



# Sea use management using a hybrid operational model: Taiwan's experience

Tzay-An Shiau\*

Department of Harbor and River Engineering, National Taiwan Ocean University, 2 Pei-Nein Road, Keelung 20224, Taiwan

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## ABSTRACT

This study proposes a hybrid operational model to manage marine activities. This approach combines cost-benefit analysis (CBA), the analytic hierarchy process (AHP), and the Dempster–Shafer theory (DST), and retains the advantages of CBA as well as facilitating the incorporation of incomplete information into the evaluation process. A particular advantage of this hybrid approach is that it can synthesize evaluation results into an easily understood unit: namely, utility. Conflicts between marine resource users (user–user conflicts) and between users and marine environment (user–environment conflicts) can easily be evaluated using this hybrid operational model. A sea use management system is proposed, which incorporates a permitting process and elements of marine spatial planning (MSP). In the proposed system, marine activities are grouped into three clusters based on their potential environmental impacts and exclusive use, then assigned to competent authorities, a panel of experts or government agencies for review and permit approval. This study suggests that the central and local governments share responsibility for approving permits for marine activities. More importantly, it suggests that the integration of marine activities needs to be handled by the central government. A numerical example is used to illustrate the application of the hybrid operational model.

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## 1. Introduction

Marine spatial planning (MSP) is recognized as a management tool to resolve conflicts between marine resource users, and to improve the sustainable development of the marine environment [1,2]. The importance of MSP has been described, including why MSP is an essential step to achieve ecosystem-based sea use management, how it can be defined, and what its core objectives are [1]. The Clyde marine spatial planning pilot project was undertaken to evaluate the European Commission's guiding principles for MSP [3]. In Belgium's case it was concluded that a legal basis for MSP, in addition to a permitting process, would provide a more strategic and integrated framework for ecosystem-based sea use management [4].

The expansion of marine activities in terms of intensity and diversity is a developing trend in Taiwan. Developing marine renewable energy in particular has become an important energy policy in recent years. MSP has also become an important issue in Taiwanese society. Three important draft laws, the Draft National Territory Planning Act, the Draft Coastal Act, and the Draft Wetlands Act are now under review in the Legislative Yuan, and there are plans to formally organize the Ocean Committee under the Executive Yuan in the near future. An overall scope and

framework for an MSP are still under construction. Since 2010, Taiwan's territorial waters have been included in the scope of its regional planning. Constructing a management system for the country's territorial waters has become a crucial and urgent task for the Ministry of the Interior (MOI). Applying land use zoning and land use designation to sea use planning is relatively difficult because of the dynamic and three-dimensional characteristics that exist in the marine environment. The development of a detailed geographic information system (GIS) for Taiwan's marine space is still in progress, and the MOI lacks sufficient information to manage the marine area by MSP alone. A combination of a permitting process and elements of MSP are necessary for establishing a management system for the marine area.

This study proposes a hybrid operational model to resolve user–environment and user–user conflicts in sea use management. The proposed management system is based on a traditional project-by-project and permit-by-permit framework, and elements of MSP have been integrated to ensure the quality and improve the sustainability of the marine environment. The 40 marine activities generated by panel discussion are grouped into three clusters, and three types of permits are proposed to reflect the management of the three clusters of marine activities. In the case where conflicts between different marine activities exist, a hybrid operational model consisting of cost-benefit analysis (CBA), the analytic hierarchy process (AHP) and the Dempster–Shafer theory (DST) is applied to evaluate sea use priorities. A numerical example is used to illustrate the

\* Tel.: +886 2 28051649; fax: +886 2 28051647.

E-mail addresses: [sta@mail.ntou.edu.tw](mailto:sta@mail.ntou.edu.tw), [snowfrank66@yahoo.com.tw](mailto:snowfrank66@yahoo.com.tw)

application of the hybrid operational model. Finally, a conclusion is presented.

## 2. Proposed sea use management system

A list of 40 marine activities was generated by panel discussion between researchers in related fields and government officials involved in sea use management. These 40 marine activities were grouped into three clusters based on the criteria of environmental impacts and exclusive use. The grouping principles and the proposed permitting procedure are described as follows:

### 2.1. Cluster 1

The marine activities that could potentially have significant environmental impacts were grouped into Cluster 1. Emergency-related national defense, disaster prevention and evacuation activities were excluded from this group. In the proposed management system, permits for development plans for marine activities in this group would be approved by an industry competent authority, a sea use competent authority, and a committee which is comprised of experts from related fields.

