak:

Lacking long-term and scientific planning has led to irrationality in conserving and developing natural resources in each locality and over the country. Destructing newly-planted mangrove forests for shrimp-farming is an example that how weak planning would result to terrible waste.

d. Actions required and the priorities

- Raising public awareness in implementing the Biodiversity Law and improving capacity for state management agencies regarding to biodiversity at central and local levels;
- Creating mechanism for connection and cooperation among management and implementation agencies of biodiversity protection and focal institutions of biodiversity conservation.
- Developing a national inter-sectoral programme to study, preserve and develop biodiversity, which is in response to climate change;
- Developing a monitoring programme and united management of biodiversity database;
- Conducting baseline investigations of biodiversity resources at national scale;
- Promoting integration of biodiversity conservation in national, ministerial, and local plans, programmes and projects;
- Priorities should be given to a/ regional biodiversity planning, b/ strict implementation of EIA for infrastructure construction projects and strict follow-up, c/ development of user-payment policies for commercial exploitation of biodiversity and ecological services.
- Sustainably developing the system of protected areas in Vietnam through combining those objectives of protection and conservation. Priority giving to assess and develop opportunity for communities to be benefited from ecosystem service provision at PAs and watershed forests.
- Enhancing the rights and capacity of local communities so that they will actively participate in biodiversity conservation and protected area management; To do these, community awareness, livelihood improvement, legal framework development, operational mechanisms for

communities to be participated and benefited from biodiversity conservation and development, particularly in PAs. Allowing local communities to traditionally use natural resources in PAs and practice their livelihoods based on consensus on planning, zoning and monitoring requirements.

- Enhancing management and gradual suspendance of illegal wildlife trade
- Paying more attention to new species importation: Production companies must strictly comply with the examination procedures and regulations to oversee imported species before being allowed to introduce for large scale production and on releasing solutions to manage and destroy harmful invasive species; s
- Strengthening diversificationand effective management of fundingsourcesfor conservation through a/ increasing total investment from state budget for conservation, and b/ focusing on strategic investment to satisfy long-term conservation.
- Maintaining more foreign aids for nature and biodiversity conservation; promoting effective cooperation with biodiversity-related international and regional organizations such as CBD Secretariat, GEF, UNDP, WWF, IUCN, etc[38].

29. *With respect to the impact and response to natural or human-made disasters and biodiversity for food and agriculture:*

❖ *Natural disaster*

a. The major gaps in information and knowledge

- There is lack of understanding of the nature of adaptation and adaptive capacities. There is evidence on the shortcoming of data on adaptation alternatives and mechanisms for disseminating and sharing information across sectors. Also, translation of scientific studies into the end-users and easy-to-understand language for various target groups is lacking. "The local people would not talk in the same language as the experts, and they don't like complicated scientific issues, so all the results should be simplified and correlated with local/regional customs and problems"[39].

- Regarding to climate change adaptation, there is a lack of knowledge which justifies the need for more evidence-based research on specific topics related to climate change as well as technical assistance from international organization. Current knowledge about adaptation or climate change impacts in Viet Nam is based on international studies. This is not enough for sector level planning and mainstreaming strategies and polices. Further, lack of proper understanding of provincial and local level needs are other gaps and concerns. Many provinces are not aware of climate change issues and, lack of information, methodologies, tools and experiences dealing with climate change and its impacts. The authorities sometime undertake climate change activities independently from the government when there are concerns about climate change impacts. In Vietnam, the concept of climate change, its potential impacts and the need for adaptation are not yet well known beyond a small community of experts and development workers; some concerned state management agencies, and some localities.

b. The main capacity or resources limitations

- Resources for natural disaster prevention and control is limited and dispersed. The technical conditions and infrastructure used for forecasting and warning of natural disasters are still facing limitations

- Human resources,especially technical staff who can guide and manage the process, are limited.

[38] Hoang Thi Thanh Nhan (2011), Action Plan for Implementing the Convention on Biological Diversity's Programme of Work on Protected Areas, Biodiversity Conservation Agency, Vietnam Environment Administration (VEA), Ministry of Natural Resources and Environment

[39]International Centre for Environment Management (2009), Climate change adaptation in the lower Mekong basin countries, regional synthesis report, CCAI (Climate Change and Adaptation Initiative)

c. The main policy and institutional constraints

- The organizational administration structure of natural disasters is not accomplished with responsibilities mostly concentrating on a number of Ministries (MARD, Ministry of Public Security and Ministry of National Defense);
- Regulations on the management of different forms of natural disasters are given in a number of legal documents and regulations on the new forms of natural disasters are still lacking, for example: droughts, damaging colds, tides, hurricanes, landslides, tsunamis and earthquakes
- Most strategies in Viet Nam are focused on emergency responses to short term climate extremes and reconstruction after them, rather than long-term adaptation. They are also not integrated into wider policies for sustainable rural development and poverty reduction.
- Another key gap is the need to generate awareness about the nature of climate change adaptation and its opportunities at all levels, specifically at senior policy and political level, and at the provincial level, where most responsibilities are being place but capacities are weak.
- Government priorities are focused on the coastalzone and two delta areas of the country but there is aneed to identify the gaps in rain-fed agriculture, ruralareas and need of water resources and irrigationin the southern part of the country. Number ofshortcoming of vulnerability and adaptationassessment also reflects that the national expertiseto undertake this (V&A assessment) is weak. Theperception of communities and some governmentalinstitutes on climate change is also a limitation intaking up appropriate activities.

d. Actions required and the priorities

- Priority areas: disaster management, water resources (agriculture), aquaculture and forestry.
- It also emphasizes the need of knowledge to identify linkages between disaster and climate risks, as National Target Program to Respond to Climate Change does not provide any guidelines or directions. It is needed to identify the research needs and create a policy brief for mainstreaming of adaptation into developmental planning. In this sense, capacity building for provinces in knowledge, skills, methodologies and measures to support the most affected and vulnerable communities is needed[40].
- An integrated approach is being undertaken to help meet the challenges that rural communities face in living with natural hazards: First, communities receive training to develop their own preparedness strategies and to integrate disaster risk management (DRM) into their communes' socio-economic development plans. Second, implementing new and better engineering standards for rural roads and irrigation infrastructure—both lifelines for rural communities to ensure their safety and livelihood. Third, enhancing livelihoods among poor households through an Agricultural Risk Management Information System (ARMIS) that assists farmers in improving productivity and enhancing resilience to droughts, floods, erosion, and heat. ARMIS also provides useful information on pest control, disease treatments, nutrient management, water conservation, planting dates and cropping patterns. And fourth, implementing structural risk reduction measures for dams, reservoirs and evacuation bridges help minimize adverse effects from disasters.

30. With respect to the impact of invasive alien species (IAS) on biodiversity for food and agriculture:

Invasive alien species are serious issues in Vietnam now with an increasing number. However, these species are not strictly assessed and controlled. In fact, the outbreaks of them have been recorded in the nature and caused heavy damages. According to the Department of Biodiversity Conservation,

[40] Assessment of Capacity Gaps and Needs of South East Asia Countries in Addressing Impacts, Vulnerability and Adaptation to Climate Variability and Climate Change

the number of invasive alien plants are now about 94 species including 42 species of invasive plant family; 48 aquatic species

a. The major gaps in information and knowledge

- Although there are many negative effects on the environment and economic, alien species continue to be introduced into Vietnam in many ways. One of the most important issue is that Vietnam lack detail assessment of invasive species as well as the inadequate guidelines for determining what specific alien species can become invasive species that can affect biodiversity and human health. The inadequate capacity for management of specific IAS and lack of information on the spread and impacts of IAS are also the main causes. Furthermore, studies are usually only conducted on those species that have an overwhelming impact on both the ecosystem and economy. There is still little awareness of codes of practice and guidelines on introductions of new species[41]. Building regional capacity to assess risks, share information and strengthen networks, are essential for protecting aquaculture and other production systems and the natural ecosystems on which they depend.
- Limitations of regconization: One of the difficulties of controlling invasive species in Vietnam today is limitation in regcognization. In fact, all exotic species discovered in Vietnam were listed in the top 100 dangerous invasive alien species in the world. However, the identification and regulations of these species at all levels from the national to local levels is limited. According to the survey results of the Biodiversity Conservation Department, 90% of staff of local authorities had insufficient capacity to manage invasive alien species and about 60% of staff of Provincial Natural Resources and Environment office could not identify the IAS. Even, the Customs Agency, an enforcement unit to control the importation of alien species but the identification of the IAS is a problem. In addition, assessment of the potential risk before being imported to Vietnam has not been paid enough attention[42].

b. The main capacity or resources limitations

The human resources and funding for management of IAS is insufficient

c. The main policy and institutional constraints

According to the Department of Biodiversity Conservation, in Vietnam, these species can invade by many different ways such as importation to serve the agricultural production or by natural way. In some cases, the introduction of exotic aquatic species to Vietnam in large numbers without strict assessment and control has caused a serious natural outbreak and damages.

Currently, the legal system of Vietnam in control of alien species was initially formed especially after therelease of Biodiversity Act in 2008. However, when reviewing the documents and found that in regulatory system of Vietnam is still gaps and still not consistent with international approaches. The management of biodiversity including invasive species is defined in the Biodiversity Law, however, the specific tasks of the ministries and agencies are not clear. For example, the agricultural sector provides the license of importation of aquatic varieties in Vietnam but the management of these species is responsibility of Ministry of Natural Resources and Environment that leads to the overlaps, inconsistency and inefficiency of the control of these species. In addition, the current regulations only focus on the importation that lacks risk assessment before being imported, early detection and rapid response to IAS. The importation of pets, ornamental plants and fodders has not been mentioned in any regulation. The movement of raising Hamsters mouse as a pet in 2008 was as an example.

[41] IUCN (2006), Recommendations from the Workshop on Alien Invasive Species held at South and Southeast Asia Regional Session of the Global Biodiversity Forum

[42] http://m.vietnamnet.vn/vn/khoa-hoc/208224/kiem-soat-loai-ngoai-lai-o-viet-nam--luat--bo--theo-thuc-te.html

d. Actions required and the priorities

The following actions prioritized at the national and regional level need to be elaborated through an IAS management strategy and national priorities:

- Establish an IAS National Focal Point for coordination of activities and information sharing, especially of scientific research on species ecology, methods of control and eradication, is required at the regional and international level.This could be implemented through a system of linked regional and national databases on IAS available in multiple languages to increase effectiveness.
- Implement surveys to identify priority IAS, assess the scale of IAS problems and economic implications. Efforts should be made to research and monitor all introduced species.
- Identify key organizations responsible for management of IAS in the country. Ensure that national governments are involved in the management planning process
- Develop a national strategy for and action plans for management and an early detection and rapid response action plan as this will increase the likelihood that invasions will be addressed successfully while populations are still localized.
- Identify opportunities for financial and technical support
- Build capacity within the community, research institutions, local governments and other key stake holders for action and management of IAS. Capacity building should target all components in society, from government decision makers and administrators, to donors, researchers, agricultural, forestry, fisheries practitioners and the public.
- Promote awareness of IAS issues by convening workshops, conducting publicity events and media campaigns and ensure community participation and involvement

CHAPTER IV. THE STATE OF USE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

(Not enough information to complete)

31. The use of management practices or actions that favor or involve the use of biodiversity for food and agriculture

Table38. Management practices that are considered to favour the maintenance and use ofbiodiversity for food and agriculture

- ✓ *Livestock grassland based production*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		NA	NA
Integrated Pest Management (IPM)[2]		2	1
Pollination management[1]		NA	NA
Landscape management[1]		1	2
Sustainable soil management Practices[2]		2	2
Conservation agriculture[1]		2	2
Water management practices, water			2
Harvesting[2]		2	
Agro-forestry[1]		-2	-2
Organic agriculture[2]		NA	NA
Low external input agriculture[2]		NK	NK
Home gardens[2]		NA	NA
Areas designated by virtue of production features and approaches[1]		NK	NK
Ecosystem approach to capture fisheries[1]		NA	NA
Conservation hatcheries[1]		1	2
Reduced-impact logging[2]		NA	NA
Others (describe)			

✓ *Livestock landless system*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		2	2
Integrated Pest Management (IPM)[2]			
Pollination management[1]		2	1
Landscape management[1]		NA	NA
Sustainable soil management Practices[2]		NA	NA
Conservation agriculture[1]		2	2
Water management practices, water		1	2
Harvesting[2]		2	2
Agro-forestry[1]			
Organic agriculture[2]		0	0
Low external input agriculture[2]		1	1
Home gardens[2]		0	0
Areas designated by virtue of production features and approaches[1]		1	1
Ecosystem approach to capture fisheries[1]		NK	NK
Conservation hatcheries[1]		NA	NA
Reduced-impact logging[2]		2	2
Others (describe)		1	1

✓ *Naturally regenerated forest*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		NA	NA
Integrated Pest Management (IPM)[2]			
Pollination management[1]		1	1
Landscape management[1]		1	1
Sustainable soil management Practices[2]		1	2
Conservation agriculture[1]		1	1
Water management practices, water		1	2
Harvesting[2]			1
Agro-forestry[1]		1	
Organic agriculture[2]		0	0
Low external input agriculture[2]		NA	NA
Home gardens[2]		NA	NA
Areas designated by virtue of production features and approaches[1]		NA	NA
Ecosystem approach to capture fisheries[1]		NK	NK
Conservation hatcheries[1]		NA	NA
Reduced-impact logging[2]		NA	NA
Others (describe)		NA	NA

✓ *Production forest system*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		1	1
Integrated Pest Management (IPM)[2]			
Pollination management[1]		1	1
Landscape management[1]		1	1
Sustainable soil management Practices[2]		1	2
Conservation agriculture[1]		1	1
Water management practices, water		1	2
Harvesting[2]			1
Agro-forestry[1]		1	
Organic agriculture[2]		1	1
Low external input agriculture[2]		0	0
Home gardens[2]		0	0
Areas designated by virtue of production features and approaches[1]		NA	NA
Ecosystem approach to capture fisheries[1]		NK	NK
Conservation hatcheries[1]		NA	NA
Reduced-impact logging[2]		NK	NK
Others (describe)		NK	NK

✓ *Self-recruiting capture fisheries system*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		NA	NA
Integrated Pest Management (IPM)[2]			
Pollination management[1]		NA	NA
Landscape management[1]		1	1
Sustainable soil management Practices[2]		1	2
Conservation agriculture[1]		2	2
Water management practices, water		1	1
Harvesting[2]			2
Agro-forestry[1]		2	
Organic agriculture[2]		1	1
Low external input agriculture[2]		NA	NA
Home gardens[2]		NA	NA
Areas designated by virtue of production features and approaches[1]		NA	NA
Ecosystem approach to capture fisheries[1]		1	1
Conservation hatcheries[1]		1	2
Reduced-impact logging[2]		1	2
Others (describe)		NA	NA

✓ *Culture-based fisheries*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		1	2
Integrated Pest Management (IPM)[2]			
Pollination management[1]		2	1
Landscape management[1]		1	1
Sustainable soil management Practices[2]		1	2
Conservation agriculture[1]		2	2
Water management practices, water		1	1
Harvesting[2]			2
Agro-forestry[1]		2	
Organic agriculture[2]		1	1
Low external input agriculture[2]		1	1
Home gardens[2]		1	1
Areas designated by virtue of production features and approaches[1]		1	1
Ecosystem approach to capture fisheries[1]		1	1
Conservation hatcheries[1]		1	2
Reduced-impact logging[2]		1	2
Others (describe)		1	2

