# The Important of Information Integration in Marine Management: A Review

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**Abstract:** The integration between marine information management is important for a sustainable marine management. It will balance the impact to environmental, social and economic of marine area. Several marine management and marine information management has been research and develop, such as integrated coastal zone management, marine protected area, marine ecosystem based management, marine spatial data infrastructure, marine cadastre and marine risk management. But this initiative has been develop isolated between each other, whereas, it resulting in autonomous, heterogeneous and distributed management. With integrated information management, it will help in enabling rapid and right decisions through an environmental, social and economical way. It also will bring together the diverse communities that involved in marine management.

**Key words:** Marine information management % Marine spatial data infrastructure % Information sharing

## INTRODUCTION

World's marine area cover almost two third of the surface of the earth [1]. Marine and coastal areas are complex in term of biodiversity and highly dynamic change due to time. Due to this complexity, marine and coastal information management are complex comparing with land information management. Several system and practise has been research and develop all over the world to handle the management of this area.

Regarding the highly dynamic and complex diversity of marine area, the integration between marine information management with spatial information is a must [2]. With this integration, the management will be more effective and accurate, which allow a better decision making. Some practise show the effectiveness on joining marine management with spatial information, such as Marine Protected Area (MPA), Integrated Coastal Zone Management (IZCM), Marine Spatial Data Infrastructure (Marine SDI), Marine Cadastre and Marine Risk Management. Without the integration in management, the decision making will be separated and not fully cover other related aspects, which also important [1].

Even with combination of marine management and spatial information, the bigger issue are the marine institutional management issues, such as overlapping jurisdiction, boundaries definition and rights [3], the effect of land activities to marine and coastal area, ocean waste disposal etc. The combination of technical and institutional issues will help a marine management to identify the problem, issues of marine area, what will lead to a better management of sustainable marine management [3, 4].

The need for true marine mapping, interoperable with land mapping through acommon agreed shoreline and forming the foundation of a Spatial Data Infrastructure, has never beengreater, to support marine spatial planning, strategic environmental and sustainability assessment [5].
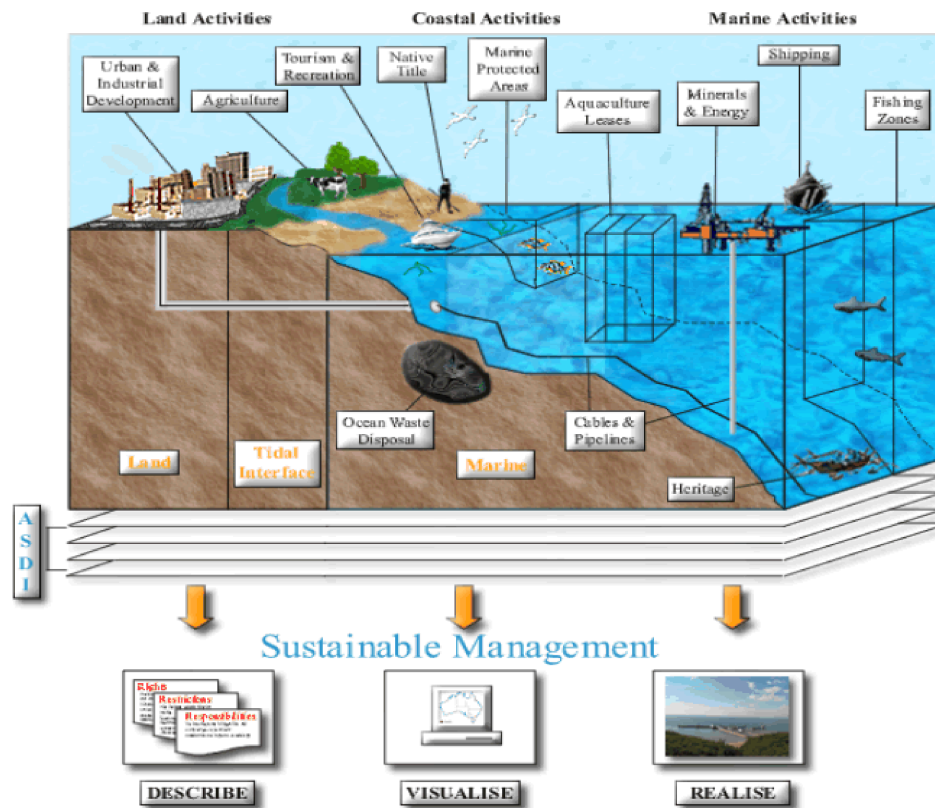
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Fig. 1: Spatial information enables a holistic view of coastal and marine zone property objects [1]

**Issues Insustainable Marine Information Management:**
A sustainable marine information management involved three main components; environmental issue, social issue and economical issue. These three issues are important to be maintaining the sustainability of the marine and coastal area. If the development is focusing on development of economical aspect, it will affect the environmental and social aspect and vice versa. Figure 1 [1] shows the linkage between land activities that will affect coastal and marine area, that it will also affect the coastal and marine activities. It also show the important of describe, visualise and realise the marine information for a sustainable management. With combination with spatial information, it will enable a holistic view of coastal and marine area.

