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## The process of establishing marine spatial planning maps in Vietnam

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### ABSTRACT

Creating a marine spatial planning map (MSP) guides the determination of the map's extent and scale, the map, the content of the map, the methods and techniques of mapping, and the sequence of steps performed. The process consists of 5 steps: 1) Define nature, requirements, scope, and methods, 2) Analyze and evaluate data and information, 3) Make and draw thematic maps and diagrams, 4) MSP mapping, and 5) Make a description of the MSP map. MSP maps' location, scope, and scale are established according to a 3-level system: national, regional, and local. The three-dimensional approach MSP map is integrated and synthesized from the marine functional zoning and marine space use zoning maps of the same scale. The set of MSP maps in Vietnam is divided into 3 levels: national level MSP maps with a scale of 1:1,000,000; regional MSP map, scale 1:500,000 together with MSP map of sub-regions at 1:250,000 scale; local-provincial MSP maps at the scale of 1:100,000 and in case of necessity, establish district-level MSP maps at scale 1:25,000 - 1:50,000. Vietnam's sea is functionally divided into 5 large marine regions, including the Gulf of Tonkin. The Gulf of Tonkin (region I) is divided into 6 functional zones, including Mong Cai - Do Son one. This area is established MSP Map at scale 1:250,000 as a reference example, showing 3 functional areas and 7 basic units using marine space.

**Keywords:** Marine space planning (MSP), MSP map, MSP mapping guide, Vietnam.

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## **INTRODUCTION**

Marine spatial planning (MSP) is an aquatic management process that balances development needs with environmental protection, creating efficient and planned economic, social, and ecological benefits. It aims to promote the exploitation of natural resources and position for sustainable coastal and marine economic development, maintain maritime ecosystem services, and reduce conflicts of interest for use. Up to now, many countries have paid attention and attached importance to MSP in territorial waters and exclusive economic zones and have achieved different results.

In the face of the need to exploit marine resources for socio-economic development in the coming time, the development of MSPs and the establishment of MSP maps have become a matter of particular concern in Vietnam. From the early years of the 21<sup>st</sup> Century, MSP has been approached in our country in terms of theory and scientific basis through the research of several topics/projects and has brought initial results.

With an MSP project, the MSP map is the most critical document to precisely display the delimited space for different marine uses and is the basis for implementing and monitoring the regulation plan. However, in Vietnam, there is no process to guide the establishment of MSP maps. To date, there is no guideline on the content of an MSP map and the accompanying notation and annotation system. It is, therefore, necessary to introduce a process to guide the establishment of the MSP map.

## **BASIS AND METHODOLOGY FOR ESTABLISHMENT OF MARINE SPATIAL PLANNING MAP**

### **The reality of marine spatial planning in some countries**

UNESCO 2009 issued a guide: “Marine Spatial Management - A Step-by-step Approach to Ecosystem-Based Management” [1] and continues to disseminate relevant guidelines today. [2]. However, this document does not

provide any procedures or policies for MSP mapping. The fact is that countries have very different characteristics in terms of natural conditions and marine resources, social institutions, and legal basis related to MSP. Therefore, the requirements for the content and the way of mapping MSP of different countries are also very different [3].

China considers the maritime functional zone (MFZ) as the official MSP in this country [4]. The decentralization of responsibility for the establishment and approval of the MFZ is very clearly defined. The MFZ system in China consists of three levels [5]: national (5 large seas and 29 seas), provincial level (11 coastal provinces), and county level. The development of the national MFZ project is chaired by the State Oceanic Administration (SOA); The provincial level chairs the provincial MFZ; The district level MFZ is chaired by the district level. The responsibility for appraisal and approval of the MFZ is as follows: the national level MFZ is approved by the State Council, The State Council approves provincial MFZ after review by the State Oceanic Administration (SOA), and the district level MFZ is approved by province [5]. The MFZ system in China has gone through three generations [6]. The third generation from 2003 to present with 8 types of functional zones of class 1, including 1) fishing and aquaculture areas, 2) port and shipping areas, 3) areas for economic and urban use, 4) energy and mineral areas, 5) tourism and entertainment areas, 6) marine protected areas, 7) special use area, and 8) reserved area. Functional zones are further divided into 22 functional subzones [5]. Limitations of the MFZ system in China are becoming increasingly prominent, so the ecological red line is considered an addition to the MSP in China [7].

The United States is an MSP hierarchical country; so far, the scope of MSP preparation is still limited to state waters or smaller areas, not at the federal level [8]. The Rhode Island Ocean Special Area Management Plan (Ocean SAMP) is an example of a positive MSP at the US state level. Particular areas are identified through regional management planning with three main functional zones: Renewable energy zones, areas of specific interest, and conservation areas [9].

Since the late 1990s, Australia has implemented a hierarchical MSP, zoned three-dimensional marine space and used the “Marine Bioregion” as a foundation for developing marine spatial management [10]. The Great Barrier Reef Marine Park in the Eastern Bioregion is a typical model of MSP based on the ecosystem approach [11]. Here, the MSP is consistent with marine conservation purposes and criteria, and areas within marine parks have been classified into protected area categories according to IUCN regulations [12].

MSPs in Germany are classified into four levels [13]. The Federal level sets forth the guiding principles and legislation and is responsible for the MSP throughout the sea. The federal level is responsible for formulating and implementing the state MSP within the territorial sea. The regional and city levels shall make regional spatial planning within the territory and internal waters where responsibilities are assigned. The MSP in Germany prioritizes offshore wind energy, tourism and nature protection, and traditional sectors such as shipping, fisheries, and defense.

The Irish MSP has an essential objective of minimizing conflicts of interest, and harmonizing the development of interests between fisheries, a traditional marine profession here, and wind farms, a new growth sector. As an important fishing area, the MSP focuses on allocating space for different types of fishing and aquaculture [14].

MSP in the Netherlands gives priority to wind farms and marine protected areas. The country's North Sea MSP reflects a strong trend of marine use development, with priority use zones: maritime, defense and conservation. Potential areas that stand out are the sites in the wind. An approach using three-dimensional space is apparent. Overlapping techniques show priority; for example, areas of exceptional ecological value are monolayer, and other operations can overlap 2 or 3 layers [1].

Belgium has a small sea area; MSP focuses on developing offshore wind farms, marine protected areas, sustainable sand and gravel mining areas, strengthening the prevention of oil pollution, and managing land-based activities that impact the marine environment [1].

