

## FUNCTIONAL ZONING FOR INTEGRATED COASTAL MANAGEMENT IN THAI BINH PROVINCE

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**Abstract.** On the basis of analyzing natural conditions, resources, current exploitation status and functional zoning principles and criteria, functional zoning maps for integrated coastal management in Thai Binh were incorporated. Results suggested classifying Thai Binh coasts into two functional zones: Urban and multi-economic development zone and ecological conservation and recovery with economic development and national defense zone. Then, zone 1 and zone 2 were classified into 3 and 4 different functional sub-regions respectively with suitable proposal of prior activities and management. This research is an important basis for coastal development and intergrated coastal management in Thai Binh.

**Keywords:** Functional zoning, integrated coastal management, Thai Binh coastal areas.

### INTRODUCTION

The coastal area of Thai Binh province consists of Thai Thuy and Tien Hai districts which are constrained by Thai Binh inlet in the North and Ba Lat inlet in the south, extending to the depth of 6 m offshore (being able to extend to 20 m offshore, depending on management level). It comprises low-lying tidal flats with diverse and high potential natural resources, especially coastal resources. Besides, this area is also very highly sensitive and fluctuating in terms of ecology - environment, affected by many kinds of natural disasters such as storm, flood, drought, storm surges and monsoon. Additionally, this area is also directly affected by climate change and sea level rise.

It is necessary to implement functional zoning in order for integrated coastal

management in sustainable coastal socio-economic development strategy in Thai Binh.

### METHODOLOGIES AND DATA SETS

Functional zoning is essential basis in planning, territorial organization for rational exploitation of natural conditions, resources and environmental protection [1–5].

Based on inherited research outputs of environmental and ecological functional zoning [3–5], this research proposes the functional zoning for integrated coastal management based on the principles and criteria of functional zoning.

The literatures used in this research were collected from data, research outputs of natural resources, natural conditions, present conditions of natural resources exploitation in

Thai Binh and adjacent areas [1]. The surveys were implemented in 2017 and 2018 to validate the research results.

Functional zoning for integrated coastal management of Thai Binh province was implemented based on principles and criteria as follows.

**Main principles of functional zoning.** Ensure the relative homogeneity of zone. Each zone was classified based on the relative homogeneity of zoning criteria. The criteria consist of natural conditions, natural resources, environment and present state of socio-economy... There are numerous criteria, therefore, major and subsidiary criteria need to be determined for each zoning level.

Ensure the objective characteristic of zoning. Zone is an objective entity, formed by co-reciprocal interaction of natural elements, follows the natural rules of energy flow and material conservation. Therefore, it is necessary to ensure the objective characteristics of zoning in balance state and accommodate the imbalance of zoning by anthropogenic impacts.

Correspond to ecological function of zones which is the ruling principle. Based on the ecological approach, each region is a large ecosystem while each sub-region is smaller ecosystem. In functional zoning principle, natural rules need to be complied in order to conserve and promote the ecological functions and environment.

Correspond to management demands, ensuring the equity between advocacy groups to avoid environmental conflicts.

Functional zoning in integrated coastal management is actually the management of natural resources utility and environmental protection. Functional zoning is the foundation to evolve legal ground to regulate the development of ecosystems and environment.

**Functional zoning criteria.** Functional zoning for integrated coastal management for Thai Binh is conducted based on functional zoning criteria as follows:

Natural conditions and environment.

Natural resources, especially soil, biological resources and their functional roles.

Present condition and exploitable capacity of natural resources for developing demands.

Anthropogenic impacts including direct and indirect exploitation of natural resources which affect regional ecological environment.

## RESULTS AND DISCUSSION

Based on the mentioned principles and criteria, functional zoning map for integrated coastal management in Thai Binh was built (fig. 1). Results illustrated that Thai Binh coastal area was classified into 2 different functional zones with prior activities and suitable management (table 1).

The major distributional characteristics, environmental functions, highlight environment issues, management orientation in natural resources exploitation and environmental protection of each zone and subzone are discussed.