**Social Issues:** Issues in social aspect including the rapid and unplanned development of coastal areas, non-appropriate valuation of coastal resources and ecosystems, a need to identify mechanism to involve the communities in the coastal resource management and developing and implementing integrated coastal policies and effective implementation [6]. There are also multiple

and unclear jurisdictional limits, various co-management arrangements, no single agency managing offshore rights and boundaries, indigenous title and enormous maritime areas to manage [7].

Underpinning this legislative framework is the complex relationship and interaction between overlapping and often competing rights, restrictions and responsibilities of stakeholders both in the marine environment and at the land-sea interface [8]. The main reason is that there are numerous marine boundaries and four dimensions at least had to be considered [9].

**Environmental Issues:** The environmental issues are the most crucial, whereas its major threat is the coastal and marine pollution, overexploitation of coastal and marine recourses and coastal habitat loss [6]. Other than that, the global warming, climate change, rising sea levels and increased commercial exploitation of the seabed and sea space are important global indicators of a changing environment aspect [2].

Other has listed seven theme for marine and coastal environment; (1) domestic sanitation, (2) fisheries degradation, (3) wetland and mangrove degradation, (4)

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industrial pollution of water resources in the coastal zone, (5) coastal erosion, (6) biodiversity loss and (7) aquatic wee encroachment [10]. This issues, are depleted marine resources and increased threat by man to the health of the marine environment [11].

**Economical Issues:** In the economicissue, industries such as oil and natural gas exploration are two examples of major sources of revenue for both government and private industry, with competition increasing for control over marine areas with vast arrays of natural resources [11]. A better information needed to support policies (6EAP), improvement of existing information flows, diversity across regions to be considered, revision of approach to reporting and monitoring, moving to concept of sharing of information [12]. Other than that, the important of highly income from tourism and aquaculture also need to be balance with social and environmental aspects.

**Initiative in Managing Marine and Coastal Resources:** Marine and coastal area hold a high and dynamic resources, which need to be well manage. Figure 2 show the demand to manage the marine and coastal resources based on the several categories, including for military users, recreation, nature and conservation, fisheries and aquaculture, waste disposal pollution control, shipping and navigation, mineral energy extraction, engineering work, agriculture and coastal industry or settlements.

Some of the categories has an initiative that been develop to manage their own categories, but it has been separated between each other. This will cause the waste of time, resources and energy to manage the data collection, storage, management and maintenance.

There are several initiatives has been done to integrated and link the management of marine and coastal area, such as Integrated Coastal Zone Management (ICZM), Marine Spatial Data Infrastructure and Marine Risk Management. This initiative has been done to enable information sharing and sustain the marine and coastal resources.

**Marine Spatial Data Infrastructure (Marine SDI):** Marine Spatial Data Infrastructure (Marine SDI) is a framework that facilitate exchange and sharing of spatial data between people [1]. It is an extended model of Spatial Data Infrastructure (SDI) which aims to for a seamless SDI that can be applied to marine, coastal and terrestrial spatial data [1].
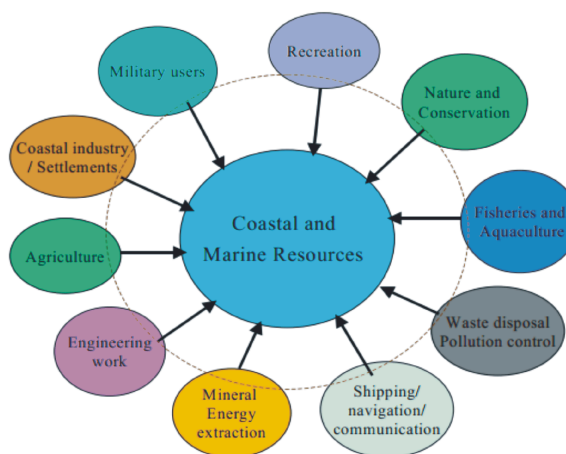


Fig. 2: Competing demand for coastal and marine resources [13]

Sharing of spatial or geographic information involves spatially enabling governments through SDI implementation more than a simple data exchange. To facilitate sharing, the GIS research and user communities must deal with both the technical and institutional aspects of collecting, structuring, analysing, presenting, disseminating, integrating and maintaining spatial data [13].

