Collaboration for enabling coastal geospatial data sharing: a review

M A Rosly, A Ahmad and Z Tarmidi

adlyquantum88@gmail.com

Department of Geoinformation, Faculty of Geoinformation and Real Estate, Universiti Teknologi Malaysia

Abstract. Geopatial data is highly necessary to be shared among organizations for sustainable coastal management and administration. To improve geospatial data sharing, it needs to have collaboration between stakeholders. Collaboration is important to enhance data sharing between stakeholders especially in collaboration process which involve geospatial data sharing components such as data framework, standard, policy, technology and people. The collaboration process involves the integration between land based stakeholders and marine based stakeholders. This article reviews about collaboration including it definition, factors of collaboration and issues in collaboration which are important to be understood before construct a collaborative strategy. This strategy is a key to develop a collaboration framework to enabling geospatial data sharing for coastal management and administration.

1. Introduction

Coastal area is defined as transitional area between terrestrial surface and sea surface[1,2]. That area is the most complex because of the overlapping jurisdiction between land and sea administration at different level of governance such as federal, state and local government [3–6] . Most of countries around the world are surrounded by coastal surface and Malaysia is one of these countries. Total areas of sea surface in Malaysia are approximately about 61,400 kilometers and total lengths are approximately about 4480 kilometers [7,8]. For Peninsular Malaysia, coastal areas are consist of beaches from all the states such as Pantai Merdeka, Kedah; Pantai Morib and Sepang Gold Coast, Selangor; Pantai Desaru and Pantai Tanjung Leman, Johor; Pantai Teluk Cempedak, Pahang; Pantai Batu Burok, Terengganu; Pantai Irama, Kelantan and others. All of these coastal areas are known for tourist and recreation activities. While, there are also coastal area which purpose for industrial and transportation such as Pelabuhan Klang, Selangor; Pelabuhan Lumut, Perak; Pelabuhan Tanjung Pelepas and Pelabuhan Pasir Gudang, Johor; Pelabuhan Kuantan, Pahang and others. Figure 1 shows Malaysia coastal area.

Coastal area is the most complex area in term of physical [2,3]. The complexity of physical surface of coastal area is a dynamical phenomenon due to temporal changes such as tidal, weather and climate changes [4]. Besides that, coastal area also complex in terms of jurisdiction overlap between federal, state and local administrative [4]. Coastal area is highly related with human and social activities such as fisheries and aquaculture, oil and gas industries, tourism and recreation, housing, and trading and transportation [2,3]. This paper will review about collaboration in coastal geospatial data

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sharing between land and marine based stakeholders which will be start with discuss about coastal management and administration with following with the discussion about coastal geospatial data sharing and the very important is reviewing about collaboration among stakeholders.

Figure 1. Coastal Area in Malaysia [7,8]

2. Coastal Management & Spatial Data Sharing

Coastal area is highly challenging area for reserving among organizations [9,10]. This is due to its dynamically surface caused by natural phenomena such as tidal, weather and climate changes, and development close to coastal area [4]. Based from previous studies, several issues are taken into account which can be divided into two (2) categories. These issues are institutional issues and technical issues[3–6].

Complex array of legislation is one aspect from institutional issues in coastal management and administration especially for federated countries like Malaysia, Australia and Canada [11–13]. This may involve a combination of cooperation and integration between federal, state and local governance [4]. So, this may cause a confusing in land-sea interface administration. State administration coverage area is starting from low water mark (LWM) to three (3) nautical miles [13]. While, federal administration is extended from three (3) nautical miles line to exclusive economic zone (EEZ) [13]. Besides that, large number of stakeholders also influence the coastal area administration [2]. Increasing number of stakeholder, difficulty of stakeholder collaboration and cooperation increase also. This is due to not all of stakeholder share same objective and goal [2,3].

Another issue in coastal administration is technical issues [3]. Technical issues involved with agreed datum issue, scale and quality of data [3]. To reduce these issues, there is a need of interoperable system that can integrate information among organizations [3]. Datum aspect is one of the technical issue which is important for spatial reference [14]. The difference of datum in coastal use is critical [13,14]. There is a difference of definition of datum especially in vertical datum definition. For example, vertical datum used in land area is MyGEOID [13,15,16]. While, vertical datum for hydrographic work is lowest astronomical mark [13]. This difference will make a difficulty in geospatial data sharing between organizations for both land and marine jurisdiction and governance [3]. Besides that, another aspect of technical issues are difference scale, data quality and satellite image coverage area [3]. Therefore, infrastructure for enabling geospatial data sharing should be interoperable which all of information could be transfer and store seamlessly [3,17]. In the development of interoperable infrastructure, there are several things should be taken into account such as metadata creation and standards, spatial precision standard, accuracy and data format, data access policies, and circulation of data security, privacy and confidentiality [3].