✓ *Rainfed crops*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		1	2
Integrated Pest Management (IPM)[2]			
Pollination management[1]		2	2
Landscape management[1]		1	1
Sustainable soil management Practices[2]		1	2
Conservation agriculture[1]		2	2
Water management practices, water		1	1
Harvesting[2]			2
Agro-forestry[1]		2	
Organic agriculture[2]		1	1
Low external input agriculture[2]		1	1
Home gardens[2]		1	1
Areas designated by virtue of production features and approaches[1]		1	1
Ecosystem approach to capture fisheries[1]		2	2
Conservation hatcheries[1]		NA	NA
Reduced-impact logging[2]		1	2
Others (describe)		NA	NA

✓ *Irrigated crop production system*

Management practices[21]	**Percent ofproduction area orquantity under thepractice (%)**	**Change in production area or quantity under thepractice**	**Effect on biodiversity for food and agriculture**
		(2,1,0,-1,-2, NK, NA)	**(2,1,0,-1,-2,NK, NA)**
Integrated Plant Nutrient Management(IPNM)[2]		1	2
Integrated Pest Management (IPM)[2]			
Pollination management[1]		2	2
Landscape management[1]		1	1
Sustainable soil management Practices[2]		1	2
Conservation agriculture[1]		2	2
Water management practices, water		1	1
Harvesting[2]			
Agro-forestry[1]		1	1
Organic agriculture[2]		1	1
Low external input agriculture[2]		1	1
Home gardens[2]		1	1
Areas designated by virtue of production features and approaches[1]		1	1
Ecosystem approach to capture fisheries[1]		2	2
Conservation hatcheries[1]		NA	NA
Reduced-impact logging[2]		1	2
Others (describe)		NA	NA

Sources: 1. *Statistics and food security data bases, MARD; 2. Statistical Yearbook of Vietnam, Statistical publishing house, General Statistic Office, 2013****; 3.*** *Primary report of general investigation result on rural, agriculture and fisheries in 2011, General Statistic Office; 4. National indicators, World Bank****; 5.*** *Lists of clones/varieties of crops/forests/animals, and fisheries and aquaculture genetic resources that was approved by MARD*

✓ *Livestock grassland based production*

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Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		2	1
Base broadening		2	1
Domestication		1	1
Maintenance or conservation of landscape complexity		0	0
Restoration practices		1	1
Management of micro-organisms		NA	NA
Polyculture/Aquaponics		NA	NA
Swidden and shifting conservation agriculture		1	1
Enriched forests		NK	NK
Others [*please specify*]			

✓ *Livestock landless production*

Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		1	1
Base broadening		2	2
Domestication		2	2
Maintenance or conservation of landscape complexity		NA	NA
Restoration practices		NA	NA
Management of micro-organisms		NK	NK
Polyculture/Aquaponics		NA	NA
Swidden and shifting conservation agriculture		1	1
Enriched forests		NA	NA
Others [*please specify*]			

✓ *Natural forest*

Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		2	1
Base broadening		2	1
Domestication		1	1
Maintenance or conservation of landscape complexity		0	0
Restoration practices		1	1
Management of micro-organisms		NA	NA
Polyculture/Aquaponics		NA	NA
Swidden and shifting conservation agriculture		1	1
Enriched forests		NK	NK
Others [*please specify*]			

✓ *Planted forest*

Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		1	1
Base broadening		2	2
Domestication		2	2
Maintenance or conservation of landscape complexity		0	0
Restoration practices		1	1
Management of micro-organisms		2	2
Polyculture/Aquaponics		NA	NA
Swidden and shifting conservation agriculture		2	2
Enriched forests		1	1
Others [*please specify*]			

✓ *Self-recruiting capture fisheries*

Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		2	1
Base broadening		2	1
Domestication		1	2
Maintenance or conservation of landscape complexity		1	1
Restoration practices		1	1
Management of micro-organisms		NA	NA
Polyculture/Aquaponics		NA	NA
Swidden and shifting conservation agriculture		1	1
Enriched forests		NK	NK
Others [*please specify*]			

✓ *Culture based fisheries and fed aquaculture*

Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		1	1
Base broadening		2	2
Domestication		2	2
Maintenance or conservation of landscape complexity		2	2
Restoration practices		2	2
Management of micro-organisms		1	2
Polyculture/Aquaponics		2	2
Swidden and shifting conservation agriculture		2	2
Enriched forests		2	2
Others [*please specify*]			

✓ *Rainfed crop production*

Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		2	2
Base broadening		2	1
Domestication		1	1
Maintenance or conservation of landscape complexity		2	2
Restoration practices		1	1
Management of micro-organisms		1	1
Polyculture/Aquaponics		NA	NA
Swidden and shifting conservation agriculture		1	1
Enriched forests		NK	NK
Others [*please specify*]			

✓ *Irrigated crop production system*

Diversity based practices [22]	**Percent of production area or quantity under the practice (%)**	**Change in production area or quantity under the practice (2,1,0,-1,-2, NK, NA)**	**Effect on biodiversity for food and agriculture (2,1,0,-1,-2, NK)**
Diversification		-1	-1
Base broadening		2	2
Domestication		2	2
Maintenance or conservation of landscape complexity		1	1
Restoration practices		1	1
Management of micro-organisms		2	2
Polyculture/Aquaponics		NA	NA
Swidden and shifting conservation agriculture		2	2
Enriched forests		NK	NK
Others [*please specify*]			

CHAPTER V. THE STATE OF INTERVENTION IN THE CONSERVATION AND USE OF BIODIVERSITY FOR FOOD AND AGRICULTURE

32. Main national policies, programs and enabling framework that support or specifically address and sustainable use of biodiversity in Vietnam

Be aware of the importance of biodiversity values and its potential contribution to national economic development, Vietnam's Government has issuedlegal document related tobiodiversity conservationin early 1960's. Since then, institutional reform and legislative development targeting to conservation and sustainable use of biodiversity have been significantly enhanced, until now more than 140 legal documents for biodiversity conservation and management have promulgated such as, Forest Protection and Development Law in 1991 (amended in 2004); Land Use Law in 1993 (amended in 1998 and 2003); Environmental Protection Law in 1993 (amended in 2005); Biodiversity Action Plans in 1995; Fishery Law in 2003;Biodiversity Law in 2008; The National Action Plans on Biodiversity in 2007;The National Strategy on biodiversityin 2013; and recently, the Master Plans of Biodiversity Conservation in 2014. The following table will present main national policies, programmes and enabling frameworks that support conservation and sustainable use of biodiversity for food and agriculture in Vietnam.

Table 39. List of legislations related to conservation of biodiversity for food and agriculture

Year	Name of legislations	Objectives related to conservation and sustainable uses of biodiversity, and associated biodiversity for food and agriculture
1991	Law on Forest Protection and Development, adopted in 1991 and amended in 2004[43]	This is an important framework for the protection of Vietnam's forestry ecosystem, including: - Protection forests are used mainly to protect water sources and land, prevent erosion and desertification, restrict natural calamities and regulate climate. - Special-use forests are used mainly for conservation of nature, specimens of the national forest ecosystems and forest biological gene sources; for scientific research; protection of historical and cultural relics as well as landscapes; in service of recreation and tourism in combination with protection. - Production forests are used mainly for production and trading of timber and non-timber forest products in combination with protection.
1993	Law on Environmental Protection, adopted in 1993 and reviewed in 2005 and 2014 (No 52/2005/QH11)[44]	- Planing, assessing and protecting zones and ecosystems which have an important national or international biodiversity value, in the forms of marine conservation zones, national parks, nature reserves, biosphere reserves or species-biotope conservation zones; - Listing and grouping genetic resources based on the level of rare, threatened extinction of genetic resources to manage; - Establishing gene banks to preserve and sustainablly use indigenous genetic resources, and developing wildlife rescue centers.
1997	The dicision No 2177/QĐ – BKHCNMT to	- To conduct survey and gather gene sources suited to the nature and characteristics of each kind of plant, animal or

[43]Law on Forest Protection and Development, adopted in 1991 and amended in 2004
[44]Law on Environmental Protection, adopted in 1993 and reviewed in 2005 and 2014

Year	Name of legislations	Objectives related to conservation and sustainable uses of biodiversity, and associated biodiversity for food and agriculture
	issue the regulation on management and preservation of plant, animal and micro-organism genetic sources[45].	micro-organism; -To protect genetic resources in order to supply original materials for the scientific research, to improve breeds and ensure the preservation of bio-diversity and essential prerequisites in the field of biological resources for the sustainable agricultural development today as well as in future.
2003	Fisheries Law, adopted in 2003[46]	- Planing, formating and decentralize the inland protected areas and marine parks in the forms of national park, species-biotope conservation zones and aquatic resource reserve, based on the levels of typical biodiversity in accordance with national and international standards. - The list of aquatic species which are named in the Red Book of Vietnam and other species prohibited to be fished; the list of aquatic species which are prohibited to be fished in time-limited manner and the closed time as well. - The fishing operations shall be ensured not lead to the depletion of fisheries resources; shall be done in compliance with regulations relating to fishing seasons, fishing time, fishing grounds, permitted types and sizes, annual allowable catch.
2003	Decreee no 109/2003/NĐ-CP of government dated on September 23, 2003 on the conservation and sustainable development of submerged areas[47]	- Giving priority to the conservation of submerged area possessing peculiar ecosystem and high biodiversity, having a function of maintaining water resource and being national or international importance; - Protecting rare and precious varieties and species, migratory birds and environment in the submerged areas; - Restoringsubmerged ecosystems which have been deteriorated or over-exploited.
2004	Strategy to Protect National environment till 2010 and orientation till 2020[48]	- Recovering 50% of mining areas and 40% of severely degraded ecosystems. - Increasing forest cover by 43% of total natural land, recovering 50% of degraded watershed forests and improving forest quality. - Increasing total area of PNAs by half as much against current area, especially MPAs and wetland preserved areas. - Recovering the area of mangrove forests by 80% of that in 1990.
2006	National water resource Strategy till 2020[49]	- Protecting the intactness of aquatic ecosystems, wetlands, river mouth areas and coastal areas.

[45]The Decision No 2177/QĐ – BKHCNMT to issue the regulation on management and preservation of plant, animal and micro-organism genetic sources

[46]Fisheries Law, adopted in 2003

[47]Decreee No. 109/2003/NĐ-CP of government dated on September 23, 2003 on the conservation and sustainable development of bubmerged areas

[48] National Strategy for Environmental Protection (NSEP) until the Year 2010 and Vision toward 2020 according to the Government Decision 256/2003/QD-TTg of December 2nd, 2003

[49]Decision No.81/2006 QD – TTg dated 14/4/2006 of the Prime Ministry ratifying the National Strategy on Water Resources until 2020

Year	Name of legislations	Objectives related to conservation and sustainable uses of biodiversity, and associated biodiversity for food and agriculture
		- Sustainably developing water resource by promoting the protection and development of forests, firstly watershed forests.
2007	The national action Plan on biodiversity up to 2010 and orientations towards 2020 for implementation of the Convention on biological diversity and the Cartagena protocol on Biosafety[50]	- To complete the system of (terrestrial, wetlands and marine) natural reserves; to restore 50% of typical and sensitive ecosystems which have been destroyed ; - To complete a conservation system to efficiently conserve precious and rare livestock breeds, plant varieties and indigenous agricultural microorganisms of high socio-economic value; - To monitor, prevent, stop and eliminate the exploitation, trading and consumption of precious, rare and endangered animals and plants; - To monitor, evaluate and prevent invasive alienspecies; - To efficiently manage biosafety to protect the people's health, the environment and biodiversity;
2007	Decision No. 18/2007/QD-TTg of the Prime Minister on approving Vietnam's forestry development st rategy in the 2006-2020 period[51]	- Establishing, managing, developing and sustainably using 16.24 millions hectares of land for Forestry; - Increasing the percentage of forestland to 42-43% in 2010 and 47% in 2020; - Ensuring large participation of different economic components and social organizations in forestry development, ecological and environmental protection, biodiversity conservation and provision of environmental services in order to help eradicate hunger, eliminate poverty and enhance the living standard of the people in rural mountainous areas.
2007	The Red Book of Vietnam	- The list of 418 fauna and 464 flora species are endangered, vunerable, threatened and rare in nature. - This is an important scientific basis to establish legal frameworks and solution for protection and management of wildlife species in Vietnam.
2008	The Biodiversity Law, adopted in 2008[52]	- Formulating a national master plan on biodiversity conservation; - Giving priority to the conservation of naturalecosystems which are important, specific or representative for an ecological region, in form of national parks, nature reserves, species/habitat conservation areas and landscape conservation areas; - Establishing the list of endangered precious and rare species prioritized for protection; - Establishing biodiversity conservation facilities for rearing or planting species on the list of endangered precious and rare

[50]Decision No. 79/2007/QĐ-TTg of Prime Minister on approving the national action Plan on biodiversity up to 2010 and orientations towards 2020 for implementation of the Convention on biological diversity and the Cartagena protocol on Biosafety

[51]Decision No. 18/2007/QD-TTg of the Prime Minister on approving Vietnam's forestry development strategy in the 2006-2020 period

[52]The Biodiversity Law, adopted in 2008 (No.20/2008/ QH12)

Year	Name of legislations	Objectives related to conservation and sustainable uses of biodiversity, and associated biodiversity for food and agriculture
		species, crop varieties, domestic animal breeds and microorganisms; - Survey, listing and control of the spread and development of invasive alien species; - Investigation, collection, storage, preservation, assessment, supply and management of genetic resources; - Management of accessing to genetic resources and sharing benefit; - Protecting traditional knowledge copyrights on genetic resources; - Responsibilities for managing risks caused to biodiversity by genetically modified organisms and genetic specimens of genetically modified organisms; - Harmoniously combining conservation with rational exploitation and use of biodiversity; and conservation and rational exploitation and use of biodiversity with hunger eradication and poverty alleviation.
2008	Project "Protecting valuable aquatic creatures endangered to be extinct - till 2015, vision till 2020"[53]	- Preventing endangered species becoming extinct - Recovering populations and developing precious, endemic and high- value aquatic species; - Conserving biological diversity and sustainably develop fishery and aquaculture with communities' engagement.
2008	Planning the system of Interior WaterPreserved Areas (IWPA) till 2020	- Designing and establishing a system of 45 IWPAs - Having detailed planning completed for IWPAs at thenational level.
2010	Planning the national system of marine protected areas (MPAs)	- Establishing a system of 16 MPAs accounting for 169,617 hectares of coastal and marine waters - Complete the detailed planning of 5 MPAs - Establish 5 operational MPAs, namely: Nha Trang Bay, Cu Lao Cham, Nui Chua, Phu Quoc and Con Co.
2012	Program on protection and development of aquaticresources through 2020.	- Establishing and putting into operation 10 MPAs and 19 IWPAs by 2015 - Having the nationally planned protected areas from the MPAs system and IWPAs system finalized andoperational by 2020 - By 2015, complete the planning of fishing-prohibited zone, promulgate the list of banned activities.
2013	The national strategy on environment protection to 2020, vision to 2030	- Mitigating the deterioration and exhaustion of natural resources - Preventing and limiting the degradation ofbiodiversity.
2013	Program on prevention and management of invasive alien species to 2020	- Ensuring that invasive alien species are periodically investigated and assessed; categorized and controlled in accordance with law - Prevent and control the spread of invasive alien species, mitigating the harmful effects of invasive species which are a

[53] Vietnam-Netherlands Mekong Delta Masterplan project "Research and assessment of water and environment in Mekong river delta: living environment, ecosystem, mangrove and natural preservation"

Year	Name of legislations	Objectives related to conservation and sustainable uses of biodiversity, and associated biodiversity for food and agriculture
		serious threat in Vietnam - Effectively managing the importation, cultivation and development of biological species that may become invasive in order to prevent negative impact on environment and biodiversity in Vietnam - Ensure 80% of communities in the provinces and cities directly under the central government have increased awareness on identifying, preventing and controlling invasive alien species.
2013	Decision No 1250/QĐ-TTg dated on July 31, 2013, approved national strategy on biodiversity until 2020 and vision to 2030	- The objectives of the strategy are ensure important natural ecosystems, endangered, rare, and precious species, and genetic resources are preserved and sustainably used, contributing to the development of the green economy, and actively responding to climate change. - Improving the quality and the increase the area of protected ecosystems, ensuring that the area of terrestrial PAs account for 9% of the total territorial area; MPAs account for 0.24% of the sea area, forest coverage reaches 45%, primary forest remains at 0.57 million hectares coupled with effective protection plans; mangrove forests, sea grass beds, and coral reefs are maintained at the current levels; 15% of degraded critical ecosystems are restored; the number of internationally recognized PAs are increased to 10 Ramsar wetlands, 10 biosphere reserves and 10 ASEAN heritage parks (AHP); - Enhancing the populations of rare, threatened and endangered species; and establishing priorities forprotection ensuring that no new case of species extinction are reported, significantly improve the status of endangered, rare and threatened species; - Compiling an inventory, store and conserve native, endangered, rare and precious genetic resources (including animals, plants and microorganisms) to ensure that they are not impaired or eroded
2014	Decision No. 45/QĐ-TTg dated on January 8, 2014, Approved the master plan on biodiversity conservation in the whole country through 2020, with orientations toward 2030	- To plan the biodiversity conservation by 2020 according to 8 geographical regions (Northeast, Northwest, Red River Delta, North Cental, South Cental, the Central Highlands, Mekong River Delta, Southeast region) in the whole country with 4 objects: natural ecosystems, conservation zones, biodiversity conservation facilities and biodiversity corridors. Orientations toward 2030 - To continue to protect natural ecosystems of international and national importance; and degraded coral reef, seagrass bed, natural mangrove forest, coastal lagoon and limestone mountain ecosystems. - To continue to establish and put into operation the conservation zones, biodiversity conservation facilities and biodiversity corridors as proposed.