Table 1. Functional zones for integrated coastal management in Thai Binh province

Zones	Subzone	Notation
Zone of urban and economical multidisciplinary development	Subzone of agriculture development (rice, fruit tree, vegetable,...)	I.1
	Subzone of aquaculture development	I.2
	Subzone of urban, residential, industrial and service development	I.3
Zone of protecting, recovering and reserving ecosystem diversity in combination with economic development and national defense	Subzone of natural reserve (Core areas of biosphere reserve zone of Red river delta)	II.1
	Subzone of coastal forest and tidal flats reserve and protection	II.2
	Subzone of ecosystem protection and conservation with tourism development and national defense	II.3
	Subzone of wetlands	II.4

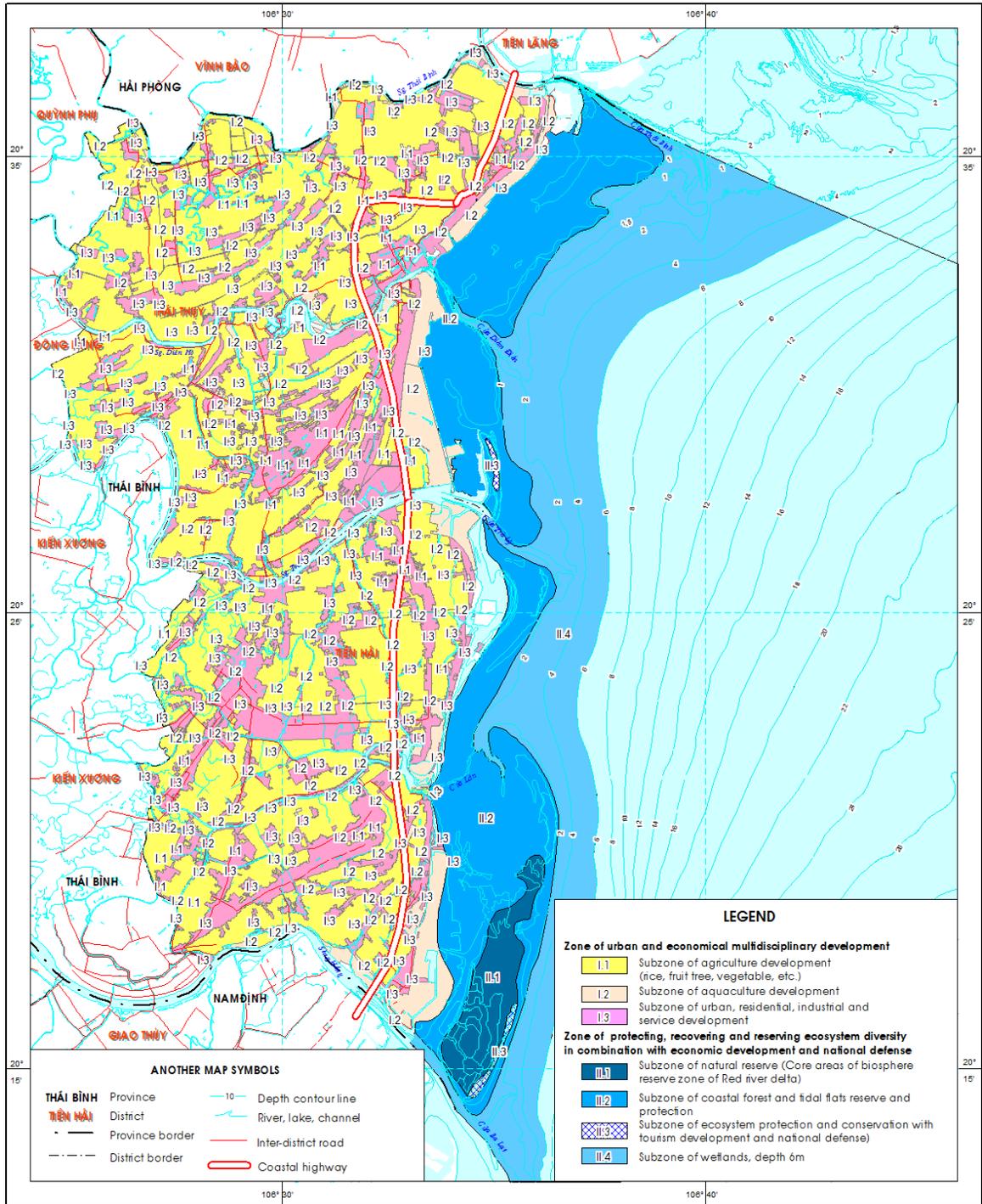


Fig. 1. Functional zoning map for integrated coastal management in Thai Binh province

**Zone of urban and economical multidisciplinary development.** This zone accounts for 80% of natural land area of Thai

Thuy and Tien Hai districts, is surrounded by sea dyke system. This zone is divided into 3 subzones:

*I.1. Subzone of agriculture development: Cultivating rice, vegetables, crops, fruit trees*

Domain: Most of areas inside sea dike system, covering the area of 288 km<sup>2</sup>.