2.1. Coastal Management and Administration

There is also an initiative that should be develop for protect the coastal area [18–21]. One of the initiative that has been developed is Integrated Coastal Zone Management (ICZM) [2,20]. This initiative is internationally developed in order to enable coastal zone would be manage with integrated approach which is based on geographical and jurisdiction boundaries [2]. This initiative is developed because of coastal zone management is uniquely due to overlapping interface land and sea. According to Group of Experts on Scientific Aspects of Environmental Protection (GESAMP), ICZM can be defined as a process which unite between government and community, science and management, sector and public interests in providing and implementing a plan of ecosystem and coastal resource preservation and development [3].

To better manage coastal, there's a need for using geospatial data such as coastal atlas, coastal GIS, coastal web and coastal SDI [2]. With these engines, information management for coastal areas can be developed [2]. Based on the information system, geospatial information can be stored and the information can be shared among the community. Besides that, with the presence of GIS for coastal management, administration and control of coastal areas can be enhanced [22–24]. For example, straight line and width spacing of a region can be measured by the presence of GIS. GIS can also help in making decisions on coastal area management [25].

2.2. Spatially Enabled Government Development

Spatial information is data that is closely related to the location where it describes the geographical location of a community as well as the relationship between the objects on the surface of the earth [26]. This is in line with Tobler's geographical basis theory which stated as any object that lies on the Earth's surface is closely related to each other [27–29]. In line with the latest technological developments, spatial information has become so important in sustaining economic, social and environmental [30]. The use of GIS in the management and development of coastal areas requires an infrastructure to enable spatial data to be shared and can be used continuously [31,32]. One of the initiative is spatial data infrastructure (SDI) [5,32].

3. Spatial Data Sharing Initiatives

SDI has gained considerable attention since the 1990s where it enhances the role of spatial information in decision-making in various sectors[12]. SDI Development is intended to enable data access, data exchange and also sharing of spatial data between stakeholders and communities [33,34]. There are various definitions of SDI in which it is in every country, region and discipline [3,13]. Basically, SDI is defined according to the SDI Cookbook 2004 as a framework that includes technology, policies and institutional arrangements that allow access to spatial data [35].

Therefore, the development of coastal SDI is a continuation of terrestrial based SDI which involves duplication of terrestrial surface with sea surface area [3,36,37]. Through SDI development, several SDIs have been developed at various stages, namely local, state, national, regional and global [31]. Previous studies on SDI's development have been more focused on terrestrial environment than marine environment as well as coastal areas [11–13,38]. With SDI development, spatial data acquisition efforts can be minimized, spatial data can be accessed more easily, facilitating decision-making and more [5,39].

3.1. Spatial Data Sharing Initiative in Malaysia

Initiative of SDI in Malaysia has been introduced under the name MyGDI [13,17,40]. MyGDI is managed under the Malaysia Center of Geospatial Data Infrastructure (MaCGDI), a spatial data sharing coordinator agency under the Ministry of Natural Resources and Environment (NRE). The establishment of MaCGDI is an extension of the establishment of NaLIS under the Department of Survey and Mapping Malaysia (JUPEM) which was established in 1997 [13,41]. Based on the figure 2, MyGDI comprises 7 components namely portal, metadata, framework, geodata, standards and partnerships.