33. *Main policies, programmes and enabling frameworks in Vietnam that enhance the application of an ecosystem approach or landscape approach to conserve and use biodiversity for food and agriculture.*

Table 40. *List of policies/regularions related to application of an ecosystem approach or landscape approach to conserve and use biodiversity for food and agriculture*

Year	Name of policies/regulations	Main points related to application of ecosystem approach or landscape approach for conservation and sustainable uses of biodiversity
2008	Decision No 05/2008/QD-UBND of People's committee of Ho Chi Minh city, approving on management regulation of Can Gio Mangrove Biophere Reserve	The decision emphazised on 12 management principles of biosystem approach in accordance with the approaches mentioned in the Convention on Biological Diversity started by the United Nations since 1998, including: - Management objectives of soil, water resources and wildlife are social selection; - Ecosystem managers have to review the effects of their activities to other adjacent ecosystems - Need to know the ecosystem in specific economic contexts to propose reasonable management solutions. - Conservation the function and structure of ecosystem in order to maintain ecosystem services is the priority target of the ecosystem approach; - Ecosystem should be managed in its limited function; - Ecosystem approach should be applied in reasonable spatial and temporal scale; - Management objectives should be long-term and in accordance with change over time and affecting range of ecosystem; - Need to accept that change is inevitable in management; - The suitable balance and integration between conservation and biodiversity is a basic factor in the ecosystem approach; - All information sources about scientific research, local and indigenous knowledge, innovation and local realities should be considered to apply in the ecosystem approach; - The ecosystem approach needs a participation of all social force and scientific organization.

Year	Name of policies/regulations	Main points related to application of ecosystem approach or landscape approach for conservation and sustainable uses of biodiversity
2012	Project "Mainstreaming Ecosystem based approach to Climate change into Biodiversity conservation planning" from 6/2012 to 12/2013	To strengthen knowleage and expriment on ecosystem approach to climate change into biodiversity conservation management, including nine solutions: - Strengthening public participation in biodiversity conservation; - Mainstreaming biodiversity conservation into plannings of social – economic development; - Establish models of subtainable economic growth; - Biodiversity conservation respond to climate change; - Formulate training programs for biological diversity; - Complete legal framework for biodiversity conservation; - Establish a crimial sanction on violences to biodivesity conservation; - Enhance financial source for biodiversity conservation; - Strengthen national and international coperation in biodiversity conservation; - Organize and emplement plans on biodiversity conservation
2013	Operational framework on "Developing and Implementing Climate Change Ecosystem-based Adaptation"	The framework is designed to provide detailed steps guiding a vulnerability assessment of the socio-ecological system. Additionally, it offers suggestions for tools and methods that can be used to analyze and prioritize appropriate adaptation options, which enable communities to adapt more effectively. The objective of the framework is to provide a user-friendly resource that: - Provides step-wise guidance on vulnerability assessment to climate and non-climate related impacts on the socio-economic system; - Supports policy makers, organizations and individuals working, on and interested in, climate change responses and policy integration; and - Introduces updated and effective tools and methods for identification of EbA measures and implementation progess.
2014	Decision No 45/QĐ-TTg of Prime minister approving the master plan on biodiversity conservation in the whole country through 2020, with orientations toward 2030	The decision mentioned study and use of various methods and tools; and application of new models to conserve biodiversity is promoted, especially the ecosystem-based approach to adaptation to climate change, in the management of conservation zones, biodiversity conservation facilities and biodiversity corridors.
2014	Project "Strategic mainstreaming of ecosystem-based adaptation in Viet Nam period 2014-2018" commissioned by German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and	Awareness raising and capacity building for stakeholders at national and provincial levels. These stakeholders should come to recognise the advantages of ecosystem-based adaptation and acquire the capacities to mainstream and implement them. Scaling up: the project is developing a solid base for the further use of ecosystem-based adaptation measures. This draws on an evaluation of existing experiences as well as a pilot measure that includes the development of technical instruments, guidelines, manuals and monitoring approaches.

Year	Name of policies/regulations	Main points related to application of ecosystem approach or landscape approach for conservation and sustainable uses of biodiversity
	the lead executing agency isMORNE	Integration of ecosystem-based adaptation into the national climate adaptation policy and the relevant legal framework (with a focus on land-use and development planning), and identification of national and international sources of financing. Processing of experiences gained through specific measures and pilot interventions; support for the partners and stakeholders in sharing the knowledge they gain from such activities by way of national and international networks and platforms.

34. Main policies, programmes and enabling frameworks in Vietnam that embed the utilization of biodiversity for food and agriculture, including its different components, into disaster management and response

Table 41. List of programs related to utilization of biodiversity for food and agriculture into disaster management and response

Year	Name of regulations	Main point related to the utilization of biodiversity for food and agriculture into disaster management and response
2007	The Law on Dyke: Management and the National Strategy for Disaster Prevention, Response and Mitigation to 2020[54].	**Article 1, part V** (Action plan): Non- structural measures, the programs onforestation and protection of upstream forests: - Establish, manage, protect, develop and sustainably use 16.24 million ha of forestry land; increase the area of forestcoverage to 42-43% by 2010 and to 47% by 2020. - Pay attention to develop and explore non-wood forestry products in the areas of protection forests to make forests protection beneficial to local people. - Plant trees to protect dyke systems
2004	Law on Forest Protection and Development:	**Article 4**: One kind of forests classified based on their major use purposes is protection forest, which are mainly used to protect water sources and land, prevent erosion and desertification, restrict natural calamities and regulate climate, thus contributing to environmental protection, including: a/ Headwater protection forests; b/ Wind- and sand-shielding protection forests; c/ Protection forests for tide shielding and sea encroachment prevention; d/ Protection forests for environmental protection
1993	The Ordinance on Prevention and Control of Floods and Storms adopted by the Standing Committee of the 9th National Assembly	**Chapter 2, article 10**: To set up plans for strengthening building facilities for prevention and control of floods and storms; to preserve and reinforce dykes; to protect and plant flood prevention forests in higher lands, to plant wave, wind and sand protection forests on sea and river coasts; to apply scientific and technological innovations to the prevention and control of floods and storms

[54] Decision No. 172/2007/QD-TTg approving the National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020

35. *Main policies, programmes and enabling frameworks in Vietnam that embed the utilization of biodiversity for food and agriculture, including its different components, into climate change adaptation and mitigation stratergies and plans.*

Vietnam is considered as a country most strongly affected by climate change, especially in Mekong River Delta. Vietnam government has approved many policies and solutions to respond to climate change.

- *Policy framework in Vietnam to respond to climate change*

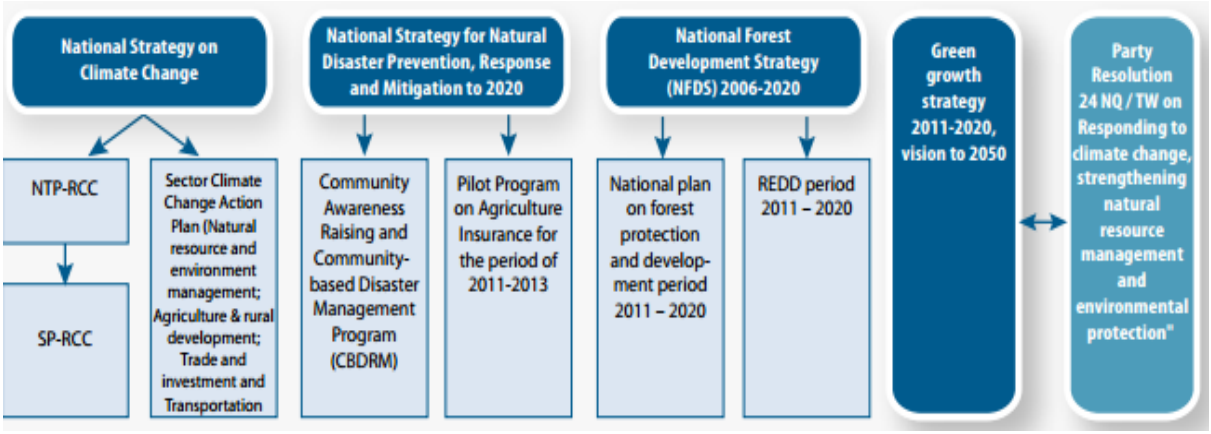

Figure 7.*National policies and programs guiding Climate Change Actions in Viet Nam (Sourcce: WWF 2013)*

Table 42. List of policies and programsrelated to utilization of biodiversity for food and agriculture into climate change adaptation and mitigation strategies and plans

Year	Name of regulations	Main Points related to utilization of biodiversity for climate change adaptation and mitigation
2008	The National Target Program to respond to climate change[55].	- The decision mentioned to response to climate change must be integrated into development strategies, programmes, plans, planning in all sectors and at all levels; into legal documents and policy institutions; into development of legal documents. - Implementation, including the programs involving in biodiversity conservation and sustainable use such as environmental protection, reasonable use of natural resources, natural disaster prevention, marine research, security of water sources, sea dyke system, reservoir, protective forests programs.
2008	National Target program to Respond to Climate Change[56].	*Climate mitigation: Agriculture, forestry sector and land use change:* - Collaborate with the programs of agro-forestry sector such as the programs to protect and conserve existing forest areas and forest plantation program, etc. in order to speed up the implementation of the programs to conserve and enhance the greenhouse gas sinks in Vietnam. Protection, develop and sustainably use of 1624 million ha of land that have planned for the forestry. Increase forest coverage from 37% in 2005 to 42.6% by the year of 2010 and 47% by the year of 2020. - Ministry of Agriculture and Rural Development co-ordinate with

[55]Dicision No. 158/2008/QD - TTg on approving the National Target Program to respond to climate change

[56] Prime Minister of Vietnamese Government approved the NTP on 02 Dec. 2008 National Target Program to Respond to Climate Change

Year	Name of regulations	Main Points related to utilization of biodiversity for climate change adaptation and mitigation
		other Ministries, sectors and localities to develop sectoral action plan to mitigate green house gases emission, protect forest and green house gases sinks via policies, technologies, awareness raising. Those are: - Develop the programs to effectively utilize bare land and bold hills to create more employment, thus promote hunger eradication and poverty reduction, and resettlement; - Participate in the programs of forestry sector to propose the policy encouraging the use of alternative materials; - Develop a plan to participate in forestry socialization, settled agriculture and resettlement program; - Develop the program to carry out the measures irrigating paddy fields; change of the crops; properly plan the season to reduce the greenhouse air; - Push up the livestock rearing, closely linked to animal feed industry and treatment of animal waste (in form of biogas);
2011	The program to support for response to climate change in the policy framework matrix[57]	The decision emphasized to formulate plans for the development of coastal protection forests, including mangrove forests and protection forest against wind and sand flying, to strengthen the availability to respond to natural disasters
2011	The policy framework matrix to Support Programme to respond to climate change[58]	This decision emphasizes the policy actions expected support to respond to climate change in Vietnam, including: Formulate the National master planning on biodiversity conservation to adapt to climate change; establish the national information system on biodiversity; raise public awareness during the period from 2009 to 2011, based on the implementation of biodiversity law; Complete the program on forest protection and development during the period from 2011 to 2015 to enhance carbon.

