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Spatial organization for rational land use and environmental protection in Uong Bi Town by functional sub-areas

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Abstract. Spatial or territorial organization is one of effective tools for sustainable land use. Spatial organization of land use and environmental protection by functional sub-areas is performed on the basis of comprehensive and integrated research on characteristics and differentiation laws of natural components and landscapes, socio-economic factors, the present status and trend of environmental changes as well as the structures and functions of sub-areas.

Uong Bi is a national center for tourism, coal mining and thermal power production. The development of economic sectors has led to a series of urgent environmental and social problems, requiring implementation of plans and solutions for ensuring sustainable development. This paper proposes a scientific-based spatial organization of land use and environmental protection by eight functional sub-areas in the Uong Bi Town area.

Keywords: Spatial organization; Land use; Environmental protection; Territorial zoning; Uong Bi Town.

1. Introduction

Land as the space for living and production activities is an extremely valuable resource, and an important component of the environment. Territorial organization of land use and environmental protection is coordinated arrangement of land uses in the multi-sectoral relationship, combining the economic development with environmental protection, with the aim to use natural and socio-economic potentials efficiently, prevent pollution and improve the environment quality [1, 2].

The Uong Bi Town is the western gateway of Quang Ninh Province, a junction for economic and commercial exchanges in the corridor of National highways No 10 and 18, which is a key economic area of Quang Ninh Province.

The Uong Bi Town area has rather rich mineral resources, consisting of coal (690 million tons), limestone (28-30 million tons), claystone (595,000 tons), and forest resources (10,736 ha), high potential tourism resources with Yen Tu tourist center, Lung Xanh waterfalls, Yen Trung reservoir. These are considered very important resources, contributing to the economic development of the town. However, the development of economic sectors, especially mining, thermal power generation, etc., has led to a series of pressing issues in terms of

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environment and society. The immediate and long term problem of Uong Bi is that concrete measures and action plans are required not only for sustainable economic growth, but also for ensuring environmental quality and social stability. For this very reason it is necessary to organize the space for rational land use and environmental protection of Uong Bi Town in the direction of sustainable development.

2. Data and research methods

2.1. Approaches to spatial organization research

The systems approach and sustainable development approach are the leading methodology in the territorial organization of land use and environmental protection.

A system is an assemblage of factors interacting with each other and with the environment through the material and energy flow. Any system is a component of a higher level system. Between those systems exists a mutual relationship. Each system is structurally complete and functionally unified. Therefore, when acting on a component of a system, its other components also change, leading to changes in the system as a whole.

The territory of Uong Bi as a geosystem formed by a mutual relationship between natural factors (geologic, topographic, climatic, hydrologic, pedologic, biologic, etc.), socio-economic factors and forms of exploitation and use of natural resources (industrial, agricultural production, etc.). This system is structurally complete and functionally unified: economic, administrative, ecologic, social, and other functions).

The sustainable development approach requires a harmonic combination between socio-economic development and environmental protection, in particular it requires to implement three objectives: (1) effective economic development, (2) harmonic development of social aspects, improvement of living standards of the population and (3) prevention of pollution and improvement of the ecological environment.

2.2. Data for spatial organization

The data sources serving territorial organization of land use and environmental protection consist of geomorphologic, pedologic, climatic, hydrologic, vegetation cover, statistical and socio-economic survey data of the whole Uong Bi Town and its wards, communes in 2004, 2005, 2005; water and air environment analysis data from pilot research sites collected in the rainy and dry seasons from 2004 to 2006; a series of 1: 25,000 scale geomorphologic, pedologic, and land use status, vegetation cover, population distribution, general economic, environmental quality status maps, natural hazards, environmental zoning maps of Uong Bi Town.

2.3. Research procedure and methods

The procedure for territorial organization research of Uong Bi Town consists of two large steps [3, 4] (Fig. 1): (1) Survey, analysis and evaluation of natural, socio-economic and environmental conditions of Uong Bi Town; (2) Orientation of spatial organization by sub-areas and recommendations of solutions for implementation.

The main research methods used include: Field survey; Sample analysis for environmental components; Mapping, remote sensing and GIS. Integrated and inter-disciplinary surveys were conducted along traverses across the main types of landforms and characteristic production areas of Vang Danh, Nam Mau coal mining areas, Yen Tu tourist area, the aquacultural area in the south of the town, etc.), the main population area at the center of the town. Soil, water and air samples were analyzed for evaluating the status, spatial and temporal variation of the environmental quality in the study area.