A need to deal with conflict, possess a long-term anticipatory vision, involve and educate stakeholders and the general public at all stages of spatial management, collect, format, share and apply data and metadata on the marine environment and its uses for marine planning purposes [14]. With the development of Marine SDI, it will help other management system to be link and integrate with each other, which will bring a better decision and planning.

**Integrated Coastal Zone Management (ICZM):** Integrated Coastal Zone Management (ICZM) also known as Integrated Coastal Management (ICM) is an initiative which the objective is to maximise long-term economic and social benefits from the wise use of coastal resources [15], which it also refers to the process through which the use of specific resources or portions of the coastal area are managed to achieve desired objectives [16]. ICZM aims is to improve the quality of life of coastal planning and management [17].

In other hand, the tangible objectives include for example, supporting fisheries, protecting the community from the ravages or coastal storms, attracting tourists,

promoting public health, maintaining yields from mangrove forests and preserving coral reefs [15]. The ICZM development need to me measure to ensure the effectiveness of this method, considering the inter-related economic, social and environmental development objectives [15]. Some have argued that the form for those structures were often associated with single-minded short-term exploitation rather than long term sustainable development [18].

**Marine Protected Area (MPA):** Marine protected area (MPA) is an initiative to protect and conserve the functioning and integrity of marine and coastal ecosystems [19] and also as a part of intertidal or sub tidal environment that have been reserved and protected by law or other effective means [20]. MPA therefore need to be part of a broader national and regional approach to land, coastal and marine management [21].

MPA are toolsfor preserving endangered species (e.g., fish, turtles andbirds), biodiversity and habitats (e.g., spawning/breedinggrounds, mangroves and coral reefs). MPAs often have anexplicit socioeconomic purpose to maintain or enhance aresource base for human use [19, 22]. MPA can also promote the recovery of overexploited populations, enhancefisheries yields through spillover across reserve boundaries, restorespecies interactions and food web dynamics, empower localcommunities and provide additional income from fishing andtourism [23]. MPA also been used to provide the sites for public education on the environment and provide reference areas for scientific research [21].

Within an MPA, the zoning of the human activities, i.e. the separation ofconflicting activities in specialized zones makes it possible to manage user conflicts and results in anoptimization of human activities for the benefit of both stakeholders and nature conservation. In this way, an MPA constitutes a scale model of what should be aregional integrated coastal management policy, including MPAs and unprotected areas [21].

**Marine Cadastre:** To justify the boundaries and jurisdiction of coastal and marine areas, the marine cadastre has been research. It is a system to enable the boundaries of maritime rights and interests to be recorded,spatially managed and physically defined in relationship to the boundaries of otherneighbouring or underlying rights and interests [24]. It also has been define as a marine information system, encompassing both the nature and spatial extent of theinterests and property rights, with respect to ownership, various rights andresponsibilities in the marine jurisdiction [25].

One of the aims of marine cadastre is forthe marine cadastre to be effective, it should not be developed in isolation from the terrestrial environment [26]. On top of that, marine cadastre also acts as a based layer within GIS. The concept of Marine Cadastre is to describe, visualize and realize [3].

**Marine Risk Management:** In general, the risk management is a method of evaluating the event that may occur and the consequences of such an event [27]. It included the process of identifying the risk, hazards and effects, assessing the risks and treating the risks [27]. In marine administration and management, the Marine Risk Management are based on the specific risk assessment, such as risk to human [27], risks to ecosystem [28], risks to fishing [29] and the risks to threatened species [30].

Each and every risk management that has been research are based on the different aim and objectives, are mostly isolated with each other's. There is a need for an integration of the risk management with sustainability assessment to better quantify risk [30].

**Integration of Marine Information Management: the Importance:** With the isolation development of marine information management, it has occurred to the awareness to a better marine information management, which is the integration and linkage of current marine management with information sharing. Figure 3 show the sustainable marine management. The most important integration is between current information management with spatial information. With better visualization, the planning and decision will be more accurate and reliable than using separated method. For example, with spatial information, users will be able to discover, understand, view, access and query geographic information of their choice from the local level to the global level, in an interoperable way for a variety of uses, such as environmental policy development and impact assessment, land use planning, natural disasters preparedness, monitoring and response [31].