[57]Decision No 1410/QD-TTg of Prime Ministerapprovingthe program to support for response to climate change in the policy framework matrix

[58]Decision No. 1410/QD-TTg Approve the policy framework matrix, Support Programme to respond to climate change

Year	Name of regulations	Main Points related to utilization of biodiversity for climate change adaptation and mitigation
2011	The National Strategy on Climate Change[59]	*Protecting and developing forests sustainably, increasing the absorption of greenhouse gases and preserving biodiversity:* - To speed up the schedule of afforestation and re-afforestation projects, encourage enterprises to invest in planting economic forests. Up to 2020, it is necessary to establish, manage, protect, develop and use 16.24 million hectares of land planned for forestry activities in a sustainable way; raise the forest coverage to 45%; sustainably and effectively manage 8.132 million ha of production forests, 5.842 million ha of preventive forests and 2.271 million ha of special-use forests; - To preserve biodiversity, protect and develop ecosystems and species which can well resist climatic changes; to protect and preserve genes and species endangered by impacts of climate change; - To craft and realize programs on reducing greenhouse gas emission through efforts of minimizing forest loss and deterioration, managing forest in a sustainable way, preserving and improving forests' absorption of carbon, and maintaining and diversifying local people's livelihood as well as helping them to adapt to climate change; - To design and implement programs on protecting and managing available natural forests, preventive forests, special-use forests, and production forests; - To design and implement models of green urban and residential areas; - To craft and realize policies on engaging socio-economic sectors in sustainably protecting and developing forests and natural ecosystems in order to cope with climate change while improving the carbon absorption of these forests and ecosystems; - To increase capacity and efficiency of systems for evaluating, forecasting, preventing, monitoring, supervising and urgently responding to forest fires

[59] Dicision No.2139/QD-TTg dated December 05, 2011,The National Strategy on Climate Change issued by Prime Minister

Year	Name of regulations	Main Points related to utilization of biodiversity for climate change adaptation and mitigation
2012	National Strategy on Environmental Protection to 2020 with Vision to 2030[60]	It contains four specific objectives of which objective 3, to reduce thedegradation and exhaustion of natural resources and reduce the rate of decline of biodiversity, andobjective 4, strengthen the capacity to respond to climate change impacts and to reduce emission ofGHG, are of particular importance to this assessment.
2012	Decision No. 1474/QĐ-TTg dated on Otober 5th, 2012 approved the National Action Plan on Climate Change for the period 2012 to 2020[61]	This plan contains 64 programmes to actively respond to serious effects of climate change and natural disaster in Vietnam: - Develop and implement programs to reduce greenhouse gases through efforts to limit deforestation and forest degradation, and enhance sustainable forest management and enhance carbon storage of forests. - Strengthen management, conservation and sustainable development of mangrove and protection forests; - Research crops and livestock changing consistent with climate change and sea level rise to actively prevent disease; application of biotechnology and advanced production processes towards modern agriculture and adaptation to climate change.
2013	Decision No. 1250/QĐ-TTg dated on July 31, 2013, approved national strategy on biodiversity until 2020 and vision to 2030[62]	- Conservation of biodiversity is one of the key solutions to adapt to and mitigate the impacts of climate change; - Research, evaluate and predict the impacts of climate change to biodiversity in Vietnam; - Establish biodiversity corridors to link between natural conservation areas for biodiversity conservation and adaptation to climate change; - Investigate the role of biodiversity in adaptation and mitigation of climate change in vulnerable areas such as river basins, coastal areas (especially the Red River Delta and the Mekong Delta) and implement solutions to improve the resilience of biodiversity to climate change in these regions; - Implement forest rehabilitation programs mainstreaming biodiversity conservation into adaptation and mitigation of climate change.
2013	The 7th Congress of the 11th Central Executive Committee, approving active in respond to climate change, improve natural resource management and	To propose solutions related to biodiversity, including: - Evaluate and promote the value of ecosystem services, landscape, genetic resources; - Planning, management and exploitation, effectively and sustainably use of national natural resources to actively respond to climate change; - Prevent the trend of degradation of fresh water and forest resources, improve the effectiveness of water use per GDP unit;

[60]Decision No. 1216/QDTTg National Strategy on Environmental Protectionto 2020 with Vision to 2030approved by the Prime Minister

[61]Decision No. 1474/QĐ-TTg dated on Otober 5th, 2012 approved the National Action Plan on Climate Change for the period 2012 to 2020

[62]Decision No. 1250/QĐ-TTg dated on July 31, 2013, approved national strategy on biodiversity until 2020 and vision to 2030

Year	Name of regulations	Main Points related to utilization of biodiversity for climate change adaptation and mitigation
	environmental protection[63]	- Balance the land for economic and social development, flexibly use 3.8 million hectares of rice land to ensure national food security and improve the efficiency of land use.
2014	The National Action Plan on Green growth in Vietnam For the Period of 2014-2020[64]	The decision emphasized on priority in changing cultivation techniques and improving management to reduce GHG emission in agro-forestry and aquaculture such as organic cultivation approach, saving materials (water, seeds and fertilizers) approach, reforestation, conservation and sustainable development of forest as well as other ecologies, combined agro-forestry-aquatic cultivation in different ecological zones to assure for economic effectiveness and environment protection; Sustainably efficient use of water and land resources; Formulate green growth policy framework and action plan for the agriculture, forestry and aquaculture sectors in the period 2014-2020.

36. What arrangements are in place or foreseen in your country that help to ensure that the conservation of biodiversity for food and agriculture is taken into account in national planning and policy development of sectors other than agriculture

37. Obstacles to developing and implementing legislation that would protect associated biodiversity identified in Vietnam

Component of associated biodiversity	Obstacles to legislation for protection of associated biodiversity
Microorganism	
Inveterbrate	
Vertebrate	
Plants	

38. Policies and programmes governing the access to its genetic resources of associated biodiversity established in Vietnam

Viet Nam has enacted several legal documents concerning issues of biodiversity conservation and plant and animal genetic resources. In relation to Access and Benefit Sharing (ABS), Viet Nam's Biodiversity Law 2008, Chapter V from Article 55 to Article 64, provides a number of documents related to access and benefit-sharing. The government is also building dossiers submitted for Government approval of the Nagoya Protocol in 2015. In fact, depend on each particular case, a company commercializing a plant will have to obtain permission of the Ministry of Agriculture and Rural Developments and could pay a Tax for using the genetic resources.

[63]Resolution No. 24 NQ/TW of the 7th Congress of the 11th Central Executive Committee, approving active in respond to climate change, improve natural resource management and environmental protection

[64]Decision No. 403/QĐ-TTg of Prime Minister, approving the National Action Plan on Green growth in Vietnam For the Period of 2014-2020

At present, the Division of Genetic Resources Management and Biosafety of the Biodiversity Conservation Agency of Viet Nam Environment Administration under the Ministry Of Natural Resources and Environment (MONRE), have state management functions over genetic resources and biosafety. The following agencies are also responsible for the management of genetic resources: Ministry of Natural Resources and Environment, Ministry of Agriculture and Rural Development, and the Ministry of Science and Technology. Other agencies involved are the Centre for Plant Genetic Resources, Southern Fruit Research Institute under VAAS, Centre for Livestock Genetic Resources of Viet Nam under the National Institute of Animal Husbandry, and the Center for Research and Development of Ethnomedicinal Plants (CREDEP).

39. Measures taken with the aim of ensuring that access to its genetic resources shall be subject to its prior informed consent (PIC) and that benefits arising from their utilization shall be shared in a fair and equitable manner.

Table 43. Policies and programmes governing the access to its genetic resources of associated biodiversity established in the country.

Component of associated biodiversity	Intended use (e.g. any use, research and development, commercial use)	Prior informed consent (PIC) and benefit – sharing required (Y/N)
Micro-organism	Research, commercial use	Y
Invertebrates	Research, commercial use	Y
Vertebrates	Research, rear, commercial use	Y
Wild and cultivated terrestrial and aquatic plants	Research, plant, commercial use	Y

40. Measures taken with the aim of ensuring that the prior informed consent or approval and involvement of indigenous and local communities is obtained for access to genetic resources

In Vietnam, a number of general principles on access to genetic resources and benefit sharing (ABS), and the participation of local community in activities of biodiversity conservation had been defined in the Law on Biodiversity in 2008 and specifically guided in Decree No. 65/2010 / ND-CP of the Government on detailed regulations and guidelines for implementation of some articles of Biodiversity Law. However, establishment of mechanisms to ensure that local communities can access genetic resources and be shared benefits, araising from local genetic resources and indigenous knowledge relating to genetic resources, have not been implemented.

In fact, there are some models for mobilizing local communities directly provide genetic resources and traditional knowledge, and share benefits. Typically, a company in Lao Cai Province, name is SaPa Napro. This is a community company, providing bath herbs of Dao ethnic people who are major shareholders, supplying material and traditional knowledge about bath herbs to the company. Each household has 4-5 hectares of forest land which put together into a sustainable harvesting and conservation area of medicinal plants. Benefits will divide for shareholders as an annual dividend about 3-4 million VND per month per person. A small proportion of profit will contribute to the social development fund of the local community. Other project has enabled local people in Cuc Phuong National Park to plant orchids to generate income. In other PAs, local people are trained to deliver ecotourism services. In the reforestation programs No. 327 and No. 661, local people have been allocated land, forests, and water to manage and utilize for production.

41. National information systems on associated biodiversity

In Vietnam, establishment of the national information system on biodiversity and cooperating mechanisms between different agencies at national level on the management and use of the national information system on biodiversity has already regulated in legal frameworks. At the moment, the Ministry of Natural Resources and Environment, coordinating with the Japanese international

cooperation agency (JICA) is caring out the project "Formulation the national database on biodiversity" and it is piloting in Nam Dinh province. The project has conducted during the four year period from 2011 to 2015, with main purposes: To formulate the structure of the national biodiversity database system (NBDS); To propose the cooperation mechanisms between different agencies on the management and utilization of the NBDS; To establish the biodiversity database system for Nam Dinh province, as a part of the NBDS; and to enhance capability in the management and utilization of NBDS. This is a scientific base to set up the national biodiversity information system in near future.

Table 44. National information systems on associated biodiversity

National information system (List)	Component of Associated Biodiversity address (List)	Concise description of information systems

42. *The most important stakeholder groups,active in the conservation of biodiversity for food and agriculture*

In Vietnam, there are many political-social organizations such as the Farmers' Association, Women's Union, Youth Union, Vietnam Association of the Elderly, Veterans Association of Vietnam, play an important role in the propaganda and implementation of national legal frameworks, including law on biodiversity and environmental protection. In addition, with the supports and consultation of authorities, these organizations have become as a specialized agencies in the field of natural resources and biodiversity conservation. The roles of the organizations are the establishment and conduction of models and programs to raise the public awareness to environmental protection and biodiversity conservation, including planting coastal mangroves forests; Planting and preventing deforestation; Collecting, sorting and treating waste in rural areas; and Bio-gas tunnels and garbage tanks. Typically, there are conservation clubs with more than 150 members of local youth union in buffer areas of the Phong Nha – Bang National Park. These clubs plays a primary role in assistance for the management board of the National Park to raise public awareness on biodiversity preservation of the national park.

43. *Incentives or benefits to support activities for the conservation and sustainable use of biodiversity for food and agriculture or associated biodiversity*

- Support to community development in the buffer area of special –use forests: This fund had defined in the Decision No 24/2012/QD-TTg of Prime Minister on approving the investment policy of special-use forests development during 2011-2020, which supply 40 million VND for a village to enhance the agro-production capability (agro-forestry encourage, seedlings, breeding stocks, agro-forestry processing equipment at small scale), or support materials to build constructions of local communities such as fresh water stations, electricity systems, public houses. The management boards of special –use forests assigned to manage the funds basing on current governing fund regulations. Annual detailed estimates of the villages will improved by the management boards, in coordination with the commune People's Committees in the meeting with each village.
- Pilot programs of payment for ecosystem services/environment services (PES) in some areas in Vietnam: The basic idea of "payments for environmental services", or PES, is to create

incentives for individualsand communities to protect environmental services by compensating them for any costs incurred in managing and providing those services. In 2004, the government of Vietnam, drawing on the concept of PES, laid the foundations for a nationwide program of Payments for Forest Environmental Services (PFES), set out in the revised Forest Protection and Development Law. In 2008, Decision No. 380 established conditions to support PFES pilot projects in Lam Dong and Son La Provinces[65]. In 2010, Decree No. 99 mandated the implementation of PFES nationwide[66]. Vietnam is the first country in Asia to initiate a nationwide PES scheme.The goals of the PFES program in Vietnam are to improve forest quality and quantity, increase the forestry sector's contribution to the national economy, reduce the state's financial burden for forest protection and management, and improve social well-being.The government of Vietnam has made a strong commitment to PFES. Twenty legal instruments- Decrees, Prime Ministerial Decisions and Circulars— form the legal basis for PFES implementation. Of the four environmental services listed in Decree 99, the PFES program for watershed protection services has the most advanced legal setting and offers the most useful lessons[67].

44. *Major projects (either in progress or completed in the last five years) that support the conservation and sustainable use of biodiversity for food and agriculture, associated biodiversity and/or wild foods.*

a. CO2OL Biodiversity Project: It is a project of two parties, the ForestFinance Group and the SFE (State Forest Enterprise). The reforestation of former fallow land or excessively used grasslands in Vietnam through the exclusive planting of native species.CO2OL Biodiversity Reforestation is the reforestation of former fallow land in Vietnam throughthe predominant planting of native species with the long-term goal to create a species-richmixed forest. The project is supported by the GTZ (Gesellschaft für TechnischeZusammenarbeit) on site. The reforestation project helps to build up ecological structures inareas that suffered from major battles during the Vietnam War or were otherwise massivelydeforested. The planting of trees already started in 2009. The reforestation project is supervisedand audited by several governmental departments.

b. A project on Capacity Building for Biodiversity Conservation (CBBC) in Vietnam (2009-2010)**.** The project focuses on the development and operationalisation of training curricula for managers, technical and field staff of the Forest Protection Department to support them to implement Vietnam's forest and biodiversity legislation and strengthen forest and biodiversity governance and management. FRR is providing strategic guidance to the project and developing training programmes and manuals for FPD staff, as well as developing an inter-agency enforcement mechanism for Vietnam's forest protection and biodiversity legislation.The project aims to address the ineffectiveness of implementation of Vietnamese forest and biodiversityprotection legislation throughout the country (highlighted by the Management Strategy for the Protected AreasSystem (MASPAS) as a particular problem for Vietnam's protected area system, but even more pronouncedoutside of protected areas, resulting from a lack of training capacity and thus operational capacity, plus a lack ofunderstanding and cooperation between FPDs and related enforcement agencies.

c. Project "Biodiversity conservation and sustainable use of marine resources in Con Dao National Park, Vietnam": This GEF project aims to strengthen local capacity for marine and coastal biodiversity conservation, improve integration of conservation and environmental management into development planning, establish sustainable financing mechanisms for

[65] Decision No. 380/QĐ-TTg2,dated April 10, 2008 approved by Prime Minister on established conditions to support PFES pilot projects in Lam Dong and Son La Provinces

[66]Decree No. 99/2010/NĐ-CP mandated the implementation of PFES nationwide dated September 24, 2010

[67]Payments for forest environmental services in Vietnam: from policy to practice (Pham Thu Thuy, Karen Bennett, Vu Tan Phuong, Jake Brunner, Le Ngoc Dung and Nguyen Dinh Tien (2013)

biodiversity conservation and link local efforts to national strategies and policy development. It contributes to the conservation of globally significant coastal and marine biodiversity. The work includes project design and management, and design and assessment of an enforcement programme for Con Dao National Park.

d. Projects to conserve traditional medicinal plant resources from 1997 to 2010: the Ministry of Health assigned the Institute of Medicine conducted this project since 1997. Over 12 years of implementation, the project had achieved encouraging results. The activies such as conducting surveys, collecting medicinal plant species and Traditional Prescription Drug of all ethnic minority communities in many parts of the country, for example, Dao people at Ba Vi National Park possesses 579 medical plant species and 125 prescriptions; Muong people (Cam Lien commune, Cam Thuy district, Thanh Hoa province) has 136 species and 102 prescriptions; Hmong people (Ky Son, Nghe An) has 206 species and 32 prescriptions; Tay people (Vi Xuyen, Ha Giang) had 292 species; The Tay - Nung (Trang Dinh, Lang Son) has 126 species and 51 prescriptions; the Muong (Vinh Lac, Luc Yen, Yen Bai) has 40 species and 40 prescriptions; 85 prescriptions of the Dao; 72 prescriptions of the Hmong; 16 of the Thai and Kho Mu; and 11 of the Bru - Van Kieu. Develop and commercialize 3 prescriptions of Katu people (Nam Dong, Hue) contributing to the income of the local people. In addition, the project built the model gardens for medicinal plant conservation in the community and encourage the participation of local community including 8 gardens in Sapa, Lao Cai; Bach Ma National Park 4 gardens; Yen Bai province 2 gardens; Nghe An 1 garden; Hoa Binh province 1 garden; Thanh Hoa province 1 garden; Lang Son province 4 gardens; Ha Giang province 1 garden; Vinh Phuc province 1 garden; Hanoi 1 garden. Furthermore, training courses and rasing public awareness activities on the conservation of medicinal plants were organized. Simultaneously, this also contributed to conservation indigenous knowledge of medicinal plants used for treatment of ethnic minorities in Vietnam.

