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Ecosystems and Their Services in Da Bac District, Hoa Binh Province

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Abstract: Da Bac - the largest district of Hoa Binh province, has an undeveloped economy and more difficult living condition, in comparison with other districts, cities in the province. Therefore, it is necessary to analyze the ecosystem diversity and ecological services of ecosystems of Da Bac district for sustainable socio-economic development. In this study, different ecosystems of Da Bac have been identified based on the basic understandings of ecology. Then, the important levels/values of their ecosystem services were analyzed and estimated to suggest important ecosystems for protection priorities and help the policy makers allocate resources properly between competing usage demands for a sustainable development.

Keywords: Ecosystem, ecological services, sustainable development.

1. Introduction

Da Bac is a mountainous district of Hoa Binh province, with many ethnic groups living together and the interference of the different cultures creating special charm for tourists. The district has favourable conditions to develop tourism such as natural forests, rivers, lakes, beautiful landscapes as well as special advantages. However, the economy of the district is undeveloped, mainly based on agriculture and forestry.

With the aim of sustainable socio-economic development, it is necessary to analyse the diversity and ecological services of ecosystems in Da Bac district; then propose orientations for their protection and development. This aim to optimize the ecological services for socio-economic development. The study is the whole picture of ecosystems of Da Bac district.

2. Methodologies

- The study site is Da Bac district, Hoa Binh province in the Northwest area of Vietnam (about 90km away from Hanoi and about 20km away from Hoa Binh city). It is bordered by Mai Chau, Tan Lac and Ky Son district to the South, by Hoa Binh city to the East, by Phu Tho province to the North and Son La province to the West [1].

- Methods: the following methods are used:

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- Ecological fieldwork: observe and take photos of ecosystems.
- Sociological survey
- Collecting documents, synthesis and statistical data processing
- Analysis of ecological services

3. Results and discussions

3.1. Main ecosystems of Da Bac district [2, 3]

Da Bac district has 13 main ecosystems, which are distributed alternatively, each of them has typical characteristics:

3.1.1. Natural forest ecosystems (limestone, soil mountain) composed of indigenous trees and not classified as forest plantation. The forest can be grown on the soil mountain or limestone mountain... and is widely distributed in Da Bac district. Natural forest ecosystems may be classified as natural, terrestrial ecosystems. The forest function in term of socio-economic is important but perhaps functions in terms of environment, protection and biodiversity genetic resources are more important. Phu Canh Nature Reserve was established in Da Bac district with over 5,000 hectares. Forest ecosystems in Da Bac district were developed in the hilly and mountainous areas. Originally, Da Bac was fully covered by forests. Then, Kinh people reclaimed (settlers) forest to upland fields and ethnic burned, cleared forests for cultivation of food crops. Natural forests outside protected areas are not much and distribute with small scale. Forests ecosystem is rated as the most diverse and plentiful. However, due to hunting and the pressure of population, forest biodiversity has been declined. The research on biodiversity in natural forest ecosystem in Da Bac focused mainly in Phu Canh Nature Reserve which has currently 143 plant families with 52 rare species; 85 birds species with 4 rare species; 27 mammal species with 7 rare species and 43 reptiles, amphibians species with 8 rare species. The management should be enhanced and expanded with suitable conservation measures to overcome the biodiversity degradation.

3.1.2. Home garden ecosystems (the fruit trees...) are defined as the family garden with many sizes and different levels of development. The majority of households in Da Bac has medium family garden, often in nearby houses. The products obtained from the garden are just for meal supplements and contribute to the family income. Garden ecosystem is classified as artificial and terrestrial ecosystems with the productivity from low to high of fruit trees, vegetables … Currently, in Da Bac, people have adopted many fruit trees model which have high economic efficiency to provide more income, including models of planting lemon, grapefruit in Cao Phong commune, Toan Son commune and models of planting Thailand papaya in Hao Ly commune. Initially, these models bring high efficiencies and should be replicated in many other communes. Similar to plantation ecosystems, biodiversity of species in the garden ecosystem is not high. The animals and plants living in this ecosystem have their own characteristics as pollinating insects (bees, butterflies, ...). So far the investigation and research on biological diversity in garden ecosystems is very little, mainly reports on cultivation fruit tree species.