Some of the research has been done, to integrate some of the marine information management, Comert, 2008 [32] has made a research on integration between Marine SDI and ICZM and its show that the Marine SDI help in
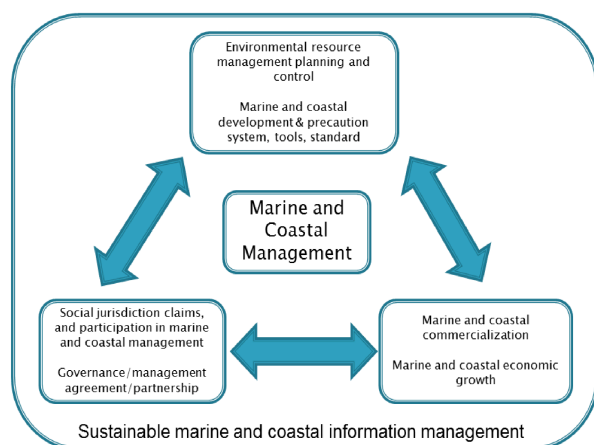
Fig. 3: A sustainable marine and coastal information management need integration between environmental, economic and social aspects

enabling rapid and right decisions through an economical way, which rapid decision required rapid data access and use while right decisions may require various qualified data.

Other research by Cicin-Sain [33], show the important of linking between MPA with ICZM. The actors involved in MPA networks and in ICM programs are often different,and reflect different cultures, different networks of relationships, different ministries anddifferent goals and motivations. Such coming together for joint planning and, ultimately, joint governance will need to be facilitated by third parties knowledgeable about both ICM and MPA processes. With this linkage, the planning and development of coastal and marine area will include the management of MPA, which will also bring together the diverse communitiesinvolved in marine protected areas, coastal and ocean management and watershed management tocollaborate in national-level ocean and coastal planning.

From theprevious research, it shows the important of information sharing. The information sharing and integration between different management will help a better decision making. With information sharing, such an entity can be enhanced so that it is possible to share, in addition to data, business goals, strategies, processes, operations and value-added products which can help to facilitate spatial enablement across government and different jurisdictions [13].

Information sharing also improved cross-border policy making, improve information quality and reduced duplication of geographic data [31]. Information sharing, with spatial or geographical information involve spatially

enabling governments through SDI implementation more than a simple data exchange. To facilitate sharing, the GIS research and user communities must deal with both the technical and institutional aspects of collecting, structuring, analysing, presenting, disseminating, integrating and maintaining spatial data [13].

The other important component for integration is to have ageoportal, which using World Wide Web (WWW), it offer services to discover, understand, view, access and query geographic information. The geoportal will facilitate links and coherence with many institutional servers and portals and will provide on-line access to collections of spatial data and services supplied by multiple public and private organisations [31].

## CONCLUSION

Marine sustainable management are important to sustain the marine resources, from environmental, social and economic aspect. But current practise show the development of marine management is isolated with each other's, with different function, jurisdiction and implementation. Without the integration and linkage between agencies, the sustainable marine management is far from success.

Future research will be the development of infrastructure to integrate between different marine information management, including infrastructure for institutional cooperation, a proper information management, network services, standard for information sharing and policy enhancement. This will bring into proper cooperation and smooth information exchange and sharing, toward a sustainable marine information management.

## REFERENCES

1. Andrew Binns*, et al.*, 2005. "Supporting Decision Making and Management in the Marine Environment," GIS Development, 9: 16-18.
2. Osborne, M. and J. Pepper, 2007. "Marine SDI," Hydro International, 11: 23-25.
3. Andrew Binns*, et al.*, 2003. "Issues in Defining the concept of a Marine Cadastre for Australia," presented at the Seminar/Meeting On Marine Cadastre, Frederiction, Canada.
4. Williamson, I.P., A. Rajabifard and A. Binns, 2004. "Issues in Developing Marine SDI," presented at the International Workshop on Administering the Marine Environment-The Spatial Dimensions, Kuala Lumpur.

5. Osborne, M.J. and J. Pepper, 2010. "Creating Marine Spatial Data Infrastructure for the UK," Coastal and Marine Geospatial Technologies, 13: 51-55, 451.

6. Chuenpagdee, R. and D. Pauly, 2004. "Improving the state of coastal areas in the Asia-Pacific region," Coastal Management, 32: 3-15.

7. Rajabifard, A., *et al.*, 2005. "Administering the marine environment - The spatial dimension," Journal of Spatial Science, 50: 69-78.

8. A.A.W. Rajabifard, I.P., 2003. "Asia-Pacific Region and SDI Activities," Journal of GIS Development, pp: 7, July 2003.