Natural conditions: Estuarine deposition topography, late Holocene period, clay, mud and sand deposition. These characteristics promote the development of rice, crops and fruit trees agriculture.

Natural resources: Land resources consist of cultivated land, less salty, are less aluminous, situated at high topography with good drainage.

Major environmental functions: Habitat of the majority of rural population, consequently, it contains the household and villages wastes.

Concerned environmental issues: Wastes from agriculture activities, soil contamination, waste water from living, farms, villages, residues of chemical fertilizers and pesticides,...

Oriented management and utilization: Develop sustainable agriculture, diversify plants and livestock, select kinds of rice and plants which can tolerate the drought and salinity, increase use of organic fertilizer, strict control of the use of pesticides.

*I.2. Subzone of aquaculture development*

Domain: Covering the area of 60 km<sup>2</sup>, mostly distributed in the brackish waters, river inlets, coastal areas. In recent years, this subzone has been extending to low hollow areas with poor drainage, resulting in less effective rice growing.

Natural conditions: Estuarine deposition topography, late Holocene period. Low hollow areas are separated by embankments. Water intake depends on the tidal regime.

Natural resources: Thai Binh coastal area is complex, comprising many rivers, tidal channels, inter-dispersed by river inlets: Thai Binh, Diem Dien, Tra Ly, Lan and Ba Lat. Water resources are rich but suffering from salt intrusion. Annually, huge amount of sediment from Red and Thai Binh river systems has been transported to the coastal areas, creating tidal flats that are suitable for growing mangroves and aquaculture development. Abundant water resources of Thai Thuy and Tien Hai are suitable for irrigation, desalination, developing sustainable agriculture.

Major environmental functions: developing sustainable aquaculture, protecting aquaculture benefits: Breeds, kinds, ecological diversity.

Concerned environmental issues: Water and soil pollution caused by use of animal feed and pesticides (antibiotic residues). Increasing salt intrusion due to climate change and sea level rise.

Oriented management and utilization: protecting environment of aquaculture ponds. Managing aquaculture and fishery under the Fisheries Law.

*I.3. Subzone of urban, residential, industrial and service development*

Domain: Town, industrial zones (Tien Hai gas industrial zone, thermal power plant,...) residential areas along national highways and provincial roads. Additionally, coastal highways have been approved and prepared for implementation. Total area of the subzone is 139 km<sup>2</sup>.

Natural conditions: high terrain, estuarine deposition, marine-fluvial accumulation topography, easy for drainage.

Natural resources: Mostly positional resource: Geographical position has been exploited: Located on the node of transportation system; close to estuaries that are favorable for waterway traffic.

Major environmental functions: Providing spaces for urban, industrial and services development; developing traffic networks between zones and subzones.

Concerned environmental issues: Local inundation due to uncompleted construction planning. Exceeding the environmental load due to inadequate waste collecting and treatment system including waste water, solid waste and domestic waste.

Oriented management and utilization: Protecting the environment of urban areas, villages and industrial zones. Managing waste discharge activities. Developing sustainable urban areas and green industries.

**Zone of protecting, recovering and reserving ecosystem diversity in combination with economic development and national defense.** This zone is mainly located outside the sea dike

system to the water depth of 6 m according to 1971 Ramsar Convention on Wetlands. This is a part of Red river delta biosphere reserve, which was recognized by UNESCO in 2 December 2004. There are two cores comprising Xuan Thuy National Park and Tien Hai Natural Wetland Reserve. These two core zones are surrounded the buffer zones, transitional and corridor areas. The total area of the Biosphere Reserve is over 105,000 hectares. This is the habitat of many rare and precious bird species including over 200 bird species with 66 migratory birds species and more than 50 species of poultries. Many birds have appeared in the Red book, such as *Platalea minor*. Besides, this is also a home of marine species, providing abundant aquatic resources along with 500 species of aquatic plants, seagrasses and phytoplanktons.

### *II.1. Subzone of natural reserve (Core areas of biosphere reserve zone of Red river delta)*

Domain: The core of biosphere reserve areas of Thai Thuy and Tien Hai, covering the total area of 22.5 hectares.