The MSP in Latvia is within the framework of a typical block of countries around the Baltic Sea [15] that is carried out in a 5-step cycle. The established MSP map detailing the activities of using marine space has three main functional areas [16]: priority areas, potential development areas, and current use areas. Each zone is assigned space for specific marine activity. The priority and prominent marine uses are navigation, fisheries, military, tourism, and conservation.

### **Circumstances of developing the process of making marine spatial planning maps in Vietnam**

Legally, MSP has been included in the Planning Law of 2017 and Decree 37/2019/ND-CP dated May 7, 2019, of the Government detailing the implementation of several articles of the Planning Law. However, in our country, there is no process to guide the establishment of MSP maps. The Law on Planning 2017 and Decree 37/2019/ND-CP only mention the national-level MSP with a map scale that is too wide from 1:100,000 to 1:1,000,000 without specifying when maps at scale 1:100,000 and when at scale 1:1,000,000 are to compile. The legal basis allows the province to develop and implement integrated coastal zone management [17], while the MSP has not yet acknowledged the role of developing and implementing MSP within its provincial jurisdiction authority. This contradiction in legal documents causes difficulties when implementing MSP mapping projects and integrated coastal zone management projects.

Although there have been some MSP research results [18–20], there is no guideline on the content of an MSP map and the accompanying annotation and symbology system. Therefore, some concepts/terms related to this issue have been proposed but have not been unified and understood differently. There is a case where the MSP map is considered a marine functional zoning map (according to China's pattern); in some cases, the MSP map is viewed as a zoning map using marine space (actually just a product of an asymptotic to the MSP map). Decree No. 37/2019/ND-CP stipulates 9 types of maps for MSP, none of

which are named: “Marine spatial planning map” and are not apparent in the two types of maps. “Marine spatial use zoning” and “Marine spatial organization orientation” are considered MSP maps.

Some MSP maps have been established, only approaching planning in two-dimensional space (similar to land use planning on the mainland), not typical three-dimensional spatial planning using the sea, which means that the new planning objects are shown to have a horizontal distribution but have not shown a vertical distribution - a characteristic of MSP. For example, in the same sea area, in the vertical direction, mining for solid minerals can be planned to be distributed in the surface layer of the seabed, aquaculture to be distributed in the seawater mass, and hydro traffic to be distributed in the sea surface layer. As a result, it is necessary to introduce a process to guide the establishment of the MSP map. The MSP map in this process is an essential accompanying product of an ecosystem-oriented MSP project to allocate space for marine use activities, ensuring a balance of benefits between economic, social, and ecological, more specifically between economic development, nature conservation, and national defense and security.

### **Methods of creating marine spatial planning maps**

The MSP map is created in step 2 of a 5-step MSP cycle [21]. It requires the correct sequence and content of the steps according to a logical system: defining requirements, scope, and establishment method; building data and information; drawing maps and thematic diagrams based on information spatialization; MSP mapping; creating a description for the established map.

The main methods include the method of assessing the current status and forecasting the natural conditions, resources, environment, and socio-economic conditions of the sea; the process of converting and correcting the map coordinate system and seabed depth according to the VN 2000 coordinate system, elevation and projection grid; methods of map analysis and remote sensing document analysis; methods to convert

text data into data, spatial information on GIS platform; methods of building and overlaying information based on digital media and GIS technology; a process of building map annotation and symbology system; an expert strategy to consult with scientists and managers, etc.

Map scope and scale need to be defined according to the MSP mapping hierarchy [22]. Attached to this hierarchy is a map fragmentation system with compatible scope and scale, covering the entire national sea area. This system consists of three levels: the national level has a scale of 1,000,000; the regional level of 1:250,000 - 1:500,000; and the local level (provincial level) scale of 1:100,000. This decentralized system ensures centralized and unified state management of the establishment and implementation of the MSP.

GIS methods are used to build MSP maps and thematic maps. Each functional zoning unit, a marine spatial use unit/unit, or a geographic background element is represented as a vector layer of GIS information. The GIS information overlay method aggregates all marine spatial units on the background geographic GIS information layer. Unify the VN2000 coordinate system for GIS information layers according to Circular No. 973/2001/TT-TCDC of the General Department of Land Administration dated June 20, 2001. The specialized software ARCGIS 10.3 is used to build GIS information layers, editing techniques, and MSP map legends with different scales.

The MSP map and thematic maps are drawn on a GIS digitized base map of the same scale, with the coordinate system and seabed depth according to the VN 2000 coordinate system, elevation, and projection grid and selected base maps for MSP mapping.

The MSP map is superimposed and aggregated from the functional and space utilization zoning maps. The applicable zoning map shows the use function and level of permission for marine use activities. The sea use zoning map indicates the specific spatial distribution for the sea use units.

The marine spatial use zoning map shows the natural potential of sea use and is less dependent on time factors. The MSP map represents more than a social desire based on natural and temporal potential.

The MSP map comprises three GIS information layers: a group of marine functional zoning units, a group of marine spatial use units, and a geographic background group to represent the spatial relationships of the applicable zoning units and usage units with natural and administrative geographical landmarks on the planning map.

The group of marine spatial use units in the MSP map is determined to include 9 divisions belonging to 4 subgroups: 1) tourism and marine services, 2) port and maritime, 3) exploiting oil, gas, and minerals, 4) fishing and aquaculture, 5) economic, urban and coastal industry, 6) renewable energy and new economic sector 7) conservation and protection of nature, 8) special uses (defense, security, sovereignty, dumping, etc.), and 9) exclusive use. The economic development subgroup consists of the first 6 divisions. The other three sub-categories are conservation and protection of nature, special use (defense, security, sovereignty, dumping, etc.) According to the MSP map hierarchy and scale, these units can vary in number and are subdivided into more detailed secondary divisions.

Unlike land-use planning maps in two-dimensional space (by area), MSP maps approach three-dimensional space in a cubic model with vertical, horizontal, and vertical dimensions. On a particular sea space, layers of sea-use planning information can be superimposed on the seabed, sea floor, sea column, and sea surface.

The MSP map legend is a symbology of different geometries (area, lines, points, and symbols) supported by regulatory conventions of stroke and color. Line, point, and signs for small-scale map legends can be converted to color or dashed area symbols on larger-scale MSP maps.

