

**GIS Development Paper**  
**August Theme: Marine GIS**

**Supporting Decision Making and Management in the Marine Environment**

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**Introduction**

The world's oceans cover almost two thirds of the surface of the earth, regulating weather patterns and sustaining a huge variety of plant and animal life (UN, 2003). Given the diversity of this area, there is an economic, social and environmental need to effectively manage it. This management is difficult, due to the complex web of national and international government legislation, including the United Nations Convention on the Law of the Sea (UNCLOS). There are also overlapping and competing rights and responsibilities of a myriad of activities within the marine environment, often governed by separate agencies. In order to manage these rights and activities in the marine environment effectively, clear spatial certainty in relation to marine boundaries is needed (Collier *et al.* 2003). This can be achieved through the use of spatial information and decision support tools such as marine GIS.

Historically, the marine environment has been managed secondary to the terrestrial environment through sectoral planning, with government fisheries agencies managing fisheries and historical shipwrecks managed by a separate government agency. Jurisdictional limits and marine boundaries are multiple and often unclear, there is generally no single agency managing offshore rights, and the mapping of legal boundaries is difficult due to the three-dimensional aspect and lack of physical reference. Added to this, information needed to effectively manage the marine environment is stored within silos, with no interconnection between relevant information streams.

The management of the terrestrial environment evolved in a similar fashion to the marine environment, with spatial information in particular built up in silos. However the three global driver of sustainable development has created the need for greater access to environmental, economic, and social information. The introduction of Geographic Information Systems (GIS) as a tool to aid in decision making has also seen the need to break down the barriers between agencies and silos. For effective analysis within a GIS, there must be access to a wide range of interoperable spatial datasets. In order to effectively and efficiently access and disseminate such spatial data, there has been the

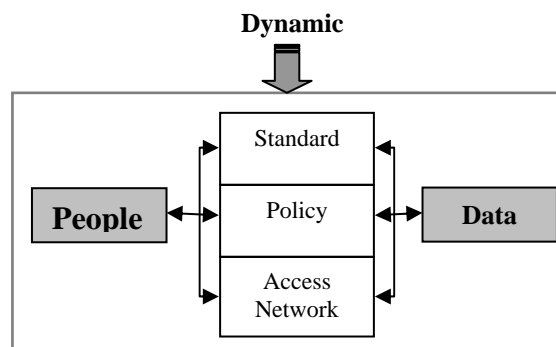
need to develop Spatial Data Infrastructures (SDI), which aid in breaking down barriers between users and producers of spatial data.

GIS is now being used to aid decision making in the Marine Environment, with interactive mapping applications, marine and coastal data download tools and associated metadata becoming readily available through various GIS systems. This paper aims to discuss the use of a SDI and marine cadastre in helping marine GIS users gain access to critical information relating to maritime boundaries and other important information used in marine management. Gaining access to such information will aid decision makers in utilising the wide range of tools offered through GIS packages in the marine environment, enabling the worlds oceans to be managed in line with current sustainable development drivers.

### **Spatial Data Infrastructures (SDI)**

It is increasingly being recognised that spatial information is one of the most critical elements underpinning decision making for many disciplines. Spatial information provides a spatial/geographic context to planning, management, and resource allocation allowing a better understanding of, and thus better management of an area. In response many countries around the world are developing SDI as a way to better manage and share their spatial data assets (Rajabifard and Williamson 2004)

An SDI is a framework or system that facilitates the exchange and sharing of spatial data between people (Figure 1). It can be described as the underlying infrastructure, often in the form of policies, standards and access networks that allows data to be shared between and within organisations, states or countries. It has been likened to road or rail infrastructure, which supports transport over land, and comprises roads as well as the rules, maintenance policies, and jurisdictional rights to them.



**Figure 1: SDI Components**

SDI is comprised of 'policies, standards and procedures under which organisations and technologies interact to foster more efficient use, management and production of geospatial data' (FGDC, 1997). Some of the benefits of developing SDI are: improved access to data, reduced duplication of effort in collecting and maintaining data, better availability of data and interoperability between datasets.