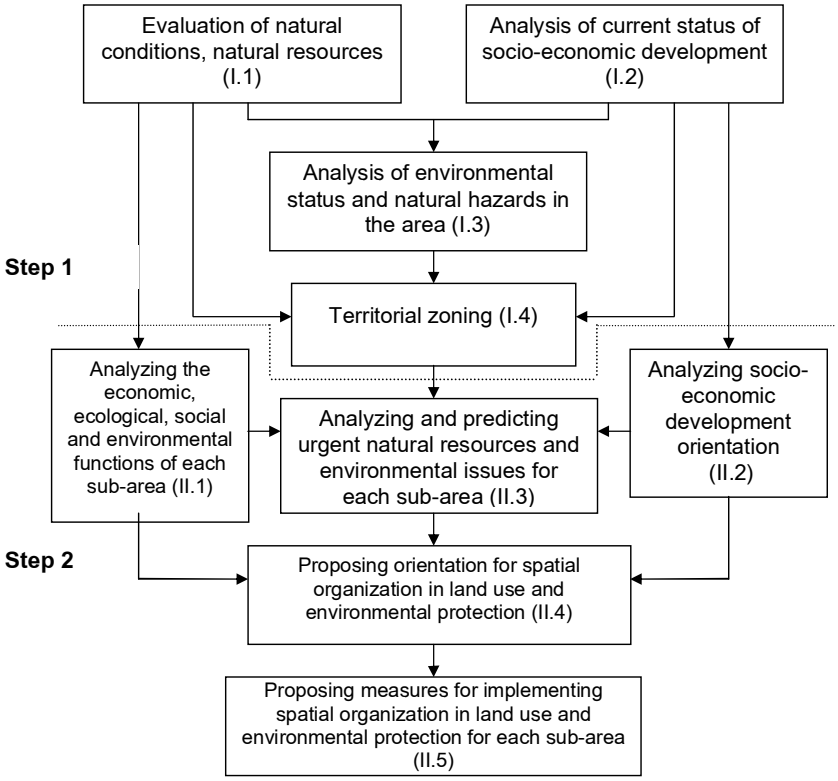

Fig. 1. Research procedure for spatial organization of land use and environmental protection in Uong Bi Town.

The mapping, remote sensing and GIS methods were used in various stages in the research process, with the aim to present the distribution and relationship between natural, socio-economic components in the territory of Uong Bi Town. In the research process, SPOT 5 space images with resolution of 2.5 m and various software programs (Mapinfo 7.8, ArcGIS 9.0) were used for compiling thematic maps and territorial organization maps of land use and environmental protection.

3. Spatial organization of land use and environmental protection

3.1. Territorial zoning of Uong Bi Town

Zoning of Uong Bi Town is essentially dividing this area into sub-areas with particular natural, socio-economic and environmental characteristics.

Sub-area is a particular territorial unit which is considered a geosystem consisting of relatively homogeneous natural conditions, socio-economic activities which have mutual interactions creating specific characteristics allowing to orient for exploitation and use of natural resources and environmental protection.

Research and evaluation of these sub-areas will create a scientific basis for planning the economic development attached with the rational exploitation and utilization of natural resources and environmental protection in the direction of sustainable development.

Each sub-area is delineated based on the

following characteristics:

- Relative uniformity in terms of natural conditions (geology, geomorphology, climate - hydrology, soil-vegetation);
- Specific characteristics in terms of economic development, exploitation and use of natural resource (mining, forms of land use, degree of urbanization and industrial development, rural areas and agricultural, forestry and fishery development);
- Assemblage of urgent environmental problems and natural hazards.

Although each sub-area has particular characteristics in terms of groups of natural, socio-economic and environmental factors, the names of sub-areas are usually attached with their geographic names and functions for easy identification of their spatial distribution, characteristics, role and functions.

Based on the above indicators, the study area is divided into 4 groups of sub-areas consisting of 8 sub-areas (Fig. 2).

3.2. Spatial organization of land use and environmental protection by sub-areas

Based on the results of research on structures and functions of sub-areas, analysis of the current status and the trend of socio-economic development, regional environmental evolution, combined with the consideration of orientation for development of Uong Bi area and Quang Ninh Province, a spatial organization of land use and environmental protection by sub-areas has been proposed.

• *Yen Tu tourist and medium mountain forest landscape conservation sub-area*

This is an area with medium height, steep slope mountains of Yen Tu mountain range. The landform in this sub-area is developed on coarse grained sedimentary rocks, consisting of alternating layers of conglomerate, gritstone, sandstone, claystone and coal seams of Hon Gai formation. The soil here is of feralite type, of yellowish red color, with rather high humus content, vulnerable to erosion and acidification. This is an area of close, ever green, humid subtropical forest with broad leaf trees (mixed with some conifer trees), with many species of precious timber trees, valuable medicinal herbs, beautiful flowers.