## **PROCEDURES FOR ESTABLISHING MARINE SPATIAL PLANNING MAP**

### **Determine the nature, requirements, and scope of MSP mapping (Step 1)**

#### ***Defining vision, purpose, requirements, criteria, and planning principles***

The MSP in Vietnam is defined for 2030, with a vision up to 2050. It takes advantage of

the ecosystem for the following purposes: allocating and rationally using marine space for economic activities, national defense and security, nature conservation and environmental protection for effective socio-economic development, ecological balance, and harmony between the benefits of using the sea to serve the integrated management of natural resources and the environment, towards sustainable development of the sea. Specific planning objectives are determined based on the planning level and map scale.

MSP sets out requirements: ensuring sustainable socio-economic development while maintaining ecological balance; ensuring a reasonable and optimal space allocation for marine use activities; ecosystem-based approaching; centralizing and unifying state management following existing plannings; reducing conflicts in the use of the sea; ensuring the substantive participation of relevant parties; convenience and transparency in licensing the use of the sea; providing the rationality in organization and coordination between functional agencies and authorities at all levels; contributing to promoting international and regional integration and cooperation.

MSP is based on four criteria: 1) socio-economic development criteria; 2) measures for ensuring national defense - security, sovereignty, and interests at sea; 3) criteria for ecological balance and environmental protection; 4) for sustainable marine management. It is also based on ten proposed principles [20].

#### ***Determining the location and extent of maps established in the MSP map hierarchy***

The MSP map in Vietnam is a hierarchical system consisting of 3 layers with the level, scope, and scale determined as follows [22]:

National level MSP map, scale 1:1,000,000; tasked with functional zoning for large sea areas under national sovereignty, sovereign rights, and jurisdiction; spatial allocation for marine use in Vietnam. The delimited functional regions form the basis for establishing more detailed MSPs at the regional level.

Regional level MSP maps delineate the extent and support MSP mapping of coastal provinces in large sea areas. The regional MSP

map, scale 1:500,000; has the task of zoning functions for small seas (sub-regions) of large seas; allocation of marine space for different types of marine use according to the functions identified in the national-level MPA map. In the regional MSP map, some important small sea areas (sub-regions) need to be mapped in more detail by the MSP at a scale of 1:250,000 according to the function identified in the MSP.

The MSP map at the local level, i.e., at the provincial level, at the scale of 1:100,000, is responsible for zoning marine functions and allocating space for use to the sea areas under the province's management. The proposed

provincial MSP coverage is 6 nautical miles from the multi-year mean lowest sea level, and a specific example is considered in the case of Quang Ninh province (Figure 1). In case of necessity, a district-level MSP map of 1:25,000 to 1:50,000 scale should be established with critical and specific island districts. The proposed district-level MSP coverage is 3 nautical miles from the mean lowest sea level for many years. Regarding the right to license the use of the sea under the current regulations, the outer limit of the local MSP should not exceed 6 nautical miles, calculated from the mean lowest sea level for many years.

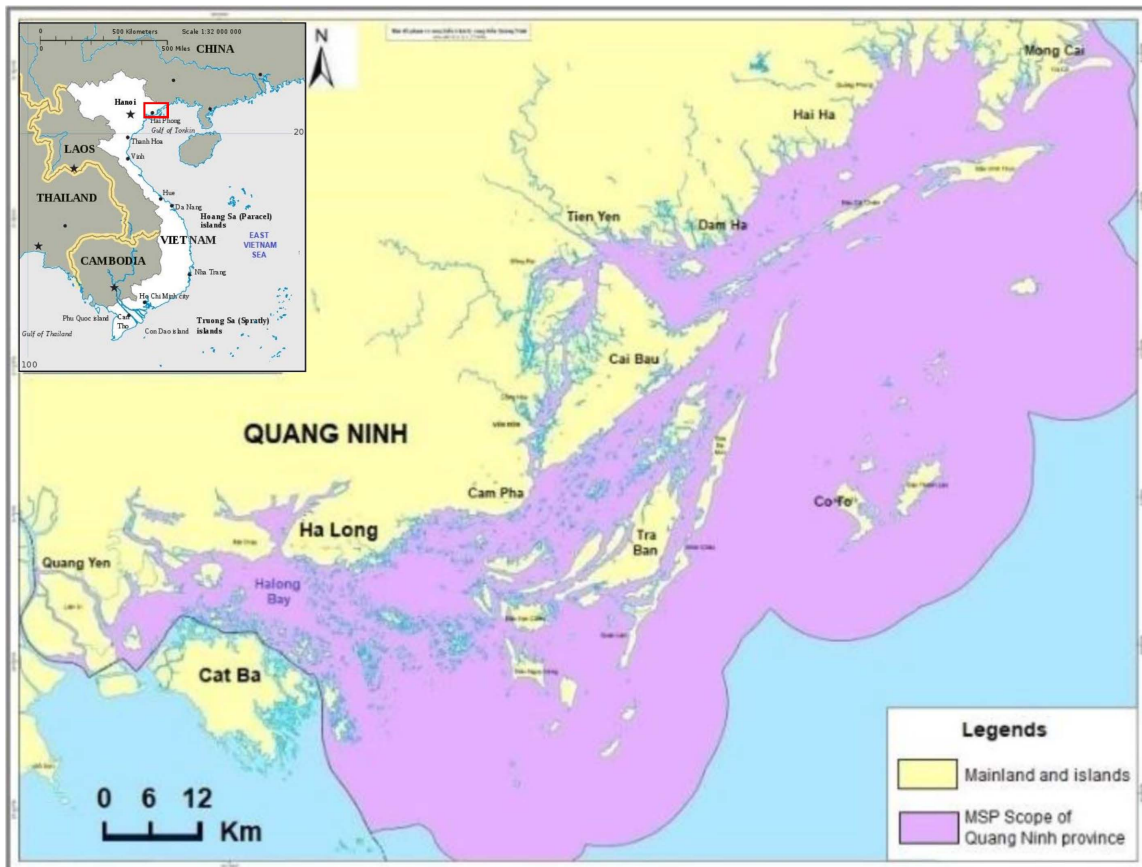


Figure 1. The marine spatial planning scope from the mean lowest sea level to 6nm for the case of Quang Ninh province [Source: Quang Ninh Provincial People's Committee]

The recommended MSP mapping time range and iteration cycle are 5–10 years at the local level, 10–15 years at the regional level, and 15–20 years at the national level. The vision of the plan is extended for another 20–30 years.

### Analyze and evaluate data and information serving MSP (Step 2)

From existing sources and results of additional investigation and research (including

the latest updated remote sensing data), conduct analysis and synthesis evaluation of data and information to serve MSP planning and mapping with the following principal contents.