3.1.3. Plantation forest ecosystems are defined as the place of recovering forest. The forest can be planted on land or limestone mountain and is widely distributed in Da Bac district. Plantation forest ecosystems are classified as artificial and terrestrial ecosystems, where forest functions play important role for economy and society, which will generate greater income. In terms of ecology, the plantation forest ecosystem has the lowest biodiversity. Almost no investigations/studies on biodiversity in plantation forest ecosystems in Da Bac because it only for the purpose of economic development.

3.1.4. Pond and lake ecosystems are identified as ponds, lakes with large or small sizes. The lake which has the largest size is Da river reservoir with a surface area of about

6,000 ha is affected by hydrological regime of the Da River, flows through the district with the length of 70km, and reserves billions m^3 of water which is very favorable for the development of fishing, aquaculture and commercial services as well as tourism. In addition, the remaining lakes are small parts of the Da River flows into the low-lying areas which create the smaller lakes, ponds or swamps. The lagoon lakes primarily serve for the purpose of providing water for local residents and aquaculture (namely cages). Lake ecosystems, dam ecosystems and river ecosystems are interconnected to form the district hydrographic network. However, droughts still appear, lack of water in May, June (dry season) and storms, floods in July, August (rainy season). Lake ecosystems in Da Bac district have rich aquatic biodiversity but are also rapidly degraded due to several reasons:

- Overfishing, use of fishing gear and methods of destruction.
- Water pollution.
- Destruction of habitat, narrowed habitats and change of using purpose.

If there is no conservation plan for lakes and their biodiversity, with the current rise of economic-society activities in Da Bac district, water quality and biodiversity in lakes will gradually reduce and disappear.

3.1.5. Stream ecosystems were identified as streams flowing from the mountains. Da Bac district has many large streams as Suoi Tuong, Suoi Chum, Suoi Lao, Suoi Nhap... Most of them are long and have different flow regime depending on the month of the year. In the dry season, many streams lack of water due to the fact that forest in the basin was destroyed. In the rainy season, many streams have strong flows and fast flowing that obstructing traffic. There are many stream ecosystems in Da Bac. Streams can originate from soil or limestone mountains. The flow from the high mountains will form many waterfalls. Stream ecosystems are classified as natural aquatic ecosystems which have important role in social and economic development due to the construction of many resorts, recreation areas, homestay houses. Suoi Nhap hydroelectric plant was built on the Nhap stream (Dong Ruong commune) with the purpose of supplying electricity to the residents of the district, creating commercial electric power. The biodiversity in streams of Da Bac district is quite diverse and abundant. Due to the specificity of them, it is necessary to promote investigation and research on ecology of streams of Da Bac as soon as possible.

3.1.6. Cave ecosystems are defined as ecosystems formed in caves. This is a special kind of ecosystems, common in the karst (Karst region). Environment and biodiversity in caves are unlike other natural ecosystems. The main environmental characteristics are: less fluctuating temperatures, less light and a limited number of groups of animals, and lack of green vegetation. Cave ecosystems in Da Bac district are less common, mainly present in limestone areas and not yet investtigated. Cave ecosystems are classified as natural and terrestrial ecosystems. Cave ecosystems in Da Bac are pristine and little noticed. Biodiversity in cave ecosystems are not yet in-depth understood and should be further researched in the future.

3.1.7. Urban/Human settlement ecosystems are defined here as Da Bac town itself, inhabited by people, where activities are associated with urban/town. Urban ecosystems are classified as artificial, terrestrial habitats, with manufacturing entities (industrial, service, commercial, ...). Da Bac town was established in 1990. Da Bac town ecosystem was formed over 20 years ago and the population is still sparse. Da Bac is a poor developing district with undeveloped infrastructure and less green landscape. Urban areas have a stable living standard, but the income rate is not high while there is no large business. Environmental quality is polluted by air, noise and poor sanitation. Like other urban ecosystems, biodiversity of the ecosystem is poor. The animals and plants living in the urban ecosystem have its own characteristics, with the

care of humans (dogs, cats, pets like birds, ...) or harmful to humans (flies, mosquitoes, rats, beetles, ...). Da Bac needs to invest its best resources to be able to have a green town (eco-urban).