9. Sutherland, M. and S. Nichols, 2006. "Issues in Governance of Marine Spaces," presented at the Administering Marine Spaces: International Issues, Munich, Germany.

10. Amlalo, D.S., 2006. "The Protection, Mangement and Development of Marine and Coastal Environment of Ghana," presented at the Administering Marine Spaces: International Issues, Munich, Germany.

11. Binns, A., A. Rajabifard, P. Collier and I. Williamson, 2004. "Developing the Concept of a Marine Cadastre: An Australian Case Study," presented at the Trans Tasman Surveyor, Australia.

12. Toth, K., 2007. "Role of Integrated Land and Marine Information in INSPIRE," in Joint EuroSDR and IHO Land and Marine Information Integration Workshop, Dublin, Ireland.

13. Masser, I., *et al*., 2008. "Spatially enabling governments through SDI implementation," International Journal of Geographical Information Science, 22: 5-20.

14. Dumashie, D., 2009. "UK Marine and Coastal Access Bill," presented at the Southern Region Autumn Symposium, Hydrography and Marine Spatial Data Infrastructure 2009, Bradfield College, Reading.

15. Burbridge, P.R., 1997. "A generic framework for measuring success in integrated coastal management," Ocean and Coastal Management, 37: 175-189.

16. Charles, E.N., 2003. "Indicators to measure governance performance in integrated coastal management," Ocean and amp; Coastal Management, 46: 335-345.

17. Strain, L., 2006. "An SDI Model to Include the Marine Environment," Master of Geomatics Engineering Department of Geomatics, University of Melbourne, Melbourne.

18. Neale, D., 2006. "A Note on Marine Administration in Small Island Developing States (SIDS)," presented at the Administering Marine Spaces: International Issues, Munich, Germany.

19. Jentoft, S., *et al*., 2007. "Marine Protected Areas: A Governance System Analysis," Human Ecology, 35: 611-622.

20. Horigue, V., *et al*., 2012. "Marine protected area networks in the Philippines: Trends and challenges for establishment and governance," Ocean and Coastal Management, 64: 15-26.

21. Boudouresque, C.F., *et al*., 2005. "Marine Protected Areas: A Tool for Coastal Areas Management Strategic Management of Marine Ecosystems." E. Levner, *et al*., Eds., ed: Springer Netherlands, 50: 29-52.

22. Grantham, H.S.*, et al.*, 2012. "A comparison of zoning analyses to inform the planning of a marine protected area network in Raja Ampat, Indonesia," Marine Policy.

23. Micheli F., *et al*., 2012. "Evidence that marine reserves enhance resilience to climatic impacts," PLoS ONE, pp: 7.

24. Robertson, B., G. Benwell and C. Hoogsteden, 1999. "The Marine Resource: Administration Infrastructure Requirements," presented at the UN-FIG Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development, Melbourne, Australia.

25. Nichols, S., D. Monahan and M. Sutherland, 2000. "Good Governance of Canada's Offshore and Coastal zone: Towards an Understanding of the Marine Boundary Issues," Geomatica, 54: 415-424.

26. Binns, A., 2004. "Defining a Marine Cadastre: Legal and Institutional Aspects," Master, Department of Geomatics, The University of Melbourne, Melbourne.

27. Campbell, M.L., 2009, "An Overview of Risk Assessment in a Marine Biosecurity Context Biological Invasions in Marine Ecosystems." G. Rilov and J. A. Crooks, Eds., ed: Springer Berlin Heidelberg, 204: 353-373.

28. Breen P., *et al*., 2012. "An environmental assessment of risk in achieving good environmental status to support regional prioritisation of management in Europe," Marine Policy, 36: 1033-1043.

29. Williams A., *et al.*, 2011. "Evaluating impacts of fishing on benthic habitats: A risk assessment framework applied to Australian fisheries," Fisheries Research, 112: 154-167.

30. Zhou, S., *et al.*, 2012. "Integrated risk analysis for rare marine species impacted by fishing: Sustainability assessment and population trend modelling," ICES Journal of Marine Science, 69: 271-280.

31. Bernard, L., *et al.*, 2005. "The European geoportal - One step towards the establishment of a European Spatial Data Infrastructure," Computers, Environment and Urban Systems, 29: 15-31.

32. Cömert, Ç., *et al.*, 2008. "The value of marine spatial data infrastructure for integrated coastal zone management," Fresenius Environmental Bulletin, 17: 2240-2249.

33. Cicin-Sain, B. and S. Belfiore, 2005. "Linking marine protected areas to integrated coastal and ocean management: A review of theory and practice," Ocean and amp; Coastal Management, 48: 847-868.