***Determining the legal basis for the establishment of the MSP map***

The legal basis includes policies and resolutions of the Party, codes, and laws promulgated by the National Assembly; Decrees of the Government and decisions of the Prime Minister; circulars and decisions of relevant ministries and branches; international conventions (especially UNCLOS, 1982), and bilateral and multilateral agreements to which Vietnam participates. Strategies and plannings of sectors and localities related to the sea approved by competent authorities following the law are also essential legal basis for the MSP.

***Analysis and assessment of the current situation of the planned sea area***

The actual status of the planned sea area includes the natural condition and the socio-economic-environmental situation. The realistic situation includes topography, geomorphology, geology, climate, river hydrology, oceanography, ecosystems and natural areas, natural disasters, biotic resources, non-living resources, and resource status.

The economic-social-environmental situation includes social-human resources, organization, and management of marine and coastal space, the current status of socio-economic development, livelihood and economic activities on the islands, national defense and security and search and rescue, nature conservation activities, international and regional development cooperation, the current status and developments of the environment, environmental incident.

In serving the planning, evaluating conflicts of interest between sectors, development, and conservation, localities, communities, and groups with interests, and potential cross-border disputes is necessary. It is also required to assess the costs and benefits of economic development activities, conservation activities, protection of nature and ecosystems, and conservation and promotion of sea cultural traditions.

***Forecasts of future conditions***

The MSP should rely on forecasts of future conditions as follows. Forecasts on socio-economic development activities include the development of economic sectors, assurance of national defense and security, assurance of national rights and interests at sea, protection of nature, and marine conservation. Forecasts on natural and environmental changes include resource use and fluctuations, quality and ecological incidents, and the source and spread of pollution at sea. Forecasts on climate change and natural disasters include storms, rain, temperature, ocean acidification, sea level rise, and natural disasters such as inundation, saltwater intrusion, erosion, sedimentation, etc. It is necessary to forecast the vulnerability of ecosystems due to climate change, natural disasters, and human activities. Finally, it must forecast the international context, the legal situation at sea, marine relations and cooperation in the region, security, and transboundary environmental issues.

***Compiling thematic maps and diagrams for MSP mapping (Step 3)***

***Building base maps and digitizing data***

The base map shows basic information such as national boundaries at sea and land. The main contours of the coastline, the main contour lines show the basic topography of the seabed, such as underground hills, depressions, channels, large islands with crucial positions, and administrative centers, major administrative and coastal economic centers. The data source in step 2 (text and map) is digitized into spatial information for making maps and thematic diagrams for planning to map. All maps and charts are built on a unified base map, using GIS technology, digitized into layers of information. The base map is selected at an appropriate scale using the projection grid system and the VN-2000 National Coordinate System, collecting and building appropriate background data layers based on existing topographic and administrative maps with the latest additions and updates.

### ***Establishing thematic maps and diagrams***

The following maps (or diagrams) have been developed to prepare MSP maps.

Group of maps on natural conditions, including maps and diagrams of geology - geomorphology: topography, coastal and seabed geomorphology, marine geology, sedimentation of the bottom layer; charts and maps of the distribution of hydrographic elements: temperature, salinity, current, wave field, etc.; Map of natural zoning of the sea.

The group of resource distribution maps includes (1) biological resources (ecology and biodiversity, fishing grounds, aquatic resource management, etc.), (2) non-living resources (minerals, petroleum, and other energy, wetlands, freshwater on islands, etc.), (3) positional resources (distribution of geologic and hydrological systems such as bays, estuaries, lagoons, peninsulas, islands, channels, economic and political centers, etc.), and (4) cultural resources (physical and intangible).

Group of maps on the environment, hazards, and nature conservation: maps, diagrams of distribution of water quality factors and zoning maps of environmental quality; environmental incident models and pollution propagation (oil and chemical spills, red tides, etc.); hazard distribution maps (coastal inundation, coastal erosion, saltwater intrusion, risk of earthquakes and landslides, etc.); map of the distribution of marine protected areas and natural protected areas; vulnerability zoning maps of ecological areas due to agents and climate change.

Group of maps on the current state of socio-economic development (by fields and in general): economic corridors and belts, key economic regions; delimited maritime boundary areas, overlapping and common exploitation areas, and undefined areas conventionally defined under the United Nations Convention on the Law of the Sea (UNCLOS 1982).

Depending on the location, scope, and scale of MSP mapping, some maps or charts may be inappropriate or unnecessary and need to be omitted to fit the actual situation.

### **Drawing up the marine spatial planning map (Step 4)**

The MSP map set consists of 4 types, organized in a tower model. First, draw up navigational maps using marine space for primary areas; next, draw a map of marine functional zoning and a map of marine space use zoning; finally, MSP mapping is made based on overlapping functional and marine space use zoning maps.

### ***Establishing directional maps for the use of marine space for primary areas***

These maps are built based on the analysis, evaluation, and synthesis of documents and data in steps 1, 2, and 3. Eight types of maps orient the use of marine space according to the primary fields, of which there are six categories for economic development; the remaining two types are for the areas of security and defense, nature conservation, and environmental protection:

Map of orientation to use marine space to develop marine tourism and service areas.

Orientation map to use marine space for port and maritime development.

Orientation map to use marine space for oil, gas, and mineral exploitation.

Orientation map to use marine space for fishing and aquaculture.

Orientation map to use marine space for the coastal economic, urban, and industrial zones.

Orientation map to use marine space to develop renewable energy and new economic sectors.

Orientation map to use marine space to ensure national defense, security, rights, and interests at sea.

Orientation map to use space for nature conservation and environmental protection.

The marine spatial use orientation maps include two main components: the spatial distribution information layers that orient the development of the mentioned field and the background information layers. GIS technology is employed to build and manage marine spatial orientation maps for essential areas.



**Making a map of marine functional zoning**

Functional zoning in the MSP ecosystem-based approach is based on the integrated analysis and assessment of natural conditions, resources, environmental status, the integrity of ecosystems, and status and desire for socio-economic development in the sea. Each functional partition represents two primary functions: the function of using the sea and the function of managing it.

**Determination by the functions used**

For the national MSP and large sea areas, the functional zoning map is on a small scale, from 1:500,000 - 1:1,000,000; the use function is determined based on the priority structure of marine use according to 3 main groups: economy, security-defense, and conservation. In exceptional cases, operations may include climate change responses. A planned sea area may have several or more functional zones, each of which has its operational structure, one of

which has economic - security - defense - conservation functions, and the other is conservation - defense - security - economy, etc. For the MSP of small and local seas, the medium and large-scale functional zoning maps, from 1:250,000 or less, the practical use is determined based on the priority structure in 3 groups: survival, transition, and development (socio-economic). In particular cases, the function should also include climate change responses.