e. The "5 million Hectares Reforestation" Program had a budget of about US$2.5 billion over 12 years. It aimed to increase forest coverage in Vietnam to 43% by 2010, and in addition conserve biodiversity, eradicate hunger, eliminate poverty and develop the national economy. Vietnam's Five Million-hectare Reforestation Program (Program no. 661) was implemented from 1998 to 2010 increased the forest coverage to 38.2% in 2006 representing an increase of 11% above the 1990 coverage. Through this process, more employment had been created, contributing to hunger elimination and poverty reduction in mountainous. The government has contributed to biodiversity management through promoting planting and reforestation with native forest species and captive wildlife breeding to support sustainable development. By the end of 2006, about 50 species of wildlife and tens of wild plant species were cultivated in 316 farms and 1,658 households, mostly for commercial purposes.

f. In 2008, the project of Protection of Endangered, Rare and Precious and Aquatic Species to 2015 and Vision Towards 2020 was approved by Vietnam's Prime Minister (Decision No.485/QD-TTg) . This project aims to prevent an increase in number of endangered species and to support the gradual recovery of endemic, rare and precious species in Vietnam through the community participation to contribute to biodiversity conservation and sustainable fisheries. This decision created a legal framework and provided guidance for an important funding program to protect genetic resources of rare, precious and valuable aquatic species in Vietnam.

g. The project on "Developing aframework for production and marketing of organic agriculture in Viet Nam" during the 2005 – 2010 period.This project aimed to improve organic agriculture in all areas from production to consumption in a sustainable manner. The project was implemented in 6 Northern provinces, Bac Ninh, Bac Giang, Hai Phong, Vinh Phuc, Tuyen Quang, and Lao Cai, and was undertaken with the participation of non-governmental organizations and the private sector. The Project's activities include: i) Examining

localdifficulties and advantages, and socio-economic conditions in transitioning to organic farming; ii) Organizing training courses for farmers from various provinces on organic production of rice (Lao Cai province), litchi (Bac Giang province), vegetables (Tuyen Quang, Vinh Phuc, and Bac Ninh province); iii) Implementing some market related initiatives toimprove the awareness of consumers about organic food and implementing the Participatory Guarantee System. With the objective of moving towards clean agriculture and ensuring phyto-sanitary standards, the Organic Farming project led by the Central Viet Nam Farmers' Union in collaboration with the provincial Department of Agriculture and Rural Development andAgricultural Development Denmark –Asia (ADDA), was implemented in Thanh Hai commune, LucNgan district - Bac Giang province, gradually changing awareness of both producers and consumers in production, and consumption of clean agricultural products, as a move towards a sustainable agriculture[68].

h. A planned network of Vietnamese marine reserves up to 2020 has been approved by the Government[69] inorder to conserve the ecosystems and marine creatures of significant economic and scientific value, contributing to the development of the ocean economy and improving the livelihoods of coastal fishing communities.Specifically, the objectives for the period 2010 -2015 are to establish and bring into use 16 marine reserves20; at least 0.24% of Vietnamese sea area is tobecome marine reserves and about 30% of the area of each marine reserve is to be strictly protected. The objectives for period 2016 - 2020 are to research and propose a plan for the development of the marine reserve network; to survey, establish, and bring into use further new marine reserves.

i. In 2008, the Government promulgated policy to provide support to the two provinces of Son La and Lam Dong for their pilot implementation of payment for forest environment services[70]. This is the first policy on forestry that regards forest protection and development, forest ecosystems, biodiversity and forest landscape conservation as services. All individuals, enterprises and organizations that use and benefit from these services are required to pay in the form of contributions to a trust fund through the forest development and protection fund to the service suppliers such as forest owners and households contracted to protect forests. The policy has created a new financial mechanism that contributesto the socialization of forest plantation, and to poverty reduction and hasrelieved the burden on the State Budget for forest protection. At present, PES is considered a policy measure to encourage and share the benefits of forest protection among the community and society, which result in better forest protection and quality.

45. Major landscape based initiatives to protect or recognize areas of land and water in your country of particular significance for biodiversity for food and agriculture.

[68]Vietnam: Some good sustainable development practices: Report at the United Nations Conference on Sustainable Development (Rio+20), 2012

[69] Decision No. 742/QD-TTg, signed by the Prime Minister on May 26th, 2010 on the network of sea reserves

[70]Decision 380/QD-TTg dated 10 April 2008 of the Prime Minister on the pilot payment for forest environment services scheme.

Table 28. *Landscape based initiatives to protect or recognize areas of land and water in the country with particular significance for biodiversity for food and agriculture*

Landscape based initiatives	**Description of sites and their characteristics of relevance to biodiversity for food and agriculture**	**Extent (area)**
Xuan Thuy National Park	Established in 1989, Xuan Thuy National Park was the first Ramsar site in Southeast Asia (and the fiftieth worldwide). Located in Nam Dinh Province, the park contains some of the last remnants of the coastal ecosystems of the Red River Delta. The park is internationally significant as a migratory bird habitat, notably for the globally threatened Black-faced Spoonbill. 46,000 households live next to the park, half of which depend in the extraction of aquatic products from the park. The park therefore makes a major contribution to the local economy. In 2004, the park was recognized by UNESCO as a core zone of the Red River Biosphere Reserve.	12,000 ha
2. Can Gio Biosphere Reserve	It is a wetland located 40 km southeast of Ho Chi Minh City. This reserve has been listed the biosphere reserve by UNESCO. The site is an important wildlife sanctuary in Vietnam as it is characterized by a wetland biosystem dominated by mangrove and many rare species. With over 150 botanical species, the major habitat types found at Can Gio are plantation mangrove, of which there is about 20,000 ha, and naturally regenerating mangrove, of which there is about 7,000 ha. Moreover, a total of 18 mollusc, 27 crustacean, 45 fish and three amphibian species have been recorded at the site. Saltwater crocodiles are used to live in in the wild here and now are living in protected area. Also, Dugong has been reported to occur seasonally in seagrass beds at the site, although these reports have not been confirmed. The intertidal mudflats and sandbanks at the biosphere reserve are an important habitat for migratory shorebirds. The mangrove forest at Can Gio performs many valuable ecological functions, including coastal stabilization, and protection against coastal erosion, oil spills and storm surges. The mangrove forest is a source of fuel wood and construction materials. Being close to Ho Chi Minh City, Can Gio Biosphere Reserve has great potential as a site for tourism, public education, scientific research and training	75,740 ha
Ba Vi National Park	It is centered on Mount Ba Vi, a mountain isolate situated about 50 km west of Hanoi. The mountain rises steeply out of a plain that rarely exceeds 30 m in elevation. Ba Vi supports 812 species of vascular plant, of which several species were described for the first time from the site, for example *Ixora balansae*, *Litsea baviensis* and *Lasianthus langkokensis*.The	

Landscape based initiatives	Description of sites and their characteristics of relevance to biodiversity for food and agriculture	Extent (area)
	forest at this Park is an important source of forest products for local communities. For example, medicinal plant collection is a major economic activity in the area. Between 1997 and 1998, an estimated 250 tones of medicinal plants were extracted from the national park. It has been estimated that 80% of the Dao ethnic group in Ba Vi commune extract medicinal plants, which is their second most important source of income.	
Tram Chim National Park	It is located 19 km to the east of the Mekong River, at an elevation of about 1m. Its topography is flat and slightly slopes to the East. The vegetation of this park comprises a mixture of seasonally inundated grassland, regenerating Melaleuca forest and open swamp. There are five widespread grassland communities at Tram Chim, of which the community dominated by *Eleocharis dulcis* and wild rice *Oryza rufipogon* is of the highest conservation significance. Tram Chim is one of the few places in the Plain of Reeds where community is likely to survive to any extent, and, therefore, one of the most important sites for the conservation of wild rice in Vietnam. The other grassland communities are dominated by *Eleocharis ochrostachys*, *Panicum repens, Ischaemum rugosum* and *Vossia cuspidata*. With a system of swamps, grass-plots and crossing canals, Tram Chim National Park has become an ideal habitat of more than 100 vertebrates, 40 species of fish, and 147 rare and precious species of birds, especially the red-head cranes. Hence, it is also an ideal place for scientists to research into the life of migratory birds. It is an ideal place for nursery garden, water treatment. This park supplies valuable commercial species such as crabs, shrimp, plant fibers and plant products.	7612 ha
U Minh Thuong National Park	It is located in the plain of the Mekong Delta. U Minh Thuong supports one of the last significant areas of peatswamp forest remaining in Vietnam, and is recognized as one of the three highest priority sites for wetland conservation in the Mekong Delta. The conservation importance of U Minh Thuong National Park is further highlighted by the high bird diversity. U Minh Thuong had the highest bird species richness of any of the sites visited. To date, 187 bird species have been recorded at U Minh Thuong, including nine globally threatened or near-threatened species. The Melaleuca forest in the core zone of U Minh Thuong National Park plays an important role in maintaining the soil and water quality in the buffer zone by preventing the acidification of topsoil and surface water, filtering ground water, and storing freshwater during the dry season. In addition, at least eight species of economically valuable fish are found at U Minh Thuong. By providing these services, the U Minh Thuong wetlands make an important contribution to	8501

Landscape based initiatives	Description of sites and their characteristics of relevance to biodiversity for food and agriculture	Extent (area)
	the livelihood security of poor households in the buffer zone.	

46. Linkages and collaboration between sectors in national programmes and policies governing conservation and sustainable use of biodiversity for food and agriculture.

Decision No. 1250/QĐ-TTg dated on July 31, 2013, approved National Strategy on Biodiversity until 2020 and Vision to 2030[71]with the aim conservation of biodiversity through sustainable utilization to reduce poverty, has defined mechanism for cooperation between ministries of which the ministries and ministerial-level agencies, within the scope of their competence haveresponsibility to coordinate with the MONRE and other ministries undertaking the strategy activitiesin development and implementation of programs, schemes, projects. People's Committees of provinces are responsible for development, organization and implementation of strategy activities at the locality according to the guidance of the MONRE.

The conservation program ongenetic resources of plants, animals and microorganisms, in short gene-bank programs have been implemented since 1987. After the release of 2177 statute, in the network of gene-bank management program period 1996-2000 was formed to link 8 ministries in implementation, in which there were 12 focal units and 70 members engaged to perform the tasks of the program and in turn, they became an official member of the Asia Pacific Association of Genetic Resources, FAO and UNEP. In 2010, the Ministry of Science and Technology issued Circular 18 to regulate the management of science and technology of terms of genetic resources to replacethe 2177 statute. Circular No. 18/2010/TT- BKHCN dated December 24, 2010[72] assigned the Ministry of Science and Technology (MOST) as an operator of the gene-bank network throughout the country to improve the effectiveness of conservation and development of genetic resources. MOST is in collaboration with other 5 ministries includingMARD; MOH; MOIT; MOET; and MODin implementation of gene-bank tasks including conservation, exploitation, evaluation and development of genetic resources.

47. Ministries working together to meet Aichi Targets as they may apply to the conservation and sustainable use of biodiversity for food and agriculture in Vietnam

In the Statement No. 1542/TCMT-BTDDSH dated 20/9/2012[73] on promulgation of National strategy of Biodiversity to 2020 and vision to 2030 mentioned to the state management of biodiversity. Vietnam government assigned particular tasks for each agency. At national level, the Biodiversity Conservation Agency under Ministry of Natural Resources and Environment; Forestry Protection Agency and Department of Capture Fisheries and Resources Protection under Ministry of Agriculture and Rural Development are as national direct coordinators of biodiversity. The management of protected areas was assigned to provincial and district levels. The provincial and district Natural Resources and Environment play a main role in implementation of government's policies and strategies of biodiversity. The NGOs and private sectors are also encouraged in sustainable conservation and utilization of biodiversity.

[71]**D**ecision No. 1250/QĐ-TTg dated on July 31, 2013, approved National Strategy on Biodiversity until 2020 and Vision to 2030

[72]Circular No. 18/2010/TT- BKHCN dated December 24, 2010

[73]Statement No. 1542/TCMT-BTDDSH dated 20/9/2012 promulgating National Stragegy of Biodiversity to 2020 and vision to 2030

Decision No. 1250/QĐ-TTg dated on July 31, 2013, approved National Strategy on Biodiversity until 2020 and Vision to 2030[74]with the aim conservation of biodiversity through sustainable utilization to reduce poverty, has defined mechanism for state management of which Ministry of Natural Resources and Environment (MONRE) is responsible for coordinating, implementing programs and strategies and assigned projects; guiding and supervising the implementation of the strategyat national scale; organizing a preliminary workshop by the end of 2015 and review the implementation of the strategy by the end of 2020.Ministry of Planning and Investment is responsible for allocation of investment capital to ministries, central agencies to implement the activities of the Strategy; and mobilization international funding for conservation and sustainable use of biodiversity. The Ministry of Finance is responsible for allocating funds from the state budgetfor the implementation of programs, schemes, projects and main tasks of the Strategy. MARD is responsible for hosting, implementing assigned programs, schemes and projects within the scope of the competence of the Ministry; and integrating the task of biodiversity conservation in the plans, programs or projects on the development of forestry, agriculture and fisheries.

[74]**D**ecision No. 1250/QĐ-TTg dated on July 31, 2013, approved National Strategy on Biodiversity until 2020 and Vision to 2030[74]

CHAPTER 6: Future agendas for conservation and sustainable use of biodiversity for food and agriculture

48. Planned actions and future priorities to improve the conservation and sustainable use of biodiversity for food and agriculture with specific reference to enhancing its contribution to:

a) improving food security and nutrition;

Food security:

✓ One of the priorities of the National strategy on climate change was issued by Prime Minister on December 05, 2011[75] is guaranteeing food security and water resource based on:

- Conservation of biodiversity focusing on protecting and developing the ecosystem, species and species with good resistance to climate change. These genetic resources are precious sources for breeding programs to create new crop varieties and animal breeds to ensure food security.
- To maintain a proper and sustainable land fund for agricultural activities in all localities in order to guarantee food security in the context of climate change;
- To survey and change the cultivation and husbandry structure in line with conditions of climate change and sea level rising as well as ecological characteristics of specific regions and localities, to make full use of all chances for sustainable agricultural development;
- To research, develop and introduce biotechnologies, apply advanced production processes for a modern agriculture which can adapt to climate change;
- To build and perfect a network of controlling and preventing diseases for crops and domestic animals under conditions of climate change. This work should be fulfilled in the main by 2020 and further completed in the following stages;
- To design regimes and policies, to strengthen insurance system for mitigating risks in agricultural activities.

✓ National target program to respond to climate change to implement the Government's Resolution No. 60/2007/NQ-CP dated 3rd December 2007 of MONRE:

- Policies to respond to climate change in agriculture include the development of an agriculture that is diverse, sustainable, fast grasp and effective application of scientific achievements;
- New and high technologies and competitive in local and international markets.
- Construct new rural areas with developed and modernizing infrastructures with relevant economic structure of agriculture-industry-services.
- Ensure enough employment, hunger eradication and poverty reduction, a rural model of socially civilizing, democracy and equity with people living in wealth. Ensure food security, ecological balance and bio-diversity.

✓ Vietnam participated in approving the strategy development of the Mekong River Basin based on integrated management of water resources for sustainable development with the goal of food security and to increase the chance of economic growth and poverty reduction in countries of the Mekong River Basin in 2011. One of the important objectives is conservation of biodiversity of Mekong River Basin to ensure sustainable development of

[75]The National strategy on climate change was issued by Prime Minister Nguyen Tan Dung in Decision 2139/QĐ-TTg on December 05, 2011

aquatic resources and agriculture. This enhances food security for the countries in this region[76].

- ✓ The Vietnam Sustainable Development Strategy for the period 2011-2020[77]released in 2012 with a main objective of ensuring food security and sustainable development of agriculture and rural areas. The maintenance and development of 3.8 million ha of rice is important for food security.