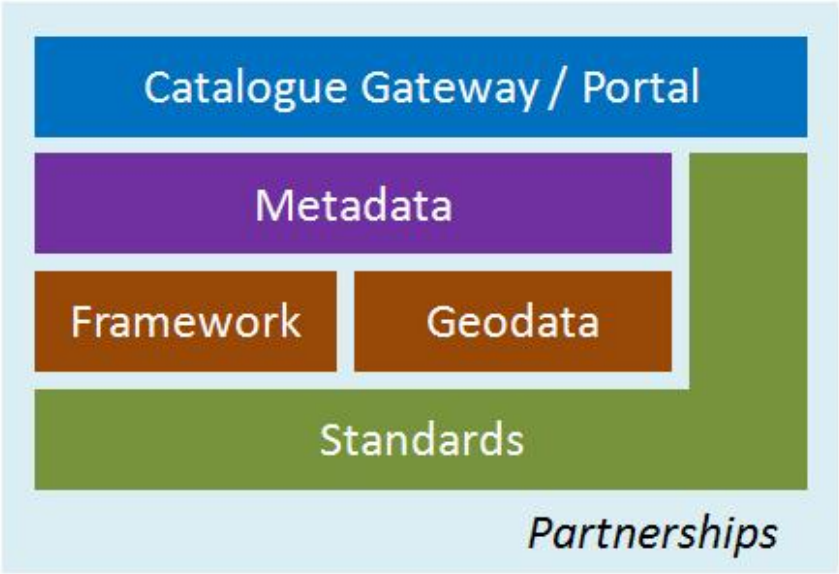

Figure 2. Components of MyGDI [13]

3.2. Coastal SDI Components

In the development of Coastal Spatial Data Infrastructure (CSDI), there are several key components of data, standards, people, policies and technologies [2,3]. They will all be discussed hereafter including the latest developments as well as issues in the SDI development. Table 1 summaries about coastal SDI components.

Table 1. Coastal SDI Components in Malaysia [13,41]

Component	**Current Practices**	**Issues**
Geospatial Data	-Using bathymetry data for marine; using topographical data for land -Geodetic datum used was GDM2000 -Vertical datum for land used is MyGEOID; while for marine applications used Low Astronomical Tide (LAT)	-Large database needed for stored 3D data with temporal data -Datum used is separately for coastal
Standard	-Used MS1759 standard -International standard used was developed by IHO S-57 and S-100	-MS1759 only extend to coastal area only
People	-MaCGDI is an agency in geospatial data sharing. -Hydrographic initiatives is extending from coastal area	-Lack of collaboration between stakeholders -Lack of understanding of integrating geospatial data
Policies	-Malaysia Government has issued several circular	-Coastal geospatial data sharing need to align with national security
Technologies	-MyGDI, MyGeoportal has been developed	-Not interoperable issues among GIS users

4. Collaboration

One of the few things that hampered coastal geospatial data sharing is the collaboration between stakeholders involved. Previous collaboration studies focus only on separate stakeholders such as land-based SDI [11,12,33,40,42] and also marine-related SDI [1,13,38] . Collaboration is a form of cooperation between stakeholders from various disciplines to solve a problem [11,13]. In spatial data sharing, collaboration is seen as very important as it will help reduce duplication of data, optimize the use of organizational resources, provide efficient and manageable management [11–13,38].

4.1. Definition of Collaboration

There are many definitions for collaboration [13]. Basically it is defined as a form of participation where stakeholders are involved in planning and working with other stakeholders to solve a problem and achieve a goal [11,12]. Collaboration is an approach in which each stakeholder co-operate with each other to resolve various issues with the unification of a common theme [12,42]. In addition, collaboration is a link between the stakeholders who join each other to solve a problem and achieve one goal [12,13,43]. It is therefore understandable that collaboration is a process to build understanding among stakeholders to achieve a common goal.

4.2. Theory of Collaboration

There is no solid theory can explain the collaboration process between organizations [12]. The concept of collaboration has been studied and viewed according to their respective perspectives, namely in terms of economic theory, strategic management, organizational theory and game theory [11,12,44]. In terms of economic theory, this concept is found to have failed to form a collaboration because it does not take into account the aspect of trust in which this concept takes into account in terms of market power, agency, transaction cost and value and also the theory of resource base theories [45]. Next the game theory can provide better results in the long run. However, this theory is still unable to give a good impression of collaboration for various organizations over a long period of time. In the next theory, organizational theory takes into account all aspects including tensions and conflicts within an organization [45]. Whereas, in strategic management, things that become drivers for a collaboration are sharing risk and cost, reducing overheads and resource dependence [12,44].

4.3. Aspects of Collaboration

In collaboration, there are several things to take into account throughout the collaboration process. Transparent decision making, better asset management, reducing duplication of work and improving speed of information access are stated as motivation in a collaboration [20]. In addition, technical competence, absorptive capacity and captures extent of organizational motivation in collaboration [46]. Next, the agreement factor is also considered in forming a collaboration between stakeholders [20,47]. Trust factor is a concern in a collaboration between stakeholders [48]. Lack of trust between stakeholders will deprive and even thwart a collaboration [48].