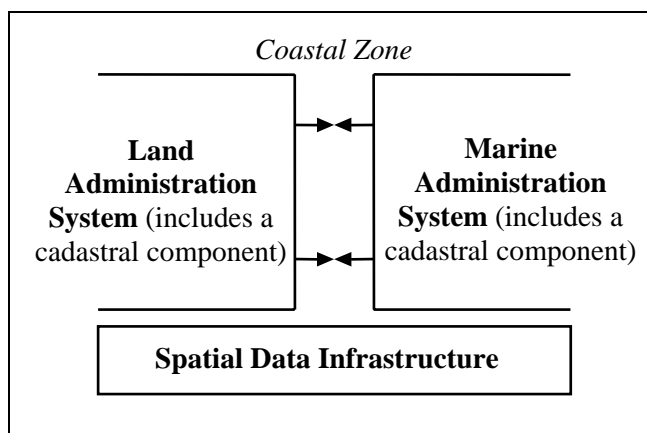
### **Marine SDI**

More recently the idea of Marine SDI is emerging. While the concept of marine SDI is relatively new, the idea of supporting marine and coastal management through better

access to spatial data or information within a GIS is more established. Several countries and different jurisdictions are trying to improve their marine management through improving the accessibility and availability of spatial data. Often while these initiatives are not labelled 'SDI' they share some of the objectives and concepts of SDI.

While many coastal countries are considering developing a marine SDI, often this is occurring separately from the existing National SDI. However planners, managers and policy makers that utilize GIS in both the marine and coastal environments will need access to spatial data that covers terrestrial, coastal and marine areas. The development of integrated coastal zone management has encouraged a more holistic approach to managing the marine and coastal environments, needing to be supported by an integrated information source (Longhorn, 2003)

The benefits of developing marine SDI using the technologies and policies established through already created understanding of SDI, is that the gap between the terrestrial and marine environments can be bridged, and allow for seamless access to spatial data (Figure 2). This development has been supported by Resolution 3 - *Defining the Spatial Dimension of the Marine Environment* - of the UN supported International Workshop on Administering the Marine Environment, the Spatial Dimension, held in Malaysia, 2004 (PCGIAP-WG3, 2004).



**Figure 2:** Seamless administration system

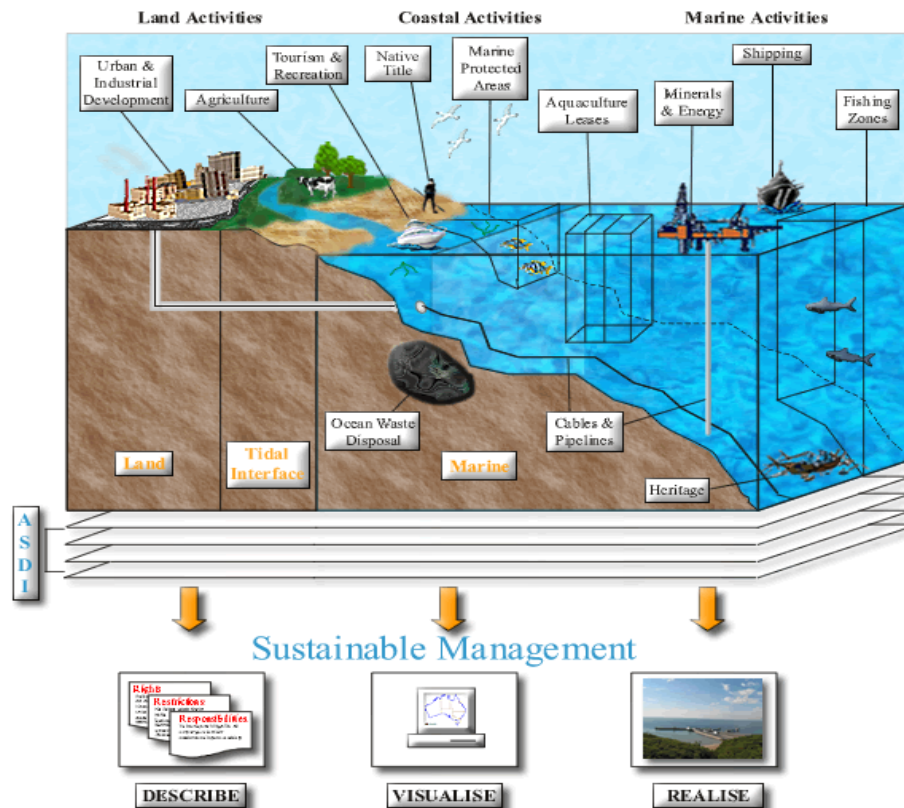
The development of a marine SDI is a critical part of the development and use of marine GIS. A marine SDI will provide access to the marine spatial data to be used in a marine GIS. Without a marine SDI, accessing and sharing marine and coastal spatial data will become a very difficult and timely process. Currently in Australia it is estimated that tens of millions of dollars is spent collecting data about Australia's marine jurisdiction, and this data is rarely re-used or shared.