Vietnam also released legal documents related to biological safety to prevent the harmful effects of the invasive alien species and genetically modified organisms (GMO) on food security:

- ✓ Decree of Biological Security on genetically modified organisms, genetic specimens and genetically modified products approved by Prime Minister in 2010 with detail instructions for assessing, testing, utilizing and managing genetically modified organisms and products[78]:

- Identifying potential hazards and possible risks of genetically modified organisms to the environment, biodiversity and health of humans and domestic animals.
- Identifying safety measures to prevent, handle and deal with risks of genetically modified organisms to the environment, biodiversity and health of humans and domestic animals.
- Organizations and individuals engaged in scientific research, technological development; assay, production, trading, import, export, transportation or storage of genetically modified organisms shall take risk management measures to ensure biosafety under law.
- When risks occur, organizations and individuals shall promptly take measures to deal with such risks and report them to provincial-level People's Committees in localities where risks occur.
- Organizations and individuals that fail to comply with risk management measures shall, depending on the severity of their violations, be administratively sanctioned, examined for penal liability or pay compensation under law.
- Line ministries and provincial-level People's Committees shall direct and organize risk management and report it to the Ministry of Natural Resources and Environment when risks occur.

- ✓ MARD has issued Circular No. 69/2009/TT-BNNPTNT dated 27 October 2009 guiding Risk Assessment of Genetically Modified Crops to Biodiversity and Environment; and Circular on the list of crops genetically modified assay allows assessment of the risks to biodiversity and the environment. At present, genetically modified maize have been conducted risk assessments[79].

- ✓ Decision No. 1250/QD-TTg on National Biodiversity Strategy dated 31/7/2013 has a goal to control and prevent intrusion of invasive alien species; strengthen bio-safety management of genetically modified organisms (GMO)[80]:

- Investigate the status of invasive alien species as well as potentially invasive alien species on a national scale, with particular emphasis on protected areas, agricultural areas, and forest ecosystems.
- Implement the program to prevent and control invasive alien species to 2020.

[76]Integrated Water River Management-based Basin Development Strategy for the Lower Mekong Basin of four countries Cambodia, Lao, Thailand and Vietnam, 2011

[77] Decision No. 432/QD-TTg approving the Vietnam Sustainable Development Strategy for 2011-2020, 2012

[78]Decree No. 69/2010/ND-CP on biosafety for genetically modified organisms, genetic specimens and genetically modified products

[79] Circular No. 69 /2009/TT-BNNPTNT on Risk Assessment of Genetically Modified Crops to Biodiversity and Environment

[80]Decision No. 1250/QD-TTg on National Biodiversity Strategy dated 31/7/2013 issued by Prime Minister

- Enhance cooperation, exchange and learning from experience on the bio-safety management of GMOs, to improve technical and professional expertise of bio-safety management agencies and units at all levels.
- Increase investment in infrastructure and resources for implementation of measures to monitor and control the risks of GMOs to the environment and biodiversity; develop and promulgate legal documents on liability and compensation in the bio-safety management activities of GMOs.

b) Improving rural livelihoods;

Vietnam also has programs, strategies and priorities for improving rural livelihoods:

Hunger eradication and poverty reduction:

- ✓ In order to achieve the Millennium Development Goals, the Vietnamese Government had*Strategy for Comprehensive Growth and Poverty Reduction to the year 2010*, which aimed to protect the environment in general and biodiversity in particular; increasing forest coverage from 33% to 43%; placing emphasis on solving environmental degradation and conserving natural resources via the improvement of livelihood for the poor people[81].
- ✓ *The National Biodiversity Strategy 2013*: Review, assess, and improve the effectiveness of the program of on-farm conservation of rare and precious crop varieties and livestock breeds; apply and develop positive incentives for farmers to encourage their engagement in conservation[5]:

- Replicate models for the management of protected areas involving community participation, and implement mechanisms to share benefits in an equitable way among stakeholders
- Develop and enforce the regulations on ecological tourism in Vietnam; promote and manage ecotourism in order to provide an important source of earnings for local communities
- Develop and implement policies to support production of agricultural, forestry and fisheries that meet international standards for conservation and sustainable use of biological resources; assess the process to grant certificates for environment- friendly (eco-labeling) products from the agriculture sector, fishery and forestry sector; support businesses in agriculture, forestry and fishery sectors to register for international certificates for sustainable and environmentally friendly products.

- ✓ *Vietnam Strategy for Forestry Development for the period 2006-2020* (2006)[82] has content about:

- Creating more jobs for the community living near the forests and PAs including wood processing and handicrafts
- Helping farmers living near forest areas to improve livelihoods, eliminate hunger and reduce poverty
- Completing transfer of forest land to organizations, companies, families, private organizations and rural community before 2010

- ✓ *The Vietnam's fisheries Development Strategy to 2020 of Prime Minister (2010)[83] focusing on:*

[81]Vietnam's strategy to reduce poverty: The Comprehensive Poverty Reduction and Growth Strategy and the Socioeconomic Development Plan 2006-2010

[82] Decision No.18/2007/QD-TTg Vietnam Strategy for Forestry Development for the period 2006-2020 (2006) issued by Prime Minister

- Industrialization and modernization of the fisheries sector with a purpose sustainable development; gradually increasing the awareness of fishermen on protecting the ecological environment and ensuring security in sea and islands.
- A goal that the fisheries economy will make up 30-35% of GDP, within the agriculture-forestry- fisheries sector.
- Creating 5 million jobs for fishermen with an average per-capita income tripling from the current level. Provide training for over 40% of fishermen

✓ *The 5 million Hectares Reforestation Program* had a budget of about US$2.5 billion over 12 years:

- It aimed to increase forest coverage in Vietnam to 43% by 2010. This increase ensured ecological security, increase freshwater generation, and conserve genetic resources and biodiversity of the tropical forests.
- The program aimed to create about two million permanent jobs, contribute to hunger eradication, poverty alleviation, promote agriculture, and enhance political and social stability. Household participating in the project have planting costs reimbursed and they share benefits according to regulations. Households may benefit in a number of ways; develop fixed agriculture program in protection and special use forests, earn wages in protection forests, and harvest firewood, thinning and non-timber forest products in protection forests[84].

✓ *Vietnam Forestry Development Strategy 2006 – 2020*approved by Prime Minister's Decision 18/2007/QD-TTg[85]. This strategy aims tocontribute to national economic growth and social stabilization, particularly with respect to ethnicminorities located in mountainous areas, while ensuring environmental protection, biodiversityconservation, and the provision of environmental services. One of its objectives - to manage, developand use forests sustainably and effectively to meet the basic demands for forest products for domesticconsumption and export - underscores the utilitarian slant of the vision that Vietnam's currentgovernment has for its forest resources. The strategy includes a program of forest protection,biodiversity conservation and environmental service development that requires VND 14,133.60 billion(approximately USD $675 million) for the 2006 – 2020 period.

c) improving productivity;

✓ MARD issued the Decision No. 774/QD-BNN-TCLN approving action plan to improve performance, quality, and value of production forests period 2014 to 2020[86] with a main objective is enhancing the production value, trading and sustainable development of the forestry: planting, processing and marketing of forest products are mounted to enhance the value of forest products, contributing to the success of Restructuring Forest Scheme.

✓ In 2013, MARD issued a Decision No. 2765/QD-BNN-KHCN approving National Product Development Program: "High Quality and High Yield Vietnamese Rice Product". In the part of strategy for science and technology development has a content of research to improve the process of advanced rice production to reduce production costs, increase economic efficiency and reduce greenhouse gas emissions in the main rice-growing

[83] Decision No. 1690/QD-TTg approving Vietnam's Fisheries Development Strategy through 2020 issued by Prime Minister in 2010

[84] Resolution No.08/1997/NQ-QH10 about the "5 Million Hectares Reforestation" Program issued by the Vietnam National Assembly in 1997.

[85]Decision 18/2007/QD-TTg approved by Prime Ministe 2007, Vietnam Forestry Development Strategy 2006 – 2020

[86]Decision No.774/QD-BNN-TCLN approving action plan to improve performance, quality and value of production forests period 2014 to 2020 of MARD

regions of Vietnam; and research to improve plant protection system to ensure sustainable development of rice production and food safety[87].

- ✓ The Prime Minister issued Decision No. 1393/QD-TTg in 2012 approving National Strategy for Green Growth[88] with main objectives to develop agricultural sector:

- Reduce greenhouse gas emissions through the development of sustainable organic agriculture, improve the competitiveness of agricultural products
- Research and planning to restructure livestock, crops, and seasons of crop cultivation, husbandry, forestry, aquaculture and non-agricultural sectors in rural areas.
- Research and application of technologies in order to use effectively and save seed, animal feed, agricultural materials, land and water resources and reduce greenhouse gas emissions in agriculture.
- Widespread application of waste treatment technology and utilization of agricultural residues in the production of animal feed, mushrooms, as raw materials for industry, biogas and organic fertilizer and reduction of emissions greenhouse.
- To speed up the plantation projects, reforestation; encourage the investment in forestry to increase the percentage of forest cover to 45 % in 2020, improving the quality of forests, increased CO2 sequestration, increased biomass; and ensure the adequate supply of wood for production and consumption.
- Implementation of the program on reducing emissions from limitation of deforestation, sustainable forest management, combined with livelihood diversification for local people.

d) supporting ecosystem function and the provision of ecosystem services;

Payments for Ecosystems Services (PES) or Payment for Environmental Services is an economic tool used by people who benefit from ecosystem services to pay for the people who are participating in maintenance, protection and development of the ecosystem functions. To promote the effectiveness of this model and lessons learned from some countries, Vietnam Government has issued some legal documents about ecosystem services, particularly forest ecosystem:

- ✓ Decision No.380/TTg dated April 10, 2008 of the Prime Minister on PES policy has indicated that PES would be piloted in two provinces including Lam Dong and Son La with some services such as water regulation, restriction erosion, sedimentation and tourist landscape. According to the Biodiversity Law, PES is also a financial source for the conservation and sustainable development of biodiversity. So far, a number of studies on the value of forests, the economic value of ecosystems have been proposed to implement. Some projects have carried out to assess the potential models and pilot PES in Vietnam. Initially, Vietnam proposed to implement four types of services: watershed protection; protection of biodiversity; ecotourism; and carbon sequestration.
- ✓ *National biodiversity strategy 2013*[5]has a main objective of improvement of the policies and institution capacity to implement payments for the forest ecosystem services at a national scale; pilot a policy about the payment for ecosystem services that is applicable to marine and wetland ecosystems.
- ✓ Decision on The Pilot Policy for Payment for Forest Environmental Services (2008) was issued for establishment of the basis for the development of the legal framework for a national policy on payment for forest environmental services to be applied in the whole country, where the responsibilities and benefits of the payers and payees of forest environmental services (here after referred to as forest environmental services: FES) are clearly defined and to socialize the forestry sector, gradually establishing sustainable economic basis for protecting the environment and ecosystems, improving quality of service provision,

[87]Decision No. 2765/QD-BNN-KHCN approving National Product Development Program of products: "High Quality and High Yield Vietnamese Rice Product" in 2013.

[88]Decision No. 1393/QD-TTg approving National Strategy for Green Growth in 2012

especially ensuring water supply for electricity production, for clean water production and ecotourism business activities[89].

- ✓ Decree No. 99/2010/ND-CP about the policies of Forest Ecosystem Payment Services (2012) has principles:
- Organizations and individuals who benefit from the forest ecosystem services must pay for these services, to forest owners who provides services;
- It can be direct or indirect payment
- Payments through the forest protection and development fund which is provided by the users of the forest ecosystem services to pay for forest owners[90].

- ✓ Decision No. 2130/QD-BNN-HTQT approving the project "Forest Certificate for Ecosystem Services – FORCES" supported by Global Environmental Fund and Ministry of Finland Affairs through the development organization of Netherland (SNV) issued by Minister of Agriculture and Rural Development has a general objective of improving and promoting the sustainable forest management and enhancement the quality of ecosystem services through the Forest Stewardship Council (FSC) certification extension for forest ecosystem services[91].

e) Improving the sustainability and resilience of production systems;

✓ The Prime Minister issued the Decision No.124/QD-TTg dated May 02, 2012approving the Master plan to develop agricultural production by 2020, vision to 2030[92] with the goal of building an agricultural comprehensive development towards a modern, sustainable, large-scale commodity production on the basis of promoting comparative advantage, applying science and technology to increase productivity, quality efficiency and high competitiveness, ensuring strong national food security for the short-and-long-term period, while adapting to the diverse needs of domestic and exports, improving the efficiency of land use, water resources, labor and capital for agricultural production.

✓ *Vietnam Sustainable Development Strategy for the period 2011-2020*[3] emphasized that one of the important factors for Vietnam Sustainable Development is the sustainable development of agriculture and rural areas: industrialization of the agriculture sector and rural areas, promote the strengths of each region; development of agricultural commodity with high quality and efficiency in production; improve the efficiency of utilization of resources (land, water, forests, labor and capital); increase income per unit of acres of arable land; improve the livelihoods of farmers. Accelerate application of science and technology in the production, processing, preservation, especially the application of biotechnology in breeding programs to create new varieties with high yield and quality. Increase the productivity of ecosystems and put sustainable agricultural development as a priority in policies of poverty reduction in the context of climate change adaptation and biodiversity conservation; minimum use of chemical fertilizers and pesticides in agriculture; strengthening scientific research and technology together with the conservation and application of indigenous knowledge in prevention of soil degradation and soil recovery.

✓ In order to synchronize the development of forestry management, protection, development, rational use of resource from forest, forest regeneration and improve the efficiency, exploitation and processing of forest products as well as the environmental services and tourism ecology, on May 02, 2007, the Prime Minister issued the Decision No.18/2007/QĐ-TTg approving the forestry development strategy in Vietnam during 2008-2020. The strategies have prioritized six research themes 1) Planning, monitoring and

[89] Decision No. 380/QD-TTg about pilot policies of Forest Environmental Payment Service issued by Prime Minister in 2008
[90] Decree No. 99/2010/ND-CP about the policies of Forest Ecosystem Payment Services of Vietnam Government, 2010
[91]Decision No. 2130/QD-BNN-HTQT approving the project "Forest Certificate for Ecosystem Services – FORCES" supported by Global Environmental Fund and Ministry of Finland Affairs through the development organization of Netherland (SNV) issued by Minister of Agriculture and Rural Development, 2012
[92]Decision No.124/QD-TTg approving the master plan to develop agricultural production by 2020, vision to 2030 (2012)

assessing forest and forest resources; 2) Forest Policy and institutional arrangement; 3) Sustainable forest management; 4) Forest environment and biodiversity; 5) Silviculture and silvicultural techniques (natural forest, plantation, agro-forestry, NTFP) and 6) Forest industry, forest product preservation and processing.

- ✓ The Ministry of Agriculture and Rural Development has approved a Strategy on development of science and technology in agriculture and rural development period 2013 - 2020[93]. Implementation of main tasks: promote research and application of science and technology to meet the requirements of agriculture and rural development; priority for development of human resources; innovation of organizations, management mechanisms, policies of science and technology innovation and promote talented , dedicated staff of science and technology in agriculture and rural development .