3.1.8. Rural/Human settlement ecosystems which are identified as the hamlets, villages ... inhabited by people whose main activities are associated with agriculture, traditional villages. Rural ecosystems distribute throughout Da Bac district, surrounding the town and are present in 19 communes of Da Bac district (Cao Son, Doan Ket, Dong Chum, Dong Nghe, Dong Ruong, Giap Dat, Hao Ly, Hien Luong, Muong Chieng, Muong Tuong, Suoi Nanh, Tan Minh, Tan Pheo, Tien Phong, Toan Son, Trung Thanh, Tu Ly, Vay Nua and Yen Hoa). Ethnic minorities such as Muong, Tay, Kinh, Dao and Thai live in these communes. Rural ecosystem is classified as artificial, terrestrial habitats, mainly agricultural. Rural ecosystems in Da Bac represent the rural ecosystems of north-western mountainous region of Vietnam. Communes Cao Son, Tan Pheo, Dong Chum, Doan Ket, Dong Ruong... are the standard communes of the minor people Dao, Tay, Muong. Influenced by the process of economic and social development in recent years, the rural ecosystems have been changed too much. Houses, gardens, ponds, transportation roads, water supply and waste management have rapidly changed. The live of the people in rural areas in Da Bac are being gradually improved. Pollution here depends on the region, but mainly due to typhoons, floods, erosion and livestock. Like other rural ecosystems, the species biodiversity is rich and diverse. In addition to the wildlife, biodiversity of species here includes species of plants and animals for the purpose of food production such as sugar cane, corn, arrowroot … Wildlife biodiversity is rapidly degraded by shrinking natural accommodation, environmental pollution, hunting… that have not been controlled by various activities of deforestation and upland planting. For a "new" rural ecosystem, it is necessary to invest more resources for getting a green, clean and nice living environment serving sustainable agricultural production.

3.1.9. Scrub, grass ecosystems are defined as the bottom of mountain hills. This ecosystem is typical for the land of bordering areas (ecozone) between the plains and mountains with the characteristics of natural flora including shrubs, weeds and trash timber, that should also be called savanna ecosystem. In vacant lands of this ecosystem, industrial crops, fruit trees or cover crops to prevent erosion could be planted, but still very few. Scrub, grass ecosystems are classified semi-artificial, terrestrial ecosystems, which can be exploited for agricultural production, stick for construction, erosion control and other services such as tourism, recreation... Formerly, this ecosystem was covered by tropical evergreen forests, however, due to mining and deforestation, the vegetation is gradually replaced by the form of shrubs, trees, trash timbers... Scrub, grass ecosystems is a tropical forest ecosystem which had just been destroyed, and now in regeneration. In many places, there are only weeds or gravel and stones. In some places, people plant fruit trees such as grapefruit, orange ... while the others have used for resettlement areas, the weekend retreat villages ("homestay")... The biodiversity of wildlife here has declined sharply due to loss of natural forests and weak management of resources. Under the exploitation pressure, this ecosystem should easily change into a bare land ecosystem.

3.1.10. Bare hill ecosystems are defined as forest, hill areas with no or very few flora, not covered green. In the past, it was natural forest ecosystem, but because of economic and population pressures, especially the indiscriminate deforestation, forest and land are quickly depleted, the forest environment in general and the habitats environment in particular are seriously degraded. Forest vegetation degeneration leads to soil degradation due to erosion. Meanwhile, forming the bare hill ecosystems reduces the productivity of the land. Bare hill ecosystem is formed from

deforestation is a major cause of many natural disasters such as floods, droughts and landslides. Bare hill ecosystems are classified as semi-artificial, terrestrial ecosystems. Biodiversity of wildlife here has degraded sharply due to loss of natural forest habitat and food. Almost no investigation or research on biodiversity of wildlife in this ecosystem.

3.1.11. River ecosystems are identified as large or small rivers, lotic ecosystems. In Da Bac, the only large river ecosystem is the Da River with about 70km length running through Da Bac district. Biodiversity in this ecosystem is typical, stable and less affected by local economic-social activities. This ecosystem forms a hydrographic network which is widely distributed in Da Bac district. River ecosystems are classified as natural ecosystem and semi-artificial (small tributaries), aquatic ecosystem with very diverse tasks for economy and society in Da Bac district: habitats for aquatic species, water transportation, water pollution treatment, biological water supply, manufacturing … Currently, this ecosystem has been dramatically changed due to the operation of the dams in the basin and the urbanization of residential areas along riverside. Biodiversity in large river ecosystems as the Da River is rich and abundant while in small river ecosystems such as in-field canals, the biodiversity is seriously degraded. The reasons of biodiversity degradation are the followings:

- Overfishing, use of fishing gear and methods of destruction.
- Contamination of organic waste, inorganic, pesticides, herbicides, heavy metals.
- Destruction of habitat, shrinking habitat, habitat conversion...