Natural conditions: Estuarine deposition topography, late Holocene period. Sand beach ridges were inter-dispersed by low hollow areas with poor water exchange capacity.

Natural resources: Conserving abundant biodiversity values of rare species with international-level importance. The habitat is diverse and distinctive with mangrove forests, saltwater marshes, tidal flats.

Major environmental functions: Providing spaces for maintenance and development of biodiversity and rare gene sources.

Concerned environmental issues: Erosion, accretion of sand beach ridges and tidal channels.

Oriented management and utilization: Strictly protecting the ecosystem of natural wetlands and sand beach ridges. Developing within the limit of the scientific tourism and ecotourism.

### *II.2. Subzone of coastal forest and tidal flats reserve and protection*

Domain: The buffer subzones of biosphere reserve areas of Thai Thuy and Tien Hai, covering the total area of 101.7 km<sup>2</sup>.

Natural conditions: Low topography with mainly saline and brackish water ecosystem. There is a pattern to develop delta seaward. Coastal erosion and accretion in local scale happens usually, consequently flattening the high parts while raising the low parts of tidal flats and sand dunes.

Natural resources: Abundant and diverse ecological resources with mangroves development for protecting the core of biosphere reserve.

Major environmental functions: Providing protective spaces for Red river biosphere reserve. Besides, this subzone also protects the coasts from coastal erosion.

Concerned environmental issues: Erosion, accretion of sand dunes and tidal channels, degradation of aquatic swamps.

Oriented management and utilization: Managing, protecting and recovering the mangrove forests. Developing within the limit aquaculture.

### *II.3. Subzone of ecosystem protection and conservation with tourism development and national defense*

Domain: Con Den and Con Vanh with areas of 1.4 km<sup>2</sup> and 8.5 km<sup>2</sup> respectively.

Natural conditions: Mostly sand dunes at Tra Ly and Ba Lat inlets. The sediment is mainly fine sand with the corpses. Covered vegetation on the sand beach ridges consists of *Spinifex littoreus*, *Ipomoea pescaprae*. Secondary shrubs with broad-leaved population are dominant, including *Pandanus tectorius*, *Scaevola*, *Hibiscus tiliaceus*,... Planted forests comprise tropical almond, casuarina,...

Natural resources: High topography with medium and fine sand, suitable for constructions and tourism, protective forests development, conservation of sand beach ridges ecosystems.

Major environmental functions: Developing the infrastructures for scientific tourism, ecotourism, national defense and security.

Concerned environmental issues: Sand beach ridges erosion, variation of sand beach ridges morphology.

Oriented management and utilization: Managing infrastructure development including

planning ecotourism activities, resorts, national defense and security constructions, marine economic development projects.

#### II.4. Subzone of wetlands

Domain: From the boundaries of subzone II.2 and II.3 to the water depth of 6 m and 20 m with the correspondent areas of 148 km<sup>2</sup> and 311 km<sup>2</sup> respectively. This subzone has been expanding over years with the expansion of the tidal flats along Ba Lat and Tra Ly river mouths.

Natural conditions: Located in the accreted areas of Red river and Thai Binh river with abundant, rich nutrient sediment. The wide tidal flats with flat topography aged late Holocene period. The surface characteristic is accumulation-cavitation type due to flow and wave, fluctuates dramatically seasonally and annually. Estuarine and marine flows are governed by tidal currents.

Natural resources: Diversity in biological resources including species with high economic value, abundant species of shrimp, crabs, bivalves and molluscs.

Major environmental functions: Conserving the biodiversity and landscapes for subzones II.1, II.2, II.3. Protecting from wave effects and increasing the sediment accretion in low tidal flats.

Concerned environmental issues: Erosion of sand beach ridges, over-exploitation of fishery resources, pesticide residues from the river mouths.

Oriented management and utilization: Managing the space for tidal flats development. Planning the aquaculture and aquatic exploitation, particularly the bivalve species. Using and managing tidal flats rationally.

### CONCLUSION

This study provides a functional zoning approach for integrated coastal management in Thai Binh province, and has indeed proposed oriented management solutions for sustainable use of natural resources and environmental protection. Functional zoning is based on rules of natural condition, natural resources, environment, present state of socio-economy to classify the coastal areas into zones and

subzones with particular characteristics. The results suggest dividing Thai Binh coastal areas into 2 main zones and 7 subzones with different environmental and ecological functions. The results from this study can be broadly transferable to other coastal provinces in Vietnam.

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