**Definition by management functions**

After zoning the use function, determine the permitted level of marine activities in those functional zones. On all available zoning units, four groups of levels of permission for sea use activities are identified (Table 1): priority activities (encouragement and endowment); permitted activity (without any conditions); restricted activity (allowed only under certain conditions), and prohibited activity (absolutely prohibited).

Table 1. Permission levels to use the sea at functional zoning units

Permissible level	Characteristics of activities using the sea
Priority	The activities are very suitable for functional units and at the same time bring high efficiency in terms of economy, society, or nature conservation, or meet urgent requirements on people’s livelihood, security, and environment.
Permitted	The activities are suitable for functional units, bring clear socio-economic benefits, do not cause adverse environmental impacts, and do not cause degradation of ecosystems.
Restricted	Sea-use activities are restricted to certain sea areas or for a certain period; activities that are not recommended are only licensed when strictly complying with the prescribed conditions.
Prohibited	Activities are prohibited because they may cause harm to the environment, ecosystem, public health or national defense, or security or fail to ensure the safety and effectiveness of the activity itself.

Next, build an annotation and symbology system, draw, and digitize information layers according to the annotation system in the form of GIS information layers and overlay the information layers on the base map. Finally, technical editing and editing of the legend system, if necessary, are needed. The list and information on the four activity groups of sea use levels, including priority, permitted, restricted, and prohibited, can be tabulated in the corner of the map. But it is often quite long, so a full description is in the supplementary

accompanying the map. After the MSP use zoning map is finally established, the extent of functional units on the marine operational zoning map can be adjusted accordingly.

**Mapping out zoning use of marine space**

This map objectively represents the natural potential with long-term usage trends and partly represents the social desire for marine use. The map is synthesized from marine spatial use orientation maps for basic areas, showing the

spatial distribution for 9 essential marine space use units as follows: 1) tourism and marine services, 2) port and maritime, 3) exploiting oil, gas, and minerals, 4) fishing and aquaculture, 5) coastal economic, urban, and industry, 6) renewable energy and new economic sectors, 7) natural conservation and protection, 8) special use (defense, security, sovereignty, dumping, etc.), and 9) reserved use.

The national marine spatial use zoning map has 9 partitions of use. Depending on specific circumstances, regional and local level maps may not cover all 9 percentiles but lack one or a few units. However, depending on the spatial scale and the allowed map scale, each marine use percentile can be detailed into several smaller-level divisions.

The system of legends and symbols is built according to the percentiles using the map's marine space and geographic background elements. Depending on the scale of the planning and the allowed map scale, the legends are presented in 4 geometric forms: area (in scale), line (scale and non-scale), point (non-scale), and icon (non-proportional). Geometries are again distinguished by color symbols, dashes, or a combination of both, to represent divisions of use in more detail.

The next step is to digitize the GIS information layers according to the map's annotation and symbology system. The sea is partitioned using three-dimensional space: two-dimensional in the area and vertical (according to the stratified structure: bottom, the bottom surface, water mass, and sea surface). Thus, two or more sea-use information layers can exist in the same marine space. Overlapping layers of helpful information on a map can lead to overlapping and spatial interference between them, creating complex contours and colors on the map. Therefore, the identification and selection of symbols for the legend must be meticulous.

#### ***Drawing up the marine spatial planning map***

The MSP map represents the society's desire to use the sea based on its natural potential, is timed, can be significantly adjusted, and supplemented after each planning

period. It is based on synthesizing zoning maps using marine space and marine functional zoning maps.

The MSP map annotation and symbology system is built based on merging the legends and symbols of the map of functional zoning and zoning using marine space. The legends and symbols are divided into three groups: a group of marine functional zoning units, marine use units, and other characters (geographic background). During the consolidation process, the symbols retain their geometry but can be modified in color or line to make them easier to distinguish and identify on the planning map.

The next step is to merge and overlap the information layers of the marine spatial use zoning map with the information layers of the functional zoning map to have a system of information layers of the MSP map. Conduct analysis and review of the spatial distribution for marine use units again to adjust the information classes of marine space use units following the functional and social wants (prioritizing users, balancing interests, minimizing conflicts, etc.). Finally, edit the necessary information to complete the marine MSP map.

#### **Developing a description for the marine spatial planning map (Step 5)**

The explanation is presented briefly and coherently to state the purpose, requirements, scale, scope clearly, and scale of the established MSP map; legal basis and data source, mapping information; mapping methods and steps; intermediate products for MSP mapping.

An introduction to the content and description of the MSP map: map structure, introductory content, annotation and symbology, conventions, etc.; describe the priority, permitted, conditionally permitted, and unauthorized marine uses in the functional zones; calculate the area of functional subdivisions, size of marine use units/units and percentages.

Finally, an assessment commentary of the map was established in terms of content, presentation, objectivity, reliability and limitations, novelty and inheritance, scope, and usability.

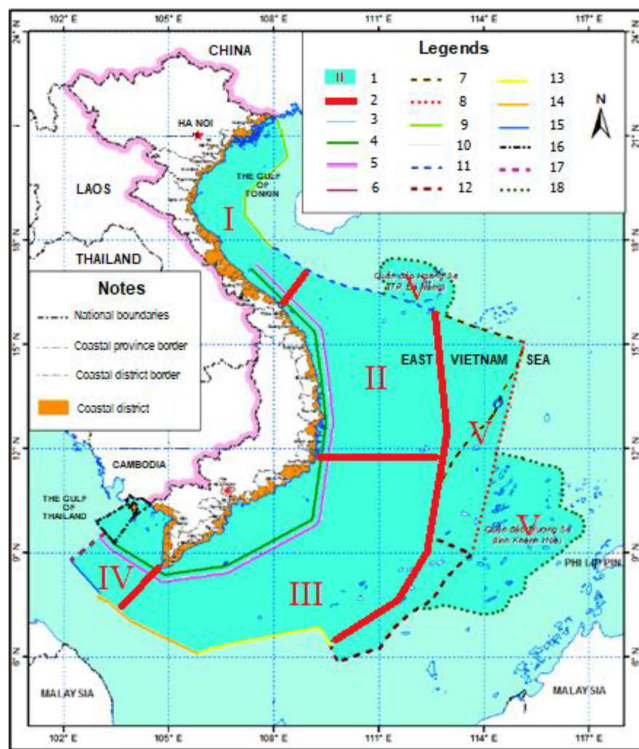
## SPACE PLANNING MAP OF MONG CAI - DO SON

### Location of MSP map of Mong Cai - Do Son region in the marine spatial planning map system in Vietnam

The MSP map of the Mong Cai - Do Son area at a 1:250,000 scale introduced below is the result of applying the MSP mapping process carried out in the state-level project code KC.09.16/16–20: “Study and develop a spatial plan for the Gulf of Tonkin” carried out in the years 2018–2020. The scope and

scale of the MSP map of the Mong Cai - Do Son Sea area is determined to be within the Vietnamese marine spatial planning hierarchy.