The main impediment to sharing data at the moment is that while there is a large amount of data collected in the marine environment, it is not coordinated and shared. There needs to be a base layer of information that conforms to set standards and is available through a common access network that other information layers can be built upon. In current SDI models these are often called the fundamental or framework datasets, with the land cadastre being one of these. Some of the most important information used in planning and management of the marine and coastal environments is the different boundaries and their associated rights, restrictions and responsibilities. Hence there is clearly a need to create a marine cadastre that will both form an important layer in a marine SDI, and also

be a base dataset upon which others can be built. This will help marine GIS users gain access to critical information relating to maritime boundaries and other important information used in marine management.

### Marine Cadastre

The concept of a marine cadastre is being considered by a number of countries in order to address the issues and problems of dealing with multiple and unclear boundaries in the marine environment, and aims to become the base layer within a GIS. There are a large range of stakeholders and activities that occur within the marine environment, ranging from tourism and recreational activities such as boating and swimming, to the disposal of waste and drilling for oil and natural gas deposits. In order to effectively manage these activities, the administrative and legal boundaries that govern where and when such activities can occur needs to be known. The rights and restrictions that go along with such boundaries also must be recorded. For example, marine protected areas have defined boundaries for the purpose of excluding or restricting the rights of other stakeholders within such an area. Knowledge of these rights and restrictions need to be attached to the boundaries, and the boundaries easily displayed and mapped within a GIS in order for them to be effective. As illustrated in Figure 3, this would enable users and stakeholders to “describe, visualize and realize” spatial information in the marine environment (Todd, 2001).

