Towards a Collaborative Strategy for Land and Marine Geospatial Data Integration: A Review

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Abstract. Malaysia is among the countries in Southeast Asia surrounded by sea, apart from Thailand, Singapore, Brunei, Indonesia, Philippines and a few others, with about 515,000 kilometres squared land at sea level skirting Malaysia along 4,809 km of coastlines. Improving the management of coastal areas is important to improve the sustainability of the areas, and one way to achieve this is through collaborative management by integrating land and marine spatial data. This paper highlights the importance of bringing in the concept of collaboration between agencies and addresses issues related to the realization of integration of dataset sharing between land and marine. The concept of collaboration, past studies related to development of collaboration strategies, issues and problems in collaboration, as well as success factors in the collaboration process are discussed in this paper to demonstrate the importance of building a collaborative strategy model to enable the integration of geospatial datasets between land and marine.

1. Introduction
The coastal area is a meeting between land and sea [1,2]. All countries located in Southeast Asia are surrounded by sea except Laos. The coastal area is a very crucial spot because it hosts a diversity of human activities such as fisheries, industrialization, exploration of natural resources, tourism and recreation, as well as transportation [3,4]. Figure 1 shows Malaysia’s coastline, which includes Peninsular Malaysia, Sabah and Sarawak, where the total distance of the coastline is 4,809 km.
Figure 1. Malaysia’s Coastline [5]

The surface of the coast is studied from two aspects. The first is the physical aspect and the second is the legal and institutional aspect [2]. The physical aspect of the coastal surface is very complex as it is constantly, dynamically fluctuating over a short period of time [6]. The process of change is due to natural effects such as tidal events, weather changes, as well as climate change [6]. The legislative or institutional aspect is also an important aspect of the coastal surface [2,4]. Coastal areas are managed by various agencies and departments [2]. Thus, it is inevitable that there will be an overlap between different agencies of the area [1] that can generate redundancy in the administrative process. Enforcement activities in the area also becomes difficult due to the lack of administrative area [3,7]. Moreover, there are many costs wasted due to repetition of work. This will further reduce the sustainability of the coastal areas. Therefore, coastal surfaces should be managed more effectively so that sustainable development can be achieved in the future in terms of environmental, social and economic stability in the country [8].

The objective of this paper is to review coastal zone management and some relevant issues. It discusses the concept of integrated spatial data sharing and the concept of collaboration in developing an integrated spatial data sharing between land and marine interface. This paper also highlights motivations, barriers and factors of a successful collaboration between agencies.

2. Coastal Zone Management in Malaysia
The coastal area is an important area to focus on when advancing the growth and development of a country. All states in Malaysia are surrounded by sea. For Peninsular Malaysia, the surface area of the coastal area is 131,590 km squared, with a total distance of 2,031 km [5], while for Sabah and Sarawak, the surface area is 198,160 km squared and has 2,778 km of total distance. This gives a total area of 329,750 km squared and a total distance of 4,809 km [5].

Malaysian governance comprises the federal government as well as the state governments [9]. The central administrative affairs are under the parliament while the states are under the respective state halls. Likewise, the coastal areas are governed inter-agency, the overlap occurring between agencies involved in land and marine at the governmental level and at state level [2]. The state government has jurisdiction over the coast area for the distance that extends from low-water mark up to 3 nautical miles [3], while the federal government’s jurisdiction starts from the 3 nautical miles of the state’s governance to the exclusive economic zone (EEZ) and the Continental Shelf [3,10].

To manage the coastal areas, there are three (3) basic issues that are of concern to policy makers, researchers, as well as involved agencies. The most important and critical issue is the natural feature of the coastal surface. As previously mentioned, the ever-changing physical characteristics of the coastal
areas result in the difficulty of determining the coastline more clearly [2]. This lack of clarity on the definition of coastal surfaces complicates the enforcement process on the coastal surface areas. Enforcement is very important to monitor marine-related activities such as fisheries, industrialization, marine crimes and marine safety [3]. That is why technical issues must be resolved in dealing with coastal administration issues and problems. In this case, the use of data is very important.

There are significant differences in the reference system of existing data, between the horizontal and vertical types of system. In addition, existing data is not based on a spatially enabled concept in which the data can provide location information to facilitate and assess the problem more clearly. Existing data also does not include the dynamics of coastal and fishery population, and biological data [4].