The central and local governments would share the responsibility for approving permits for the marine activities in Cluster 1. The central government would be responsible for approving permits for (a) marine activities with a sea use scale of more than 100 hectares and involving a marine structure higher than sea level and (b) marine activities with a sea use scale of more than 500 hectares and involving no marine structure higher than sea level. Other marine activities would be approved by the local government.

### 2.2. Cluster 2

Marine activities concerning national defense, disaster prevention and evacuation that could potentially have significant environmental impacts, but are not emergency-related were grouped into Cluster 2. For example, military maneuvers in the marine space were grouped

in Cluster 2. Activities that had partially exclusive use rights and could potentially have medium-level environmental impacts were also grouped in Cluster 2. For example, marine tourism was grouped in Cluster 2 based on this principle. In the proposed management system, permits for development plans for activities of this type would be approved by an industry competent authority and a sea use competent authority.

### 2.3. Cluster 3

Activities that are not exclusive in use and could potentially have medium-level or lower environmental impacts were grouped into Cluster 3. For example, marine fishing was grouped in Cluster 3. Marine activities that served to protect the marine area were also grouped into Cluster 3. Emergency-related national defense, disaster prevention and evacuation activities were grouped into Cluster 3 as well. In the proposed management system, permits for development plans for Cluster 3 activities would be approved by an industry competent authority.

Marine activities that are not prohibited by related laws or regulations – walking along the beach, for example – would not require permits.

Considering the necessity of integration, in situations where: (a) conflicts existed between different marine space users or (b) the scope of the use covered different counties' administrative jurisdiction, the marine activities were grouped into Cluster 1 regardless of whether or not they could be classified as Cluster 1, Cluster 2 or Cluster 3 activities. In the proposed system, the central government would be responsible for approving permits for these types of Cluster 1 activities.

Land-based zoning identifies environmentally sensitive areas (ESAs) and regulates development in or near such areas. MSP works in the same way to protect the marine environment and to integrate sea uses. The environmental impact of proposed marine activities needs to be assessed during the review and permitting process. Twenty-four types of environmentally sensitive areas are listed in Table 1.

**Table 1**  
Designated environmentally sensitivity areas (ESAs) in Taiwan.

Types	Environmentally sensitivity areas (ESAs)
1	Natural landscape areas as designated by the Cultural Heritage Conservation Law.
2	Wildlife protection areas or important wildlife habitats as designated by the Wildlife Conservation Law.
3	Areas where building is prohibited as designated by the Meteorological law.
4	Mining areas or mining reservation areas as designated by the Mining Law.
5	Designated scenic areas as designated by the Statute for the Development of Tourism.
6	Areas within a 5 km buffer of a national park boundary as designated by the Construction and Planning Agency, Ministry of the Interior.
7	Areas within a 5 km buffer of a conservation area, protection area, or reservation area boundary as designated by the Council of Agriculture, Executive Yuan.
8	Areas within a 3 km buffer of a national historic site, important archaeological site, or cultural landscape as designated by the Council for Cultural Affairs, Executive Yuan.
9	Areas within 3 km of marine discharge pipes; or within 1 km of undersea cable, undersea oil pipeline, undersea tunnel, or water transportation pipe as designated by related companies or local governments.
10	Areas within 3 km of an artificial fishing reef as designated by the Council of Agriculture, Executive Yuan.
11	Areas within a sand and gravel excavation area as designated by the Sand and Gravel Excavation Act.
12	Areas where building is prohibited or where building height is regulated as designated by the Civil Aeronautics Administration, Ministry of Transportation and Communications.
13	Prohibited areas as designated by the Nuclear Reactor Facilities Regulation Act.
14	Hot spring outcrop areas as designated by the Hot Spring Law.
15	Prohibited navigation zones as designated by the Ministry of National Defense.
16	Seawall areas as designated by the Water Act.
17	Coastal nature conservation areas as designated by the Construction and Planning Agency, Ministry of the Interior.
18	Coastal regulation areas and important military facility regulation areas as designated by the National Security law.
19	Areas within 3 km of a beach as designated by local governments.
20	Areas within 3 km of a lagoon or wetland as designated by local governments.
21	Areas within 3 km of a severe land subsidence area as designated by the Water Resources Agency, Ministry of Economic Affairs.
22	Estuary areas of river or regional drainage as designated by the Water Resources Agency, Ministry of Economic Affairs.
23	Commercial port areas as designated by the Commercial Port Law.
24	Fishing port areas as designated by the Fishing Port Act.

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