Based on current conditions, future forecasts, and existing development plans and strategies, Vietnam’s seas are functionally partitioned into five large seas, of which zones I, II, III, and IV belong to national exclusive economic zone. These basis functional areas are the foundation to support the establishment of national MSP maps at a scale of 1:1,000,000 and more detailed MSP maps at regional and local levels (Figure 2).



### Legends

1. Area of MSP; 2. National MSP area boundaries; 3. Coastline; 4. Baseline;
5. Territorial sea line of 12 nm from the baselines; 6. Continental shelf boundary of 200 nm from the baselines of Vietnam’;
7. Continental shelf boundary exceeds 200 nm, Vietnam requests UN; 8. Extended continental shelf boundary (expected to be submitted to UN); 9. Boundary dividing the Gulf of Tonkin between Vietnam and China;
10. Straight line closing the Gulf of Tonkin; 11. Assumed median line between Vietnam and China; 12. The continental shelf boundary exceeds 200 nm in common between Vietnam and Malaysia at the request of the UN;
13. Continental shelf boundary between Vietnam and Indonesia; 14. The overlapping boundary between Vietnam-Malaysia-Thailand;
15. Sea boundary between Vietnam and Thailand; 16. Boundary of historical waters between Vietnam and Cambodia; 17. Boundaries are not defined; 18. Boundaries of research in Vietnam’s marine area and adjacent areas.

Figure 2. Sketch map of Vietnam’s marine functional regions

Region I (natural waters of the Gulf of Tonkin), with a coastline extending from Mong Cai to Hai Van cape, has the following functions: economy - conservation - national defense, and security.

Region II (Central Vietnam Sea), with the coast extending from Da Nang to Khanh Hoa, has the following functions: economy - national defense - security - conservation.

Region III (Southeast Sea), with a coastline extending from Ninh Thuan to Ca Mau, has the following functions: economy - conservation - national defense, and security.

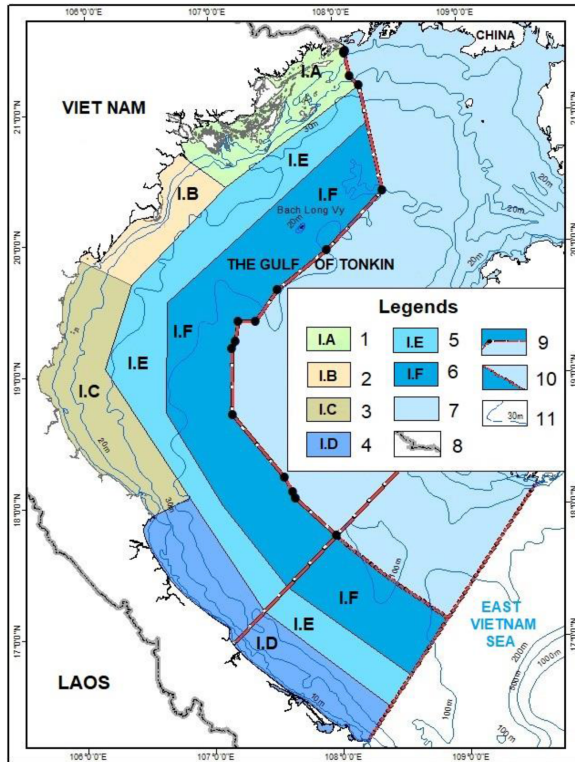
Region IV (the Gulf of Thailand or the Southwest Sea), with the coastline extending from Ca Mau to Kien Giang, has the following functions: conservation - economy - national defense, and security.

Region V (far offshore waters and Hoang Sa and Truong Sa islands) has the following functions: national defense, security - conservation - economy.

The natural Gulf of Tonkin (region I) is one of five functional zones of the Vietnamese sea, with coastal boundaries from Mong Cai to Hai

Van cape divided into six operational zones (Figure 3).

Zone I.A (the coastal waters of Mong Cai - Do Son), with a coastline stretching about 180 km, the seabed reaching a depth of about 30 m, has the following functions: conservation - development - national defense, and security.



### Legends

1. Region I.A: Conservation - Development - Defense and Security;
2. Region I.B: Development - Conservation- Climate change response;
3. Region I.C: Development - Defense and Security - Conservation;
4. Region I.D: Development - Conservation - Defense and Security;
5. Region I.E: Development - Defense and Security - Protection of fishing grounds;
6. Region I.F: Defense and Security - Development - Transboundary environmental protection;
7. The Sea of China;
8. Country boundaries on land;
9. The Vietnam - China border in the Gulf of Tonkin and demarcation points;
10. The proposed boundary line between Vietnam and China at the entrance of the Gulf of Tonkin;
11. Depth contour line.

Figure 3. Sketch map of Functional marine zones of the Gulf of Tonkin (part of Vietnam)

Zone I.B (the coastal waters of Do Son - Lach Truong) with a coastline of about 150 km, the seabed reaching a depth of about 30 m, has the following functions: development - conservation - climate change response.

Zone I.C (the coastal waters of Lach Truong - Mui Roon) with a coastline stretching about 313 km, the seabed reaching a depth of about 30–40 m, has the following functions: development - defense security - conservation.

Zone I.D (the coastal waters of Cape Roon - Cape Hai Van) with a coastline of about 311 km, the seabed reaching a depth of about 40–50 m, has the following functions: development - conservation - defense, and security.

Zone I.E (transitional sea) runs along the bay, with an outer boundary reaching a depth of about 40–90 m, with the following functions: development - defense security - protection of fishing grounds.

Zone I.F (far from the coast) is located between zone I.E and the demarcation line between Vietnam and China at sea and has the following functions: National defense, security, development, and cross-border environmental protection.