- ✓ With the objective of enhancing the livestock industry to become a goods manufacturing industry meeting the domestic demand, on 16 January, 2008, the Prime Minister issued Decision No. 10/2008/QD-TTg approving the livestock development strategy by 2020[94]. The decision also encourages organizations and individuals to invest towards developing livestock farms and processing companies;

- ✓ With the goal of "Developing cultivation towards modern, sustainable, large-scale commodity production, increasing productivity, quality, efficiency and competitiveness in order to meet the diverse needs of domestic and export; improve the efficiency of land use, water, labor and capital, increase income and livelihood of farmers ", on April 16, 2012, the Ministry of Agriculture and Rural Development has issued the project to develop the cultivation industry by 2020, vision to 2030. Key measures are approved to promote and apply high yielding varieties and manufacturing process, high quality irrigation system; accelerate mechanization of the production contract; modernize industrial storage, processing , enhance the quality, hygiene and food safety and value -added agriculture;

- ✓ In order to organize the development of sustainable aquaculture in the direction of enhancing the value added and sustainable development and adaptation to climate change as well as to ensuring the environmental and ecological protection and the aquatic resources, on August 16, 2013, the Prime Minister issued the Decision No. 1445/QD-TTg approving the Master plan for aquaculture development by 2020, vision to 2030[95];

- ✓ To build efficient and sustainable irrigation systems, serving agricultural production in the condition of gradually adapting the climate change and sea level rise, on May 25, 2012 the Prime Minister government has signed the Decision No. 1397/QD-TTg approving irrigation planning in the Mekong river delta from 2012 to 2020 and orientations to 2050 under the conditions of climate change and sea level rise. The Prime Minister also signed the Decision No.1554/QD-TTg approving the irrigation planning in the Red river delta from 2012 to 2020 and orientations to 2050 under the conditions of climate change and sea level rise and the Decision No.1588/QD-TTg approving irrigation planning in the Red river delta from 2012 to 2020 and orientations to 2050 under the conditions of climate change and sea level rise.

f) supporting sustainable intensification.

- ✓ *Vietnam Sustainable Development Strategy for 2011 – 2020[96]:* It mandates that sustainable development is critical to the process of national development. Sustainable development is

[93]Decision No. 3246/QD-BNN-KHCN approving Strategy for Development of Science and Technology of Agriculture and Rural Development period 2013-2020 issued by Minister of Agriculture and Rural Development, 2012

[94]Decision No. 10/2008/QD-TTg approving the livestock development strategy by 2020 isued Prime Minister, 2008

[95]Decision No. 1445/QD-TTg approving the master plan for aquaculture development by 2020, vision to 2030, 2013

[96]Decision No. 432/QD-TTg approving the Vietnam Sustainable Development Strategy for 2011-2020 issued on April 12, 2012 by the Prime Minister

the common work of the Party, authorities at all levels, ministries, agencies, localities, enterprises, social organizations, communities and individuals. In general, biodiversity and environment protection supports sustainable development viewpoints, objectives, contents and prioritized programs of inter-sectoral and regional development policies in Vietnam.Agriculture sectors have integrated conservation and sustainable use into national laws, policies, and programs and the national strategy.

❖ **Limitations:** Although the plans have been issued to improve the conservation and sustainable use of biodiversity for food and agriculture with specific reference to enhancing its contribution to food security, rural livelihoods, ecosystem function and the provision of ecosystem service and the sustainability and resilience of production systems, some limitations exist:

- The plans lack enough powerful policies and solutions to develop and implement them in a mandatory mode; lacking of measures to assess and determine effectiveness;
- The dissemination of information on planning for people and stakeholders are not effective , many people do not know about the plans programs and measures for agricultural development at the local level are not mentioned at the planning phase;
- There is no coherence between plans and no regional and, industry links;
- From sectoral planning to a switch economic development plan, there is no mechanism local social cohesion for leading to difficulties in switching to new rural planning.

To deal with these limitations, on June 10, 2013, the Prime Minister of Vietnam issued the Decision No. 899/QD-TTg approving the plan of restructuring the agricultural sector towards improving value-added and sustainable development (Agricultural restructuring plan-ARP). The Plan is aimed at maintaining growth, raising efficiency and competitive capacity through productivity, quality and value addition; meeting better the requirement and taste of domestic consumers and boost export. Objectives are to reach GDP growth of 2.6% to 3% in the 2011-2015 stage and 3.5% to 4% in the 2016-2020 stage.

49. Planned actions and future priorities to support conservation and management of the components of associated biodiversity and wild foods

a. Improvement of the capacity and operations of the institutions

✓ *At the national level*

Between 2007- 2010, human resources were strengthened at the national and provincial levels. At the national level in 2008 and 2010 respectively, the Government assigned three agencies to implement State management functions for biodiversity conservation and biosafety. The agencies are: Vietnam Environment Administration[97] (VEA), Vietnam Administration of Forestry [98](VNFOREST) and Directorate of Fishery [99](DOF). The Biodiversity Conservation Agency (BCA) was established under the VEA to implement state management functions for the conservation and sustainable development of biodiversity resources. The BCA is a national focal agency to implement the CBD, Ramsar Convention on Wetlands, Cartagena Protocol on biosafety, Vietnam Biodiversity Law, NBSAP 2013, National Action Plan on wetlands conservation and sustainable development. At present, the BCA has only 27 government officials to secure the state management function for biodiversity conservation at national level.The DOF and VNFOREST are both under MARD. VNFOREST is assigned

[97] Decision 132/2008/QĐ-TTg dated 30 September 2008 defining the functions, tasks, powers and organizational structure of the Vietnam Environment Administration (VEA) under the Ministry of Natural Resources and Environment (MONRE).
[98] Decision 04/2010/QĐ-TTg dated 25 January 2010 stipulating functions, tasks, authorities and organizational structure of the Vietnam Administration of Forestry (VNFOREST) under the Ministry of Agriculture and Rural Development (MARD).
[99]Decision 05/2010/QĐ-TTg dated 25 January 2010 by Prime Minister stipulating regulations on functions, responsibilities, authorities and organizational structure of the Fisheries General Department (FGD) under MARD.

to manage special use forests (SUFs) and at the same time act as the MARD focal points for the implementation of CITES and other laws related to endangered wildlife. The mandate of DOF is to generally manage fisheries resources and the marine and the inland waters protected area systems. The role of forest rangers and fisheries control officers has been strengthened over the past year within the Nature Reserves of the PA system.

- ✓ *At the provincial level*

Sixty three provinces all over the countries have established the Department of Natural Resources and Environment (DONRE) which also was initially formed units managing biodiversity conservation.Most of them work with biodiversity conservation as a part of job, a few specialize in conservation. At districts and communes, the officials will follow the activities related to biodiversity conservation as a part of environmental protection mission.

Prior to 2010, to fulfill the task of SUF management, there was only a unit with 5 to 6 officers working under the Forest Protection Department. In fact, this unit only manages six national parks over the country and most of the remaining SUF were assigned under the management of Provincial People's Committee and the provincial authorities which lack biodiversity- related specialized staff. According to a 2011 review report, the country has already established 88 SUF Ranger Units of 164 Forest Protection Units (including 30 national parks, 58 nature reserves, 45 protected landscape areas and 20 forests for scientific research and experimental). Of 164 Forest Protection Units, 6 Forest Protection Units directly under Forest Protection Department, VN FOREST, MARD; 36 Forest Protection Units directly under Forest Protection Branch and 46 so-called Forest Protection Units but acting as forest protection force of SUF Management Board, in fact.

Education[100]: The education and training network for biodiversity conservation managers and technical staff in Vietnam has been developed, and includes universities, colleges, institutes and professional centers. About 20 universities offer undergraduate degrees in biodiversity-related majors such as biology, environment management, forestry, agriculture and fisheries. Many of them have graduate programs such as the Ha Noi University of Natural Sciences, Ha Noi University of Pedagogy, Ha Noi University of Agriculture I, University of Forestry, Nha Trang University of Aquaculture, and HCMC University of Ago-Forestry.

About 200 undergraduates in biology, 200 undergraduates in biotechnology, and 400 pedagogical undergraduates in biology, together with 5,000-8,000 agricultural, forestry and aquaculture engineers complete their education every year in Vietnam. An estimated 50 Masters students and 10 PhD students are annually trained in zoology, botany, ecology, biodiversity and natural resource management; and there are also students studying overseas with support from bilateral scholarship programs or cooperation projects.

The subject of biodiversity is also included in the current curricula of primary and secondary school education programs. The subjects of biology, botany, tree planting and care techniques, soil and water and environment are being integrated into natural and social science subjects (grade 2, 3, 5), sciences-techniques (grade 4 and 5) and ethics (grade 4). Also, the concepts of biology and animal life, ecosystem components, agricultural techniques, people and the environment are included in biology and geography subjects (grade 6, 7 and 9) and technology (grade 9).

Several universities provide training programs and subjects in wetland management and sustainable use, such as the joint-training Program in wetland management by University of Can Tho, National University in Ho Chi Minh City and Mahidol University. Many conferences and short courses on wetlands have also been organized for environmental management officers at central and local levels.

[100] Vietnam's fifth national report to the United Nations Convention on Biodiversity, MONRE, 2014

b. Actions and future priorities to support the development of new policies or the implementation of the current policies that support the integrated conservation and sustainable use of biodiversity for food and agriculture

After the release of Biodiversity Law of the government in 2008, legal documents of government, related ministries and Natural Resources and Environment Departments of all provinces have been also issued to support for the implementation of this law. For example, Decree No. 65/2010/ND-CP[101] was issued to regulate and instruct in detail the implementation of terms and articles of Biodiversity Law about conservation planning for biodiversity, establishment of protected areas, conservation and sustainable development of the species and genetic resources.

Together with the new policies that support integrated conservation and sustainable use of biodiversity for food and agriculture are the legal frameworks guiding the implementation of the policies. For example, Operational Framework for Ecosystem-based Adaptation to Climate Change for Viet Nam[102] - A Policy Supporting Document: The framework is structured to provide step-wise procedural guidance on i) identifying adaptation in general and EbA specifically; ii) assessing the changes in ecosystem services under different development and climate change scenarios; and iii) prioritizing EbA solutions. Monitoring and evaluation is considered an important element of the framework. The framework is designed to provide detailed steps guiding a vulnerability assessment of the socio-ecological system. Additionally, it offers suggestions for tools and methods that can be used to analyze and prioritize appropriate adaptation options, which enable communities to adapt more effectively. The objective of the framework is to provide a user-friendly resource that:

- Provides step-wise guidance on vulnerability assessment to climate and non-climate related impacts on the socio-economic system;

- Supports policy makers, organizations and individuals working, on and interested in, climate change responses and policy integration; and

- Introduces updated and effective tools and methods for identification of EbA measures and implementation progress.

c. The major information and knowledge gaps that remain to be addressed and options that exist to address them

50. Planned actions and future priorities with respect to implementing ecosystem approaches for the various components of biodiversity for food and agriculture.

An ecosystem-based approach to biodiversity management provides an integrated approach to manage ecosystem components including land, water, and biological resources, as well as the relationship between them in order to promote conservation, sustainable use and equitable benefit-sharing of these resources and their ecological services.

The term "ecosystem based approach" (EbA) is likely new to Vietnam, but has been studied and introduced in forestry and fishery sectors, in some certain localities and into PAs such as U Minh Ha National Park, Can Gio Biosphere Reserve, Tam Giang, Cau Hai Lagoons,Tram Chim National Park and other wetland sites in Viet Nam. Activities in the Can Gio Biosphere Reserve and the cajuput forests of the Mekong Delta wetlands can be seen as demonstrations of the ecosystem-based approach in achieving integrated conservation, equitable benefit-sharing and sustainable use of natural resources and the production of specific products and services. These approaches are integrated into the land and forest allocations for local people for plantation and production management.

- ✓ *A framework for ecosystem-based adaptation (EbA) for Vietnam[103]:*

[101]Decree No. 65/2010/ND-CP regulates and instructs in detail the implementation of Biodiversity Law, 2010

[102]Operational Framework for Ecosystem-based Adaptation to Climate Change for Viet Nam, 2013

[103]Operational Framework for Ecosystem-based Adaptation to Climate Change for Viet Nam - A Policy Supporting Document

The framework is structured to provide step-wise procedural guidance on i) identifying adaptation in general and EbA specifically; ii) assessing the changes in ecosystem services under different development and climate change scenarios; and iii) prioritizing EbA solutions. Monitoring and Evaluation is considered an important element of the framework.

The framework is designed to provide detailed steps guiding a vulnerability assessment of the socio-ecological system. Additionally, it offers suggestions for tools and methods that can be used to analyze and prioritize appropriate adaptation options, which enable communities to adapt more effectively. The objective of the framework is to provide a user-friendly resource that:

- Provides step-wise guidance on vulnerability assessment to climate and non-climate related impacts on the socio-economic system;
- Supports policy makers, organizations and individuals working, on and interested in, climate change responses and policy integration; and
- Introduces updated and effective tools and methods for identification of EbA measures and implementation progress.
- The EbA operational guidance is primarily developed for usage at the provincial government agencies; that is, the sub-national level. This document also targets national policy planners and other interested practitioners in Viet Nam:
- Departments having state management function and advising in developing policies and guidelines for adaptation and mitigation measures under MONRE; MARD; MPI and others;
- The Department of Natural Resources and Environment (DONRE); Department of Agriculture and Rural Development (DARD) and Department of Planning and Investment (DPI) and others are responsible for policy management and implementation at provincial level;
- Non-government organizations working on conservation and development; and Research institutes, universities and consultancy firms working on and interested in climate change in Viet Nam.

✓ *Obstacles that emerge in the application of ecosystem-based approach for biodiversity conservation in Vietnam include:*

- Although some EbA initiatives have been implemented in the coastal area of Viet Nam, these are at very small scale. There is still a need for broader awareness regarding EbA and guidance for EbA design and implementation. Technical guidance on developing and implementing EbA solutions will assist in awareness raising and capacity building to implement EbA solutions, and promote the replication of EbA strategies nationwide.
- Stakeholder participation in planning and management is not highly effective;
- Terminologies and definitions are inconsistently applied in the "ecosystem-based approach";
- Decentralization and sectoral cooperation is usually weak due to inadequate capacity;
- Inadequate awareness and understanding of ecosystem functions, and the lack of professional agencies to guide the ecosystem-based approach;
- The lack of guidance in using ecosystem-based approach as a tool to integrate biodiversity management into broader development activities; and
- Challenges in solving conflicts between conservation priorities, development needs and requirements and identifying suitable solutions.
- International experience and the experience in Vietnam reveal that the most common obstacle in biodiversity management and conservation is the lack of consensus in the

establishment of a focal point with full authority for long-term and consistent implementation.

51. Planned actions and future priorities to improve stakeholder awareness, involvement and collaboration in the conservation and sustainable use of biodiversity for food and agriculture

a. Improve the role and responsibility and enhance the participation of business community, socio-political organizations, social-professional organizations, non-Governmental organizations and residential communities in deploying sustainable development

✓ Decision No. 45/QD-TTg dated 8 Jan 2014 of the Prime Minister approval the Master plan on biodiversity conservation in whole country to 2020 and orientation to 2030[104], a legal document that mentioned to resource mobilization of organization, individuals and communities in the conservation of biodiversity; ensuring the principle of equitable sharing, harmony of interests of the parties involved: Develop mechanisms and policies to encourage organizations and individuals, especially the local community involved in the planning of biodiversity conservation; assigned to local authorities, strengthen the role of community in organization and management of protected areas, establishment of biodiversity conservation and biodiversity corridor in the regions; develop policies to support the investment in the communities of the buffer zone of the protected areas and biodiversity corridors; improving the effectiveness of the state management agencies on biodiversity: clearly define the functions of each agency, attach special importance to implementing the planning of biodiversity conservation; strengthen law enforcement, sanctions, strictly handle violations of planning biodiversity conservation.