The Yen Tu historical - cultural site is a national Buddhist Center, a special natural beauty spot. The conversion of Yen Tu area into a large scale cultural - ecological tourist site brings great socio-economic benefit, but on the other hand it also causes great pressures on the environment, especially in the festival season. Therefore it is necessary to preserve and refurbish historic and cultural relics, protect the natural landscape of the beauty spot, especially the forest cover along the tourist route; adopt strong sanctions to prevent illegal exploitation of timber, medicinal herbs and other non-timber forest resources.

• *East Yen Tu - Bao Dai low mountain and hill forestry sub-area*

The northern part of this sub-area is characterized by medium mountains composed of coarse grained terrigenous rocks of Hon Gai formation. The topography here is of high slope, strong dissection. Here occurs a well preserved primary forest cover, where originates the system of rivers and streams flowing to Uong Bi Town. The main function of this sub-area is to protect the watershed forest, contributing to the regulation of surface water flow and improvement of the ecological environment.

The southern part of this sub-area is of low mountain topography, composed of volcano-sedimentary rocks of Binh Lieu formation. This is where originate most of streams flowing into the Sinh River and Vang Danh stream in Thuong Yen Cong population and agricultural sub-area. It is crossed by the Yen Tu tourist route, therefore the vegetation cover here has been strongly impacted. Besides the secondary forests there are humid tropical secondary scrubland savannas. Here priority should be given to the forest zoning and regeneration, soil protection and erosion control.