The next issue, those of the institutional and legal type, is very crucial because it involves organizations and agencies. The overlap between different governance levels such as the federal government, state governments and local governments [9] makes it difficult to come up with a decision to achieve an objective. Similarly, collaboration and lack of collaboration also become one of the factors of inefficiency in the institution [2,11]. The legislation for the management and administration of existing coastal areas does not complement each other, especially when it involves two interfaces between the ground and marine surfaces [12,13]. Hence, it affects monitoring activities on coastal areas, regulation and enforcement on national security affairs, as well as the construction of policies for national development [14,15]. Therefore, the integration of data sharing would address the abovementioned issues on management and administration of coastal areas. The data becomes more meaningful and complete with spatially enabled data. Spatially enabled data should be shared between land- and marine-related agencies and would become an asset that is very important for any agency as well as policy makers [3,4,16].

3. Need for an Integrated Spatial Data Sharing
To achieve spatially enabled governance, the assemblage of spatial data should move towards an integrated partnership especially for land and marine agencies [17–19]. Nearly 80% of the existing data is based on spatially enabled data [20–23]. The various data are obtained in various ways and they evolve in accordance with the technological developments. For example, remote sensing satellites provide image data [24–26], UAVs supply RGB image-like data [27,28], GNSS satellites provide data positioning [29–32], and so on. Therefore, the data obtained by each agency should be shared between each other. This is how the concept of sharing information is spatial, or known as spatial data sharing.

3.1. Spatial Data Sharing Concept
The concept of spatial data sharing constitutes a framework that includes data, policies, standards, technology and people as pillars in the exchange of data [33,34]. Spatial data infrastructure (SDI) was created to facilitate administrative affairs by reducing the efforts in the process of obtaining high-cost spatial data [3,9,17]. With SDI, the data can be coordinated with each other in terms of quality and accuracy. Additionally, the infrastructure can reduce duplication of agency resources such as human resources, finance and effort [6,35,36]. Indirectly, the partnership process can create collaboration which helps in achieving the objectives of the agencies involved [17,37].

In the management and administration of coastal areas, the spatial data used is more complex [38,39]. Hence, there is a need to create an integrated spatial data sharing to bridge the gap between terrestrial surface spatial data and the marine spatial data [4,40]. So far, existing spatial data sharing exists separately between the land and marine. Thus, with the integrated data sharing, spatial data can be stored continuously and seamlessly across governance and jurisdictions.
3.2. Integrated Spatial Data Sharing Concept

The purpose of SDI is to produce seamless data exchange [33]. However, existing SDI works in separate environments [4]. This problem affects the homogeneity of the data exchange on coastal environment. Previously, SDI had focused on land or terrestrial environment. After that, marine SDI was proposed as an extension of land SDI which covered the marine interface. As a result, SDI could not achieve its main objective and purpose. The enhancement and integration of the existing SDI should focus highly on the coastal environment to achieve the integrated spatial data sharing. Because the coastal environment spatial data is complex due to dynamically marine changes, most of the data should be updated short-term, rather than depending on land-based data. Figure 2 shows the essential components of the spatial data sharing concept.

![Figure 2. Spatial Data Sharing Concept [3]](image)

3.3. Development of Integrated Spatial Data Sharing

In enhancing and upgrading the existing SDI to achieve an integrated SDI, each fundamental component of SDI should be viewed and understood in its entirety. Table 1 shows the issues and strategies to integrate land and marine spatial data sharing according to each component.

| Component       | Issues                                                                 | Integration Strategies                                                                 |
|-----------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Data Framework  | -Separate datum between the two interfaces                             | -Provide standards on spatial data collection                                          |
|                 | -Different accuracy and quality of data                                | -Provide standards on spatial data accuracy and integrity                             |
|                 | -Different scale and format of data                                    |                                                                                        |
| Data Standard   | -Separate standards between land and hydrography data                  | -Malaysia’s national standard should comply with the international standard          |
| People          | -Lack of collaboration between stakeholders                             | -Should have a clear collaboration and engagement                                      |
|                 | -Lack of understanding and awareness of spatial data integration       | -Should have clear and effective communication                                        |
| Policies        | -Unalignment between agencies’ policies                                 | -Should have unified and seamless policies among agencies                              |
| Technologies    | -Technologies not interoperable between agencies                        | - Need to centralize and synchronize the data exchange system or framework             |
4. Collaborative Integrated Spatial Data Sharing

Previous studies focused on separate interfaces such as land-based agencies and marine-based agencies. To achieve an integrated spatial data sharing between land and marine agencies, it is important to have a collaborative partnership. Collaboration is a key factor for the success of developing and maintaining spatial data sharing, particularly for an integrated environment [3,37]. The cooperation must be between those from various backgrounds and disciplines working towards the same objective [3], which is sustainable development. With that, efficient and applicable management could be accomplished, and human resources, financing and funding and added value to the data could also be achieved from the collaborative environment.