✓ Decision No. 79/2007/QD-TTg approving "National Action Plan on Biodiversity to 2010 and orientation toward 2020 for implementation of the Convention on Biological Diversity and the Cartagena Protocol on Biosafety[105]. The document regulates the responsibility of Ministers, Heads of ministerial agencies and governmental agencies; Provincial People's Committee Chairmen; Government Office, Ministry Offices and ministerial agency offices, governmental organization's offices, provincial People's Committee offices enforcing and overseeing cooperation missions as followings:

✓ The Ministry of Natural Resources and Environment are the National Focal Point for the implementation of the Convention on Biological Diversity and the Cartagena Protocol on Bio-safety; to assume the prime responsibility for, and coordinate with relevant ministries, branches and localities in efficiently and timely implementing the national action plan, and annually reporting implementation results to the Prime Minister; to assume the prime responsibility for implementing the national action plan within the scope of its functions, tasks and powers. To assume the prime responsibility for elaborating, approving or submitting to competent authorities for approval, and implementing, the following contents:

- A scheme to consolidate the system of state management agencies in charge of biodiversity and biosafety;
- A scheme to raise the capacity of bio-safety management of genetically modified organisms, and products and commodities originated from genetically modified organisms;
- A plan to prevent and control invasive alien species;
- A program on propagation and education to raise public awareness about biodiversity and biosafety;

[104]Decision No. 45/QD-TTg issued by Prime Minister, 2014 on Master Plan on National Biodiversity Conservation to 2020, vision to 2030

[105]Decision No. 79/2007/QD-TTg approving "National Action Plan on Biodiversity to 2010 and orientation toward 2020 for implementation of the Convention on Biological Diversity and the Cartagena Protocol on Biosafety, 2007

- A project to develop an information sharing and database system of biodiversity and biosafety;
- An action program on biodiversity for the northeastern, northwestern, northern plain, northern central, southern central, central highlands, southeastern and southwestern regions.

✓ The Minister of Natural Resources and Environment shall establish an inter-ministerial steering committee of which he is the head to organize the implementation of the national action plan. The membership and the operation regulation of the steering committee and its office shall be decided on by the Minister of Natural Resources and Environment.

✓ The Ministries of Agriculture and Rural Development; Fisheries; Science and Technology; Education and Training; Culture and Information; Trade; Foreign Affairs; Planning and Investment; and Finance, the Vietnam National Administration of Tourism, and the Vietnam Science and Technology Institute shall, based on their functions, tasks and powers, properly implement relevant contents in the national action plan.

✓ The Ministry of Planning and Investment and the Ministry of Finance shall balance, allocate and guide the use of capital to efficiently and timely implement the national action plan.

✓ Provincial/municipal People's Committees shall properly implement the national action plan's contents related to their localities, especially the elaboration and implementation of action plans on biodiversity in territories and localities with high biodiversity.

Challenges:

- Stakeholder participation in planning and management is not highly effective;
- Regulations for biodiversity conservation sometimes provide no incentives for local stakeholders to engage in biodiversity management. In many cases,local stakeholders have high levels of dependency on forest and marine resources. There is nomotivation for sustainable use of genetic resources.

52. *Planned actions and future priorities to support the role of farmers, pastoralists, fisher folk, forest dwellers, and other rural men and women dependent on local ecosystems in the conservation and use of biodiversity for food and agriculture.*

✓ Action Plan on National Environmental Protection Strategy to 2020 and vision to 2030[106] has a content that the management and implementation of conservation activities has to pay attention to the economic aspirations and encourage the participation of the communities living around the nature reserve. Raising awareness about the economic, environmental and sciencetific values of nature conservation. In addition, promoting the management role of the People's Committees at all levels, especially at commune and district levels. Encourage the organizations such as the Women's Union, Vietnam Farmers Association, Youth Union, and local communities to participate in conservation planning and implementation of activities to raise public awareness.

✓ The Master plan of biodiversity conservation of the whole country to 2020, orientation toward 2030[107] mentioned to strengthen the communication on the benefits and responsibilities of communities in the implementation of planning, especially communities living in and around protected areas and biodiversity corridors.

[106]Decision No. 166/QD-TTg issued by Prime Minister about the Action Plan on National Environmental Protection Strategy to 2020 and vision to 2030 January 21, 2014

[107]Decision No.45/QD-TTg approving the Master plan of biodiversity conservation of the whole country to 2020, orientation toward 2030, 2014

- ✓ Decree No. 57/2008/ND-CP[108] of the Government issued regulations on the management of National Important Marine Protected Area were about to encourage local community to participate in the management, conservation, construction and development of marine protected areas in accordance with state law by activities like communication, education and awareness improvement on the protection and conservation of biodiversity; monitoring, patrolling and protection of marine protected areas; scientific research and training in marine protected areas and development of ecotourism services in the MPA.
- ✓ Decree No. 117/2010/ND-CP[109] released on December 24, 2010 of the Government on organization and management of special-use forest system of Vietnam mentioned to encourage the local community living near the SUF to participate in the management SUF to improve the livelihoods and sustainable socio-economic development.
- ✓ National Action Plan on Biodiversity to 2010 and orientations towards 2020[110] about the implementation of the Convention biological Diversity and the Cartagena Protocol on Biosafety has mentioned about the improvement of livelihood of local community such as establishment and implementation of the integrated management model of wetland resources and marine in consistent with local regulations; enhancement of education and raising public awareness about conservation , development and sustainable use of biological resources; implementing strongly the movement of local community in conservation of biodiversity. In addition, organizing training courses, regular communication programs on biodiversity and biosafety; ensuring the rights and community participation in the assessment process of policies, strategies, plans, programs and projects related to the conservation of the natural protected areas as well as decision making process on biosafety; diversification of management models, development and sustainable use of biodiversity based on the community; and bring into play live style of the living in harmony with nature of the minority ethnic people.
- ✓ Development Strategy of Vietnam's fisheries sector by 2020 ion No. 1690/QD-TTg (2010)[111] of the Prime Minister issued to approve the had an article on the building the management mechanisms to exploit, conserve and develop marine fisheries resources and improve the community participation.
- ✓ Decision No. 218/QD-TTg[112] of the Prime Minister approving the Management strategy of special-use forest systems, marine reserves, protected areas inland waters of Vietnam to 2020 and vision to 2030 mentioned that Vietnam government has strategy to encourage the investment of the agencies, individuals, scientists and international organizations as well as encourage the participation of community in the management of buffer zones of SUF, belts of marine protected areas and inland waters for sustainable management in accordance with the state law.
- ✓ Vietnam has issued legal document supporting for benefit sharing and indigenous knowledge associated with genetic resources held by indigenous and local communities, as well as to genetic resources held by indigenous and local communities where the rights of these communities over these resources have been recognized. For example, legislations and policies on Access and Benefit Sharing (ABS): Viet Nam has enacted several legal documents concerning issues of biodiversity conservation and plant and animal genetic resources. In

[108]Decree No. 57/2008/ND-CP of the Government issued regulations on the management of National Important Marine Protected Area, 2008

[109]Decree No. 117/2010/ND-CP released on December 24, 2010 of the Government on organization and management of special-use forest system

[110]Decision No. 79/2007/QD - TTg[110] on May 31, 2007 of the Prime Minister approving the "National Action Plan on Biodiversity to 2010 and orientations towards 2020

[111]Decision No. 1690/QD-TTg (2010)[111] of the Prime Minister issued to approve the Development Strategy of Vietnam's fisheries sector by 2020

[112]

relation to ABS, Viet Nam's Biodiversity Law 2008, Chapter V from Article 55 to Article 64, provides a number of documents related to access and benefit-sharing. The government is also building dossiers submitted for Government approval of the Nagoya Protocol. At present, the Division of Genetic Resources Management and Biosafety, of the Biodiversity Conservation Agency of Viet Nam Environment Administration under the Ministry Of Natural Resources and Environment (MONRE), have state management functions over genetic resources and biosafety. The following agencies are also responsible for the management of genetic resources: Ministry of Natural Resources and Environment, Ministry of Agriculture and Rural Development, and the Ministry of Science and Technology. Other agencies involved are the Centre for Plant Genetic Resources, Southern Fruit Research Institute under VAAS, Centre for Livestock Genetic Resources of Viet Nam under the National Institute of Animal Husbandry, and the Center for Research and Development of Ethno medicinal Plants (CREDEP). In addition, the Nagoya Protocol addresses traditional knowledge associated with genetic resources with provisions on access, benefit-sharing and compliance. It also addresses genetic resources where indigenous and local communities have the established right to grant access to them. Contracting Parties are to take measures to ensure these communities' prior informed consent, and fair and equitable benefit-sharing, keeping in mind community laws and procedures as well as customary use and exchange.

- ✓ *Payment mechanisms for ecosystem services*: Payment mechanisms for ecosystem services were identified and drafted in 2008, with pilot programs implemented in Lam Dong and Son La. As part of the agreements, facilities that utilize catchment water, including hydropower plants and bottle water producers, are required to pay for environmental services. Of the income generated from the payment for environment services, approximately 80-90% of the funds are paid to the provider of the ecosystem services. These include forest owners, local communities, organizations, forest management boards, and a percentage of the funds is planned to be returned to the state budget. Since September 2010, the mechanism has been widely applied and enlarged to include carbon finance and related instrument (MORNE).
- ✓ *Ensure equitable sharing of benefits arising from genetic resources:* Ensuring community's rights and participation in the process of developing and reviewing policies, strategies, plans, programs and investment projects related to PAs are some of the approaches adopted in implementation of the NBAP 2007, and this approach is gaining acceptance. On the other hand, the policies of the Government reflected in sectoral development strategies and projects, have recognized the importance of equal sharing of benefits from biodiversity resources and ecological services. One project has enabled local people in Cuc Phuong National Park to plant orchids to generate income. In other PAs, local people are trained to deliver ecotourism services. In the no. 327 and no. 661 reforestation programs, local people have been allocated land, forests, and water to manage and utilize for production.

APPENDIX

Appendix 1. Reporting Party and preparation of National Report

A. Reporting Party

Contracting Party	
NATIONAL FOCAL POINT	
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SUBMISSION	
Signature of officer responsible for submitting national report	
Date of submission	31 December 2014

List of key organizations and people contributing to the National Report

No.	ORGANIZATIONS
	MINISTRIES
1	Ministry of Agriculture and Rural Development
2	Ministry of Natural Resources and Environment
3	Ministry of Science and Technology
4	Ministry of Public Security
	RESEARCH ORGANIZATIONS
5	Vietnamese Academy of Forest Sciences
6	Institute of Ecology and Biological Resources
7	National Institute of Animal Sciences
8	Research Institute for Aquaculture No.1
9	Institute of Oceanography
10	Hanoi National University

Appendix 2. List of organizations participating in conservation of crop genetic resources

Source: Report on conservation status of crop genetic resources, Plant Resources Center, 2014

No	Organization	Number	Location
I	**Cereals**	**11.975**	
1	Plant Resources center	8.963	Ha Noi
2	National Maize Research Insitute	616	Ha Noi
3	Institute of Agricultural Science for Southern Vietnam	396	HCMC
4	Cuu Long Delta Rice Research Institute	2.000	Can Tho
II	**Vegetable, herbs and edible mushroom**	**4.110**	
1	Plant Resources Center	3.957	Ha Noi
2	Agricultural Genetic Institute	130	Ha Noi
3	Bavico Joint Stock Company	23	Ha Noi
III	**Fruit tree, industrial tree, and mulberry species**	**4.277**	
1	Plant Resources Center	551	Ha Noi
2	Fruit and Vegetable Research Institute	146	Ha Noi
3	Agricultural Science Institute for Northern Central Vietnam	5	Nghe An
4	Southern Horticultural Research Institute	642	Tien Giang
5	Xuan Mai Fruit Tree Research Center	53	Ha Noi

No	Organization	Number	Location
6	Research and Development Center for Vegetable, Flower and Fruit	252	Phu Tho
7	Research and Development Center for Temperate Plants (Sa Pa)	40	Lao Cai
8	Research and Development Center for Fruit and Industrial Tree	230	Nghe An
9	Research and Development Center for Vegetable and Flower	37	Lam Dong
10	Center for Technological Consulting and Development	38	Ninh Thuan
11	The Western Highlands Agriculture & Forestry Science Institute	383	Dac Lac
12	Sugarcane Research Institute	545	Binh Duong
13	Tea Research and Development Center	193	Phu Tho
14	Northwestern Center for Research and Development of Agro-Forestry	111	Son La
15	Lam Dong Center for Research and Development of Agroforestry	138	Lam Dong
16	Vietnam Sericulture Research Center	202	Hanoi
IV	**Tuber Plant**	**2.282**	
1	Plant Resources Center	2.151	Hanoi
2	Research and Development Center for Vegetable and Flower (Da Lat)	96	Lamdong
3	Institute of Agrobiology (Vietnam National University of Agriculture)	35	Hanoi
V	**Legume**	**3.092**	
1	Plant Resources Center	3.092	Hanoi
VI	**Flower**	**230**	
1	Agricultural Genetic Institute	230	Hanoi
VII	**Crops for soil fertility and fodder**	**123**	
1	National Institute of Animal Science	60	Hanoi
2	Soils and Fertilizers	63	Hanoi
VIII	**Other** (Plant Resources Center)	**13**	
Total		**26.102**	

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Decision No.18/2007/QD-TTg date 5 February 2007 of the Prime Minister approving the Vietnam Strategy for Forestry Development for the period 2006-2020

Decision No. 172/2007/QD-TTg date 16 November 2007 of the Prime Minister approving the National Strategy for Natural Disaster Prevention, Response and Mitigation to 2020

Decision No. 79/2007/QD-TTg date 31 march 2007 of the Prime Minister approving "National Action Plan on Biodiversity to 2010 and orientation toward 2020 for implementation of the Convention on Biological Diversity and the Cartagena Protocol on Biosafety

Decision No. 79/2007/QD - TTg date 31 May 2007 of the Prime Minister approving the "National Action Plan on Biodiversity to 2010 and orientations towards 2020

Decision 380/QD-TTg date 10 April 2008 of the Prime Minister on the pilot payment for forest environment services scheme.

Decision No. 380/QD-TTg date *April 10, 2008* of the Prime Minister on pilot policies of Forest Environmental Payment Service

Decision No. 10/2008/QD-TTg date *10 March 10, 2008* of the Prime Minister on approving the livestock development strategy by 2020

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Decision No. 1690/QD-TTg date 16 September 2010 of the Prime Minister issued to approve the Development Strategy of Vietnam's fisheries sector by 2020

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Decision No. 2130/QD-BNN-HTQT date 24 January 2012 approving the project "Forest Certificate for Ecosystem Services – FORCES" supported by Global Environmental Fund and Ministry of Finland Affairs through the development organization of Netherland (SNV) issued by Minister of Agriculture and Rural Development, 2012

Decision No.124/QD-TTg date 2 February 2012 of the Prime Minister approving the master plan to develop agricultural production by 2020, vision to 2030

Decision No. 3246/QD-BNN-KHCN date 27 December 2012 approving Strategy for Development of Science and Technology of Agriculture and Rural Development period 2013-2020 issued by Minister of Agriculture and Rural Development

Decision No. 432/QD-TTg date 12 April 2012 of the Prime Minister approving the Vietnam Sustainable Development Strategy for 2011-2020

Decision No. 2765/QD-BNN-KHCN 12 November 2013 approving National Product Development Program of products: "High Quality and High Yield Vietnamese Rice Product"

Decision No. 1250/QĐ-TTg dated on July 31, 2013, approved National Strategy on Biodiversity until 2020 and Vision to 2030

Decision No. 1445/QD-TTg date 16 August 2013 approving the master plan for aquaculture development by 2020, vision to 2030

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