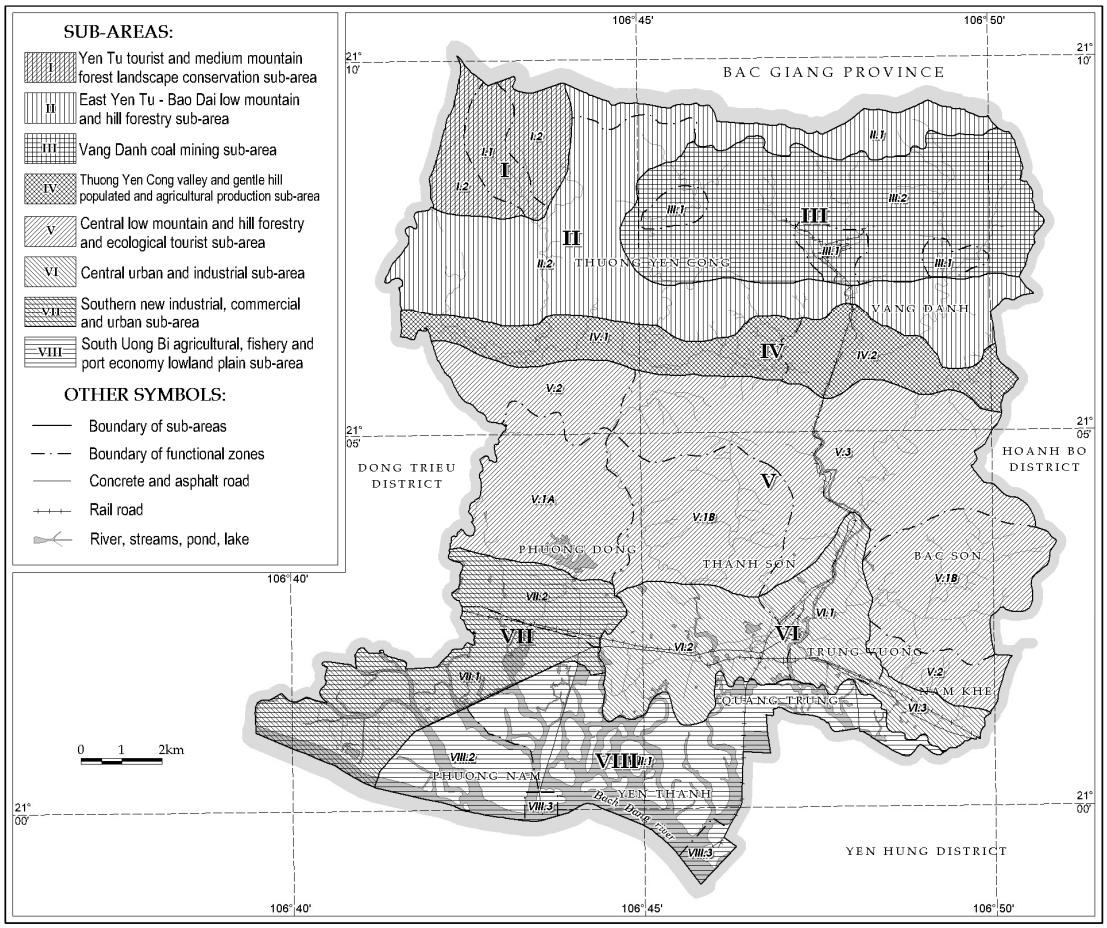

Fig. 2. Sub-areas of Uong Bi Town for spatial organization of land use and environmental protection.

• *Vang Danh coal mining sub-area*

The vast mining sites of Vang Danh, Vietmindo and Nam Mau coal companies to the NE of Uong Bi Town. The extent and output of coal mining are increasing for both open pit and underground mines. Coal mining brings big economic benefits, but impacts strongly the land and forest resources, causes ever more serious environmental pollution in the mining area and the surroundings. Coal mining is the greatest source of environmental pollution in the area of Uong Bi Town. It is necessary to perform well and in time the land rehabilitation and reforestation, plan appropriate coal mining waste dumps.

In the area of the coal processing plant appropriate technological solutions must be used for treatment of the waste water from the coal processing, reducing dust and noise.

• *Thuong Yen Cong valley and gentle hill populated and agricultural production sub-area*

The topography of this sub-area consists mainly of tectonic valley, structural- denudation types with accumulative-denudation and delta margin landforms, composed mainly of coal bearing terrigenous sediments. In the sub-area are formed the main soil types: colluvial soil, sterile alluvial soil, and yellow feralite soil on

sandstone. The soils are in general rich in nutrients, tend to be acidified (pH = 4 ÷ 4.5). With the relatively gentle topography, the water from the Sinh River and the Uong River can be used for agricultural development. The colluvial and alluvial soils are favorable for cultivation of rice and dry crops. On the other hand, this sub-area is crossed by National road No 18B in E-W direction, so it is the favorable for population settlement and agricultural development in comparison with the other sub-areas in the mountain area north of the Uong Bi Town.

For the Thuong Yen Cong rural and agricultural development priority area, priority is given to rice cultivation to ensure food supply to the population, fruit trees and vegetable growing to serve tourists in Yen Tu during the spring festivals and the population of Vang Danh Ward.

Agricultural and forestry cultivation models on the plain marginal hills and tectonic valleys which bring high economic efficiency and maintain the ecological sustainability should be established: an appropriate cultivation technique should be used, the soil quality should be protected and improved, soil erosion and wash-off should be prevented.

The Vang Danh urban and service area is the main living area of the population in Vang Danh Ward and most miners' households, with many restaurants, trade and service establishments. The environmental issues given priority for solution include: clean water supply and domestic waste water treatment, collection and disposal of domestic wastes.

• *Central low mountain and hill forestry and ecotourist sub-area*

This sub-area is mainly of low mountain and hill landforms on coal bearing terrigenous sediments, together with some other types of landforms such as plain marginal hills composed of coal bearing terrigenous sediments, erosion-tectonic valleys with hummocky topography formed by dissection of terraces and pediments. The soil cover consists mainly of yellow red or yellow gray feralite soil on sandstone. In this sub-area occurs mainly close, humid tropical board leaf, ever green forest type with predominance of wood trees and secondary humid tropical shrubs.

The main function of this sub-area is to develop forestry, build reservoirs, ensuring sufficient clean water for domestic water supply and for production in Vang Danh Ward.

The Yen Trung reservoir area should be built as an ecological tourist and resort area with protection, restoration and planting of pine forest. The waste water treatment and the collection of solid wastes from tourist area should be properly conducted.

Construction of a dam across the Sinh River and Muoi Hai Khe stream to create a multi-purpose reservoir is a strategic turn for domestic water supply in Uong Bi Town [5]. Full use of the beautiful scenery of the reservoir area should be made for developing ecotourism and resorts, but special attention should be paid to the protection of the water environment in the reservoir.

The forest cover upstream of the reservoirs must be strictly protected to ensure constant water supply sources for the reservoirs even during the dry season, contributing to the reduction of soil erosion, suspended solids contents in the river and stream water and sedimentation in the reservoir.