For two types of large river ecosystems and small river ecosystems such as in-field canals, the above factors do not have the same impacts. The investigation/research on biodiversity and wild aquatic organisms here is incomplete, fragmented and not updated. However, in the Report on biodiversity planning of Hoa Binh province by 2020 and towards 2030 [1], there are the following lists:

- List of species of phytoplankton in Da River and other rivers
- List of species of zooplankton in Da River and other rivers
- List of species of zoobenthos in Da River and other rivers
- List of species of aquatic insect in Da River
- List of species of fish in Da River and other rivers

3.1.12. *Agricultural ecosystems* are defined as the land area used for planting food crops, food, livestock and poultry... Food crops including several kinds of vegetables and crops like rice, upland rice, maize, potato, cassava... In addition, here there are also sugarcane and arrowroot. Sugarcane is grown for sale to factories producing sugar and arrowroot is planted to produce vermicelli. Because irrigation system here is not complete, making irrigation water here remains difficulty for both paddy rice and upland rice. Due to irrigation difficulties, it is suitable for planting sugar cane, arrowroot and plants adapted to drought conditions. Agricultural ecosystems distributed throughout Da Bac district, closely related with the rural ecosystems. Rural ecosystems with agricultural ecosystems respectively formed villages, communes... Agricultural ecosystems are classified as artificial and terrestrial ecosystem including both aquatic and terrestrial parts that are responsible for the production of agricultural products (including fisheries). Agricultural ecosystems are derived from natural wetlands or renovated from hill areas. Due to bad management and poor planning ... this ecosystem has been strongly destroyed with low productivity. The wildlife organisms are very useful for the development of this ecosystem (birds, fish ...). Because of biodiversity degradation, many valuable species are disappeared. The main reason is: indiscriminate cultivation of all fertile land and continuous reclamation of new land.

Table 1. Ecological services of ecosystems and their important level

	Ecological services	Natural forests	Home gardens	Planted forests	Ponds, lakes	Streams	Caves	Urban	Rural	Scrub, grass	Bare hill	Rivers	Agri-culture
	Provisioning group												
1	Forest resources	3	0	2	1	1	1	1	1	0	0	0	1
2	Wildlife resources	3	1	1	2	1	2	1	1	1	0	1	1
3	Aquatic resources	0	0	0	3	3	1	1	1	0	0	3	1
4	Agricultural resources	2	3	3	3	1	0	1	3	0	0	1	3
5	Forage (grassland…)	2	3	2	1	1	2	1	3	3	0	2	3
6	Industrial materials	2	0	3	0	0	2	2	1	0	0	0	1
7	Fuel	2	0	2	0	0	1	1	0	0	0	3	1
8	Gene resources	3	1	1	2	2	1	1	1	1	0	3	2
9	Water supply	2	1	2	3	3	1	2	2	0	0	3	2
10	Waterways	0	0	0	3	0	0	0	0	0	0	3	0
	…												
	Regulating group												
1	Climate control	3	2	3	2	1	0	1	1	1	0	3	2
2	Flood/draining flow	3	1	2	3	3	0	1	1	1	0	3	3
3	Epidemic control	3	3	2	1	1	0	3	3	1	0	3	3
4	Riverbank stability	3	0	2	3	3	1	3	3	3	0	3	3
5	Prevention storm	3	1	3	2	2	2	3	3	1	0	3	1
6	Maintaining quality/ purifying water	3	2	2	3	3	3	3	3	1	0	3	3
7	CO_2 absorbing	3	2	2	1	1	1	1	2	2	0	0	3
	…												
	Supporting group												
1	Regeneration of nutrients	3	3	2	1	1	1	1	3	3	0	2	3
2	Land construction	3	1	2	1	1	1	1	2	2	1	2	2
3	Biological productivity (primary,..)	3	3	2	2	2	1	1	2	1	0	2	3
	…												
	Cultural group												
1	Biodiversity	3	1	2	2	1	1	1	2	2	0	3	3
2	Aesthetic/moral/ spiritual	3	3	3	3	3	3	3	2	2	1	3	3
3	Entertainment/ tourism	3	3	3	3	3	2	3	2	1	0	3	2
4	Education	3	2	2	2	2	1	2	2	1	0	3	2
	…												

3.1.13. In addition to these main ecosystems, Da Bac has some other ecosystems with smaller areas such as industrial ecosystems (hydroelectric plant, sugar plant...).