In addition, the behavioral aspects of an organization are also very important in establishing a collaboration. Examples are awareness of collaboration [20] and individual personalities and attitudes . These are very important to be taken into account as it involves individuals in an organization. Each individual is responsible for their organization in accordance with their duties. Furthermore, the aspect of effective communication also plays an important role in establishing collaboration [49]. Through effective and effective communication, good relationship between stakeholders can be enhanced [50]. Thus, it affects a stakeholder trust. Ineffective communication will have a long-term impact which will inhibit a collaboration. Among the impression examples are mistrust [51], different perceptions of risk and misinformation [52].

The technological aspect also provides the roles and impacts of effective communication between stakeholders in a collaboration. Interoperable technology is needed in collaboration. This is to ensure that information can be shared through various mediums. With an interoperable system, decision-

making process can be implemented more efficiently and effectively [24]. Things to consider in this regard are common technical standards, platforms, software and applications.

5. Discussion

Based on previous studies on aspects and factors allowing collaboration, it can be seen that collaboration can create and enhance the process spatial data sharing by emphasizing the network between organizations. In spatial data sharing, organizational and institutional aspects are seen as very important as it involves the management of technology. It is also very important because a medium of information sharing requires strong collaboration between organizations.

Collaborative aspects such as institutions, engagement, communication and technology are fundamental aspects that are essential to enhancing collaboration. This is because collaboration created reduces data duplication between local, state and federal organizations [12,13,53,54]. Some outcomes include return of investment (ROI), relationship between inter organizational can be improved, organizational efficiency, data related benefits, compatibility, organizational effectiveness and overall satisfactions can be obtained. Figure 3 shows linkage between component that need to be include in collaboration process.

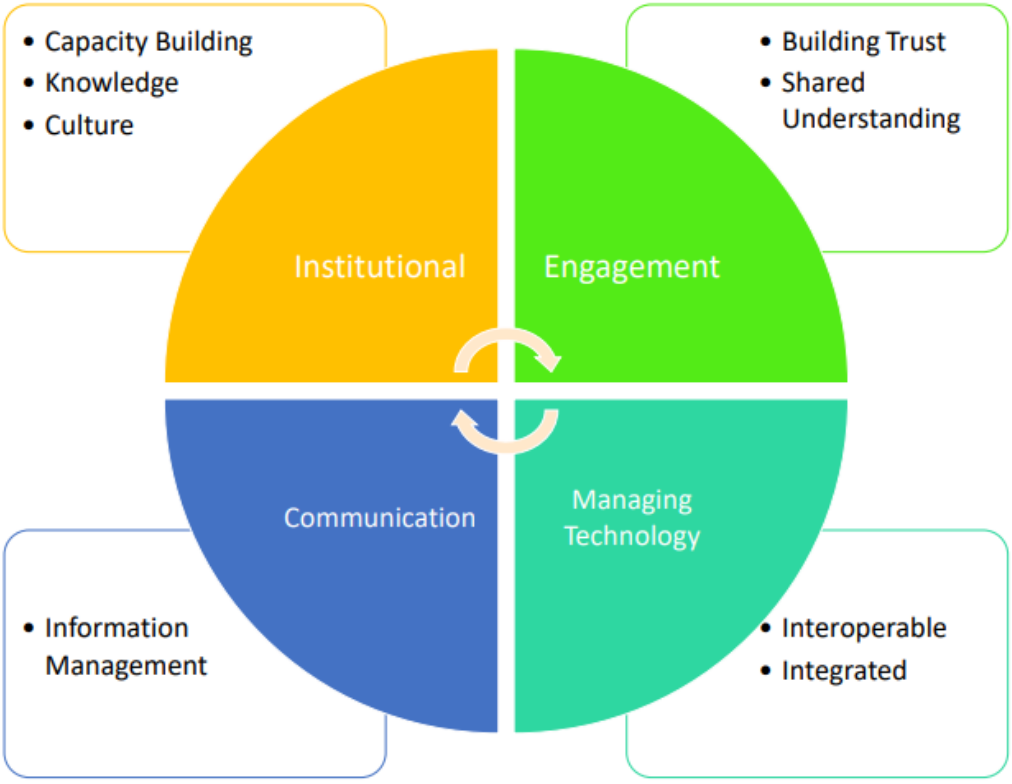

Figure 3. Aspects of Collaboration

6. Conclusion

As conclusion, coastal area should be preserved properly by understanding stakeholder goals and objectives. To engaging stakeholder involved, needs of Coastal SDI is an infrastructure will helps in making GIS-based decisions in multiple levels of governance in the management and administration of coastal areas. Therefore, collaboration for the organization is necessary to make the SDI more effective and efficient. Indirectly, not just duplication of data is minimized, even saving resources and labor can be minimized.

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