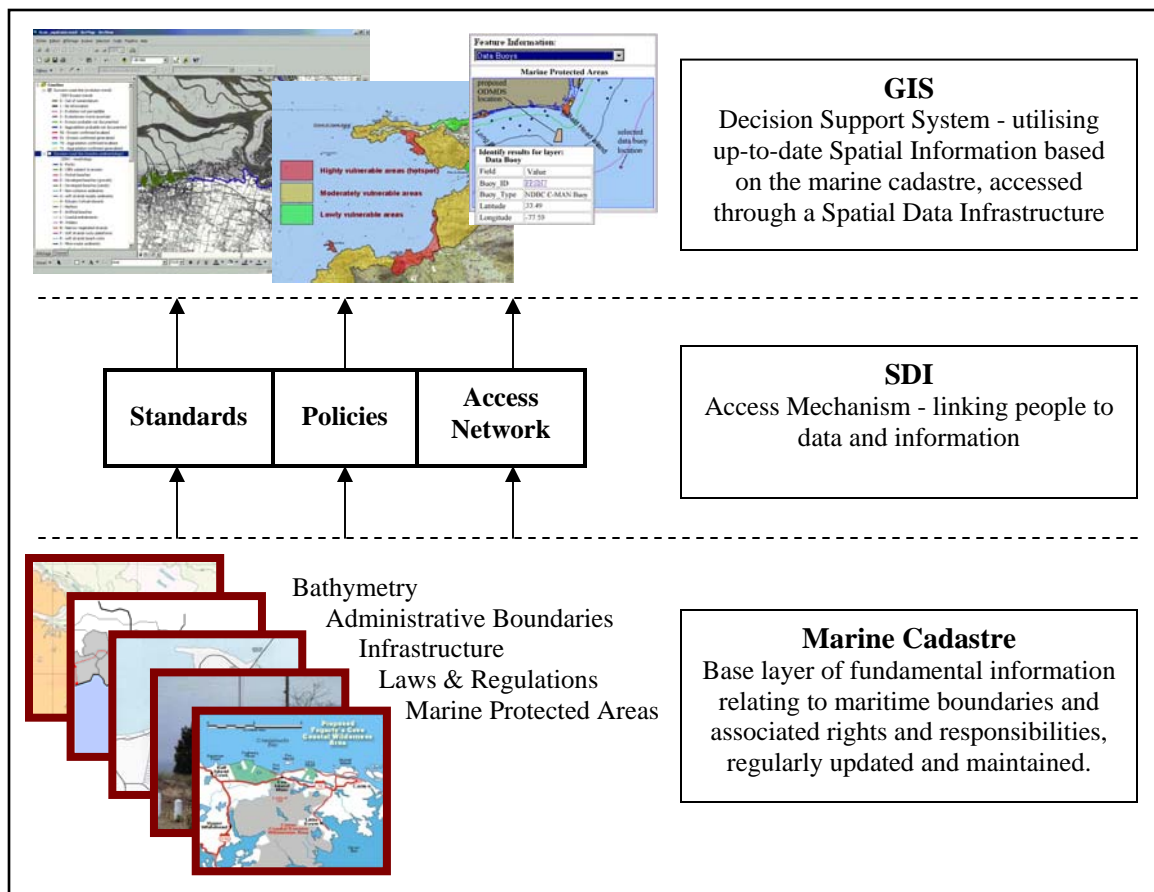


**Figure 3 – Marine Cadastre Concept**

The creation of a marine cadastre would also need to include mechanisms to enable spatial information within the marine environment to be continually updated and maintained, in a similar fashion to the terrestrial cadastre. New marine parks are continuously being created, new fisheries zones drawn up as old fisheries become over-fished. For decision makers utilising tools such as marine GIS, the ability to access up-to-date spatial information regarding maritime boundaries would aid in activities such as managing and creating new fisheries or aquaculture leases, policing marine protected areas, oil and gas exploration, and the laying of cables and pipelines.

## Way Forward

The use of GIS as a decision making tool within the marine environment is increasing, but there is a need to improve the underlying framework for access to up-to-date data and spatial information. Currently, the ability to provide consistent and accurate spatial information on the wide range of rights and spatial boundaries in the marine environment is hampered by the fact that interests overlap and information is held within silos by various agencies.



**Figure 4:** Underlying Infrastructure for Marine GIS

As seen in Figure 4, research into marine SDI and the development of a marine cadastre is aiming to increase this underlying infrastructure by providing an access mechanism to more up-to-date and accurate information regarding maritime boundaries for use within marine GIS and other decision support systems.

### **Acknowledgements**

The authors wish to greatly acknowledge the support of the University of Melbourne, Land Victoria, Geoscience Australia, Department of Natural Resources and Mines Queensland, Department of Lands NSW, the Australian Research Council (ARC) and members of the Marine Cadastre Research Group and Centre for SDIs and Land Administration at the Department of Geomatics, University of Melbourne in the preparation of this paper and associated research. The views expressed in this paper are those of the authors and do not necessarily reflect the views of these groups.

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