The landscape of this sub-area is being impacted by human activities as it is located adjacent to National road 18B and crossed by coal hauling roads from Vang Danh coal mine to Dien Cong port. The vegetation cover consists mainly of secondary shrubs and planted forests. The soil cover in many places is strongly eroded, exposing bed rock. For this sub-area, priority is given to the zoning of forest for regeneration, forest planting, soil protection, erosion control.

• *Central urban and industrial sub-area*

The industrial part of this sub-area has high population density with concentration of industrial production. To improve the quality of environment it is necessary to restrict construction of new industial facilities here. The most urgent environmental issue in this sub-area is the industrial and municipal waste management. Appropriate technilogies must be used for mitigating the pollution due to gas emission from the thermal power plant, treatment of industral waste water, close management of solid industrial wastes, especially hazardous wastes.

The urban part of this sub-area has diverse sources of industrial and domestic wastes, which have caused local environmental pollution. Urgent environmental issues to be solved include: ensuring sufficient clean water suply for the urban population; planning for collection and treatment of waste water from domestic activities and from service establishments, market places, retaurants; collection and full disposal of hazardous wastes from the hospitals, health care facilities in the urban area of the town and dispersed industrial facilities; classifying solid wastes at the source and establishing new waste collection stations, performing good collection and disposal of urban wastes; planning and building new recreation grounds and parks, developing spaces such as greeneny areas, etc.; taking measures to closely manage the transportation of fill and construction materials for implementing construction projects.

• *Southern new industrial, commercial and urban sub-area*

This sub-area is characterized by low-land marine-alluvial accumulative plain landform. Here are concentrated agricultural, fishery, forestry activities of tidal area, operation of the coal terminal and implementation of industrial, commercial and new urban development projects. The main environmental issues of this sub-area are air pollution, noise, water pollution due to transport activities, construction projects and development of population areas. Besides, waste water treatment and rehabilitation, upgrading and construction of water supply and drainage systems are also important issues raised for this sub-area.

It is necessary to promote integrated development of industrial and commercial areas concentrated along National roads No 10 and 18A taking into consideration the space for development of the new urban area, making use of the advantage in terms of position and privileged investment policy to help the development of the sub-area and create jobs for the local people; closely managing the construction of infrastructures; taking measures for mitigating dust and gas emission by means of transport carrying fill and construction materials for construction projects along the roads; closely controlling the discharge of waste water from factories, commercial areas, mitigating their impacts on the environment, especially water environment.

• *South Uong Bi agricultural, fishery and port economy lowland plain sub-area*

This sub-area is a strip of low-lying accumulation plain of fluvio-marine genesis along the sides of Da Bac River. The elevation combined with strong effect of the tides led to the formation of an acidic and saline soil cover. The soil is of low humus, total and available NPK contents and relatively high Cl content. The vegetation cover is mainly halophilous and acidophilous flora.

Commercial agriculture should be developed on the land side of the dike and aquaculture should be developed sustainably on the river side. Environmental sanitation should be well carried out in the population clusters in the low-lying plain along the river sides. The residual limestone mountains in the low-lying plain along Hang Ma and Da Bac rivers, which form charming landscapes,

require investment for development of ecotourism and resorts.

The Dien Cong coal terminal and Bach Thai Buoi integrated terminal need to be upgraded in size and application of appropriate technical measures to prevent water and air pollution caused by coal transportation.

The coal hauling routes start at mining sites of Vang Danh, Vietmindo, Nam Mau coal companies and end at Dien Cong coal terminal. The coal hauling railway and road infrastructures are in bad condition and need to be upgraded to meet the increasing demands of coal extraction and transportation in coming years. Greenery corridors with a width of 20 - 30m should be established along the roads to minimize the air pollution and improve the climatic condition in the area.

4. Conclusions

Territorial organization is one of effective solutions for management and rational use of land resources toward sustainable development.

A spatial organization of rational land use and environmental protection of Uong Bi Town area has been proposed on the basis of structural-functional analysis of sub-areas, with special attention paid on the economic and environmental functions.

Based on the characteristics of natural, socio-economic conditions, the present status and trend of environmental changes, the Uong Bi area is divided into 4 groups of sub-areas consisting of 8 sub-areas: Yen Tu tourist and medium mountain forest landscape conservation sub-area, East Yen Tu - Bao Dai low mountain and hill forestry sub-area, Vang Danh coal mining sub-area, Thuong Yen Cong valley and gentle hill populated and agricultural production sub-area, Central low mountain and hill forestry and ecological tourist sub-area, Central urban and industrial sub-area, Southern new industrial, commercial and urban sub-area, South Uong Bi agricultural, fishery and port economy lowland plain sub-area.

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