3.2. Analyse and assess the importance of ecological services of ecosystems [2, 4, 5]

Each ecosystem of Da Bac district has different importance level of its ecological

services. Based on understandings of ecological services, important levels of the services of each ecosystem is shown by below assessment table (table 1). Table 1 lists the various importance levels of ecological services of ecosystems in Da Bac district: 0 = not important; 1 = less important; 2 = fairly important; 3 = highly important.

3.3. Propose important ecosystems for protection priorities [1, 3, 5]

The following aspects will explain why important ecosystems need to be protected: biodiversity (genetic resources, endangered species,...); economic development (agriculture, forestry, fisheries, commerce, services,...); the preservation of the national culture for supporting people's life; the socio-economic problems of Da Bac district.

- Natural forest ecosystems (limestone, soil mountain): Biodiversity of several endangered species is much richer than the other ecosystems that need to be protected; Besides, this ecosystem plays important roles in environment, economy and society that also need to be preserved. Besides, narrowed forests face difficulties due to indiscriminate deforestation. Natural forests of Da Bac district need strengthened management and expanded investment in the future. First priority is protecting not only the areas in the nature reserve, but also in forest areas outside protected areas.

- River, lake and pond ecosystems have quite rich and abundant biodiversity. However, this ecosystem is significantly degraded by many reasons (as mentioned above). It could be said that the life of the inhabitants so far has been associated with the ecosystem of rivers, lakes and forest through aquaculture, agriculture and forestry activities. Therefore, in order to maintain the development of ecosystem services for this ecosystem there is, a very urgent need for measures to protect, conserve and enhance the people's awareness and involvement more attention from the government.

In the long run, the most effective forms of conservation will be those that engage local stakeholders; the cultivation of sustainable ecosystems and their services must be promoted along with conservation of endangered species and populations. The emerging field of ecological economics can unite these goals by revealing the connections between human well-being and conservation.

4. Conclusion

- Da Bac district has 13 major ecosystem types. Each type of ecosystem in Da Bac district has different importance levels of ecological services (24 main services). According to 4 groups in planning, exploitation and use, these ecosystems should be divided as: 2 types for "resident" group and 11 types for production, services and protection.

- There is one Nature Reserve in Da Bac named Phu Canh which could be considered to be sufficiently researched on biodiversity while investigation/research on biodiversity of other ecosystems were also implemented but still have not been completed and updated. It is very necessary to have further investigation and research on biodiversity if Da Bac aim to have a plan of biodiversity conservation.

- In order to develop socio-economic of Da Bac district sustainably, it is necessary to orient the development and management of Da Bac district's ecosystems towards maximizing their ecological services.

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Đa dạng hệ sinh thái và các dịch vụ sinh thái của huyện Đà Bắc, tỉnh Hòa Bình

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Tóm tắt: Đà Bắc - huyện lớn nhất của tỉnh Hòa Bình, với nền kinh tế thấp và điều kiện sống của người dân khó khăn hơn so với các huyện, thành phố khác trong tỉnh. Vì vậy, rất cần thiết để phân tích đa dạng hệ sinh thái và các dịch vụ sinh thái của các hệ sinh thái trong huyện Đà Bắc để phục vụ cho mục tiêu phát triển kinh tế - xã hội bền vững. Trong nghiên cứu này, các hệ sinh thái khác nhau của Đà Bắc đã được xác định dựa trên những hiểu biết cơ bản về sinh thái học. Sau đó, tầm quan trọng/giá trị dịch vụ sinh thái của các hệ sinh thái đã được phân tích và dự kiến đề xuất các hệ sinh thái quan trọng cần ưu tiên bảo vệ, giúp các nhà hoạch định chính sách phân bổ đúng nguồn lực cho sự phát triển bền vững.

Từ khoá: Hệ sinh thái, dịch vụ sinh thái, phát triển bền vững.