These primary functional areas are the foundation to support the establishment of MSP maps of the Gulf of Tonkin at a scale of 1:1,500,000 and more detailed plans for small seas (sub-regions) at a scale of

1:250,000, and coastal provinces have a scale of 1:100,000.

**Contents of the Mong Cai - Do Son MSP map**

**Map of functional zoning of Mong Cai - Do Son Sea space**

Mong Cai - Do Son (I.A) marine zone is one of the six functional zones of the Gulf of Tonkin. The 1:250,000 scale functional zoning map has a zoned area of 899,118 hectares. This sea area is divided into three functional areas: conservation area I.A.1. (14.93%), I.A.2 transition area. (26.15%), and I.A.3 development area (58.92%). The map is based on three layers of GIS information: conservation area, transition area, and development area, in addition to some background geographic information layers.

Regarding management, the I.A.1 area aims to protect heritage values, biodiversity, ecosystems, and natural landscapes; I.A.2 is for

development in harmony with protection, restoration, rational use of heritage, ecological, and natural landscape values; the I.A.3 area is to promote sustainable socio-economic development and environmental protection.

About scope and boundaries: conservation area (I.A.1) is the geographical scope of the world natural heritage Ha Long bay, World Biosphere Reserve of Cat Ba islands, Cat Ba National Park, Bai Tu Long National Park, Co To Marine Protected Area - Tran island, Dong Rui Wetland Protected Area, mangrove strip and wetlands of Tien Yen bay - Ha Coi and Ka Long estuary. The development area (I.A.1) is the land and water near the coast (including islands) and the outer area from a depth of 15 m. The transition area (I.A.2) is a strip extending from the outside of the Ka Long estuary to the outside of the Van Uc estuary, and it covers many large islands in Bai Tu Long and Ha Long bays.

Table 2. The permissible level of marine use activities in the functional waters of Mong Cai - Do Son

Functional areas	Priority activities	Permitted activities	Restricted activities	Prohibited activities
Conservation (I.A.1)	Manage and protect biodiversity, ecosystems, and natural landscapes	Scientific inspection and investigation	Travel along defined routes; construction of facilities in conservation service; habitat restoration	Housing works, aquaculture, and resource exploitation are all activities that impact the environment
Transition (I.A.2)	- Protect and restore ecosystems, protection of breeding grounds and spawning grounds. - Ecotourism associated with nature conservation and, environmental protection; ecological farming of native species.	Building infrastructure for nature conservation and protection; scientific investigation and research; prevention of coastal erosion and other natural disasters; and recreational fishing.	Infrastructure, wharf channels; the area for transshipment and anchorage to avoid storms; farming does not cause pollution, exploiting aquatic products according to the time limit, and diving.	Wasting and dumping; hunting and exploiting forests on the island; hunting rare and precious species in the sea; mining; water traffic causes turbidity and noise and creates pollutants
Development (I.A.3)	- Ecotourism and culture. - Services, seaports, fishing ports, and anchorages. - Linking security and defense with nature conservation and cultural relics.	- Economic, industrial, and urban zones; aquaculture. - Environmental protection activities; disaster prevention and control.	Catching, general waste dumping, mining; The project dramatically changes the natural landscape and hydrodynamic structure.	Fishing vessels of 12 m or more in length; areas where fishing is prohibited; destructive fishing; exploitation of rare and precious species; dumping hazardous waste; pollution facilities.

In each functional area, marine use activities are identified in 4 groups: priority, permitted, restricted, and not allowed (Table 2).

### ***Map of zoning the sea space of Mong Cai - Do Son***

This map includes 39 GIS information layers belonging to 7 spatial use groups and one geographic background group, shown on the attached annotation system. Information layers are represented by area, line, point, symbol, and the sign of space extents.

The group of tourism and marine services includes four layers of information: service and tourism sectors (areas), ecotourism areas (regions), beaches (spots), and tourist ports (icons).

The group of ports and navigation includes five layers of information: general ports of types of IA and I (area), general ports of class II (symbol), specialized ports (mark), coal ports (icon), and shipping channels (line).

The group of petroleum and mineral exploitation includes seven layers of information: oil and gas exploration sector (area), coal mine area (area), coal mine (point), brown coal mine (point), Zircon mine (point), glass sand mines (points) and construction sand mines (points).

Fishing and aquaculture include five layers of information: fishing areas (area), aquaculture ponds (area), cage aquaculture (area), places where fishing is prohibited for a limited time (area), fishing port, and ship anchorage (icon).

The group of coastal economic and industrial zones includes four layers of information: coastal economic zones (area), coastal industrial zones (area), centrally affiliated coastal cities (points), and coastal urban centers directly under the central government or province (point).

The group of nature conservation and protection includes five layers of information: world natural heritage (area), world biosphere reserve (area), national park (area), marine protected area (area), and wetland protected area (area).

The special-use group consists of three layers of information: priority areas for defense

activities (area), border ship management areas (area), and dredging areas (area).

The group of background geographies includes six layers of information: airport (point), isobath (line), national boundary on land (line), provincial boundary (line), district/town boundary (line), mainland and floating island (area).

### ***Map of marine spatial planning of Mong Cai - Do Son area***

The marine spatial planning map of Mong Cai - Do Son at the scale of 1:250,000 (Fig. 4) is the superposition and synthesis of two zoning maps using marine space and a map of marine functional zones of the same scale.

The map shows three functional areas: conservation, transition, and development. The whole planning area has an area of 99,118 ha, of which the functional conservation area (I.A.1) has an area of 134,261 ha (14.93%); the transitional conservation functional area (I.A.2) 235,122 ha (26.15%); and the operational development area (I.A.3) 529,735 ha (58.92%). Each zone has essential functions and different management characteristics and is accompanied by activities using the sea with varying levels of permission: priority, permitted, restricted, and prohibited.

The map shows the specific distribution of marine space for marine use activities belonging to 7 marine space use units, including tourism and marine services, port and maritime, petroleum and mineral exploitation, fishing and aquaculture, coastal economic and industrial zones, conservation and protection of nature, and particular use.

The map comprises 48 layers of GIS information and the accompanying system of annotations and symbols (Fig. 3). The group of marine functional partitions includes three layers of information. The sea-use activities include 39 information layers, including 4-layer tourism and marine services, 5-layer port and maritime activities, 7-layer petroleum and mineral exploitation activities, five layers of fishing and aquaculture activities, four layers of coastal economic and industrial zones, five layers of nature conservation and protection, and three layers of special use. The background geography group consists of 6 layers of information.