4.1. Collaborative Concept
There are various definitions of collaboration. Initially, it could be defined as agencies participating to reach the same goal and achievement [10,11]. Collaboration can also be defined as cooperation between agencies in resolving an issue [41,42]. Essentially, collaboration is the process of building an understanding between participators and agencies in achieving the same objective.

4.2. Motivations of Collaboration
It is important to identify the motivations of forming a collaboration. Several motivations in a collaboration process have been identified from previous studies, the major motivations being technical competence, absorptive capacity and organizational extension [43]. Internal motivation among participants [44] and trust between agencies and willingness to participate [45,46] have also been highlighted as motivations of collaboration.

In order to strengthen the engagement between agencies, effective communication between the participants should be implemented such as the enhancement of dialogues and interactions [47]. This is essential to build trust and good relationship among agencies [48]. The technological aspect is also important in motivating the collaboration process. The key to a successful collaboration in this aspect is interoperability whereby information can be shared among various agencies [49,50]. The decision-making process could also be optimized.

4.3. Barriers of Collaboration
Before developing a collaborative environment, it is essential to identify the barriers and issues that have hampered, and would hamper, the collaboration process. Based on previous studies, the major issues and barriers are limited resources of the organizations, unbalance in stakeholder power and opposed objectives [41,42]. All these barriers could be categorized as institutional barriers.

Meanwhile, some of the policy issues are low capacity for collection region, absence of concrete policy on data sharing, quality of the geospatial data, appointment of authority for the coordinator agency, right of privacy and confidentiality and lack of awareness of open data and its benefits [42]. The technical barriers that have been identified are lack of ability to access the data, lack of quality of the data and messy data format and lack of data exchange standardization [7]. All of the barriers identified above should be minimized and understood carefully in order to build collaboration in spatial data sharing in the integrated environment.

4.4. Factors of a Successful Collaboration
In order to overcome the barriers in collaboration, it is important to understand what makes a successful collaboration. Based on previous studies, trust among agencies, balancing of power, shared common vision, clear understanding among agencies and existence of leadership can be identified as successful factors in building a collaboration [3,11,41,48]. Another study also highlighted that a successful
collaboration in spatial data sharing should have a mutual understanding, having a lead agency and representative among agencies [3,11].

Another study showed that goodwill, transparency, mutual needs and organizational culture are necessary for the success of a collaboration [37,41], and so are defined business goals and technical capacity [41].

4.5. Strategies to Overcome the Barriers in Collaboration
Based on the synthesis of the previous studies, strategies to overcome the barriers of collaboration can be formulated. The first strategy is to identify the capacity of the agencies in both the organizational and technical aspects [3,11]. With this, issues such as financial constraints could be resolved properly. In addition, the process of establishing an engagement requires defined goals, trust and, most importantly, transparency [37,41]. This process should be accomplished through effective communication among the agencies so as to overcome issues like opposed objectives among agencies [19].

In the collaboration process, having a lead agency is very important to establish structure among the agencies [3]. This would also solve the barrier of unbalanced power among agencies. The lead agency should arrange a clear and effective communication in terms of the medium and interoperability of the system to communicate among agencies [48]. Improvement of knowledge is another strategy to overcome the barriers in collaboration [42]. It can be divided into two (2) aspects: organizational and technical. In term of organization, awareness among the agencies should be improved especially on the importance of spatial data sharing, while from the technical aspect, skills and understanding of the system’s operation should be developed and improved as well.

5. Conclusion
Coastal zone management should be understood properly especially in terms of spatial data sharing among agencies. It is important to have an integrated spatial data sharing between land and marine interfaces, and its implementation would enable coastal sustainability for the community. Agencies should have a strong desire to collaborate with each other through an integrated spatial data sharing. Developing collaborative strategies, understanding the motivations, and identifying the barriers and factors of a successful collaboration should be undertaken between the agencies. The collaborative strategies could be applied to improve the integrated spatial data sharing, and with a solid sharing environment, coastal issues could be resolved properly.

6. References
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