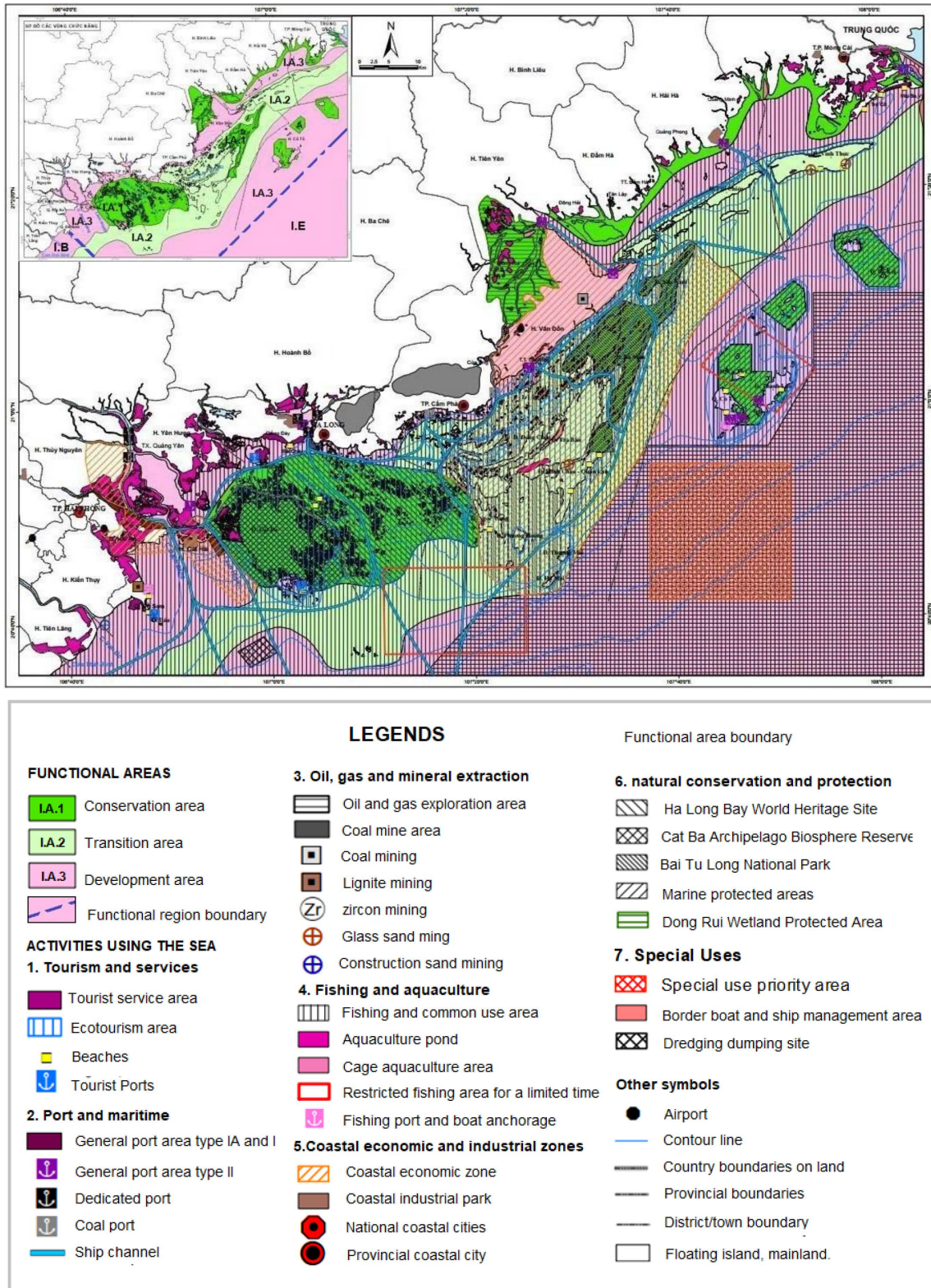


Figure 4. Marine spatial planning map of Mong Cai - Do Son area (reduced from 1:250,000 scale)

The planned area is only 899,118 ha, but the total size of planned use units is up to 1836,088 ha, an increase of more than two times (Table 3) as a result of three-dimensional spatial planning, as the same extensive sea area is planned for two or three different uses.

Table 3. Allocation of space use area of Mong Cai - Do Son waters

No.	Space use activities	Area (ha)	Ratio (%)
1	Tourism and marine services	301,401	33.52
2	Ports and navigation (only IA and I type)	1,688	0.09
3	Exploration, oil-gas, and mineral exploitation	421,193	46.84
4	Catching and marine cultivation	685,179	76.20
5	Economic and coastal industrial zones	241,600	26.87
6	Nature conservation and protection	120,547	13.40
7	Special use	64,480	7.17
Total planned area of use units		1,836,088	204.09

The most prominent use area is fishing and aquaculture activities of 685,179 ha (76.2%); however, 657,471 ha is used in common with other activities (exploration and extraction of oil and gas, minerals, etc.). Next is the area of oil, gas, and mineral exploration activities of 421,193 ha (46.84%), but most of it is used in conjunction with other activities. Notably, the area of nature conservation and protection is 120,547 ha (13.4%), which is a very high rate compared to other sea areas of Vietnam.

## CONCLUSION

Based on the actual situation of Vietnam's sea, the feasibility and effectiveness of implementation, the MSP and the accompanying planning map in Vietnam should have the same decentralization as many countries have. An MSP map will have the size, and scale corresponding to the level and location of the MSP identified in the nationwide MSP map fragmentation system. MSP in Vietnam is classified into 3 levels: national MSP map with scale 1:1,000,000, regional MSP map, scale 1:500,000 together with MSP map of sub-regions at 1:250,000 scale, MSP maps at the local - provincial level at the scale of 1:100,000 and in case of necessity, establish a district-level MSP map at the scale of 1:25,000-1:50,000.

The MSP map is drawn based on GIS digitization with GIS information layers and an accompanying annotation and symbols system.

It was established based on overlapping the marine functional zoning map and the marine space use zoning. The applicable zoning map includes available units using the sea, expressing more than a social desire that can change with planning cycles. The marine spatial use zoning map has specific sea use divisions, represents more natural potential, and is more stable over time.

A 5-step sequence guides the process of creating a marine spatial planning (MSP) map: 1) Determination of properties, requirements, scope, and methods; 2) Analyze and evaluate data and information; 3) Make and draw thematic maps and diagrams; 4) MSP mapping; 5) Make a description of the MSP map.

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