# The Needs for Marine Cadastre and Supports of Spatial Data Infrastructures in Marine Environment – A Case Study

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**Key words**: Marine cadastre; spatial data infrastructures; marine rights, restrictions and responsibilities.

## SUMMARY

The *Federation Internationale des Geometres* (FIG) statement on the cadastre has been widely accepted and is now an established principal of land administration systems. The cadastre, a parcel based land information system linking various administrative considerations (such as rights, restrictions and responsibilities) to geometric descriptions of areas of land. It is also a valuable means of linking records of ownership and potential utilities (FIG, 1995).

In the marine environment, however, the concept of the cadastre is still quite unclear due to problems such as the discontinuity of land and marine areas, as well as various technical, legal and institutional issues. What exists at present is a confusing and often conflicting overlap of international, national and state jurisdictions. In this paper I will highlight these issues associated with the development of marine cadastre in an Australian context. The 1982 UN Conventions on the Law of the Sea (UNCLOS) sought to resolve such dilemmas, however, have been unsuccessful in overriding national and state legislatures with regard to the regulation of marine-related activities.

This paper will analyse the issue of rights, restrictions, and responsibilities in the marine environment with reference to a case study undertaken off the coast of South Eastern Australia. This area was chosen because of the complexity of the issues confronting a range of stakeholders with different interests and perspectives.

A particular focus of this research is a review of administrative interests at the land-marine interface. Utilising the case study has been conducted, analysing and integrating datasets to provide stakeholders access to dynamic information. The use of Spatial Data Infrastructures (SDI) in the marine environment will also be examined by evaluating their application to the implementation of current policies in this particular area.
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# The Needs for Marine Cadastre and Supports of Spatial Data Infrastructures in Marine Environment – A Case Study

**M. Sigit WIDODO, Australia**

## 1. INTRODUCTION

This paper will concentrate on the basic issues confronting the marine cadastre, which is a relatively new concept in the field of land administration. The concept is an evolving one and indeed, one day we may even have a "space cadastre". Canada and the United States have been at the forefront of establishing marine cadastre and New Zealand has also being working on the concept but there is no country yet which has completely setup the marine cadastre (Nichols et al., 2000; Fowler, C. and E. Treml, 2001; Grant, D. 1999). Australia has recently started looking at the issue via the Australian Research Council (ARC) Marine Cadastre Project established in early 2002 (Collier et al., 2001). This paper will be discussing the development of a cadastre and spatial data infrastructure in the marine environment with a particular focus on a case study area in the Gippsland coastal region in South Eastern Australia.

The marine cadastre poses a whole series of different issues to that of the "land cadastre". The most striking and obvious example is that there is no physical or visible boundary demarcation on the seabed. Due to the immense ocean volume and complexities of the ocean climate, there is really indeed very little which has or can be done to map the ocean floor.

If geographic position is to be adopted in the marine environment as a fundamental element in the creation of relevant data sets, it will be necessary for a paradigm shift to occur on the part of the custodians of many of the data sets which have been developed for the purposes of land tenancy or utilisation.

The creation of a legal coordinated marine cadastre has provided a challenging opportunity for survey professionals. The surveyors' role in the marine environment is, by necessity, fundamentally different to that which has been adopted in the traditional delivery of land based boundary definition and survey. While being different, these new survey requirements will in many instances be equally, if not more demanding of sophisticated survey expertise than has previously been the case.

The recent introduction of the new marine boundary system has therefore created an opportunity for surveyors to expand both their skills and the range and sophistication of the survey services that they can offer to the client community. At the same time, a survey operational environment will facilitate the investigation and testing of the real potential of conventional and developing technologies such as Global Positioning System (GPS) and Geographical Information System (GIS), to resolve any ambiguities that may be raised when coastal or marine activities are carried out.

## 2. DEVELOPMENT OF CADASTRE

The ecological history of humankind, traditionally, reveals that most of the riots, conflicts and wars have been related to conflicting land interests. Even now, many military conflicts have been related to contesting claims for territories and the expansion of rights. The concept of a land cadastre has developed throughout history to its current maturity as a formal, established system. Currently, a cadastre could be explained as a parcel based and up to date land information system consisting of a record of interests in land. These interests encompass issues such as rights, restrictions, responsibilities and jurisdictions (FIG, 1995).

The cadastre consists of a geometric description of parcels that relate to other records describing the nature of interest and ownership or control of those interests, and even including the value of the parcel and its improvements. The cadastre currently plays an important role in the regulation of land use. In land development, the cadastre forms an essential part of the information required by private developers, land owners and public authorities to ensure that benefits are maximised and costs (economic, social and environmental) are minimised. Through centuries the concept has evolved and transformed into many other parallel forms that continue to offer assistance in various ways to a range of stakeholders.

The Spatial Data Infrastructure (SDI), which builds on the concept of a Geographical Information System (GIS), has been engaged in many current development programs and projects. The role and capability of the land cadastre has been further extended into a multifaceted information system that continues to improve the efficiency of services as well as creating dynamic partnership between private and government organisations.

As the land cadastre and SDI have gradually become more mature and functional, there has been growing support towards attempting to implement the identical management information and administration system in the marine environment. In spite of the fact that humans spend most of their time on land, we have become gradually more aware and concerned about the marine environment. We must not neglect the fact that the oceans consist of 70 percent of the earth’s surface while the remaining 30 percent of land is becoming overpopulated. Human beings have spent most of their entire history in pursuing the conquest of territories. It would be a significant historical achievement if even the slightest achievements in land management could be realised in the proper management of our oceans. Research shows that the vast oceans would be more spatially complex to measure than land. Therefore, the newly proposed concept of the “Marine Cadastre” has evolved to determine, model and manage offshore territory.

## 3. NEEDS FOR MARINE CADASTRE

The nature of the marine resource has a number of characteristics which have a profound bearing upon the consideration of its utility as a resource. Particularly, when it is viewed from the perspective of a largely land-based socio-economy. These characteristics are also of fundamental importance when looking at the areas under research; that is the leasing and licensing of marine areas for various uses (Munro-Faure, 1991).

The role of the sea, the sea bed and the strand as a source of food, of raw materials such as salt and fertiliser and energy, its function to ease the political and physical frictions of land for transportation; its use as a base for construction, and indeed its conversion into dry land for all kinds of use; the timeless practice of employing it as a sump for waste products: all of these have developed as mankind has himself developed.

In addition, Munro-Faure (1991) stated that more than two thirds of the world's population currently lives within 80 kilometers of a coast and almost half of the world's major cities are built on or near an estuary. The impact of population growth in raw terms is compounded by a rural-urban drift, which puts increasing pressure on these coastal areas.

The marine resource is as subject as any other resource to these pressures, and the recognition of its actual and potential value is rapidly developing. In very broad terms these pressures relate to those activities which require a legal interest in the form of a lease or license for them to take place, and those that do not.

One of the basic principles of a marine cadastre is that it relates closely to the land cadastre and thus expertise gained from studying the land cadastre could be applied to the marine environment, with some adjustments. However, an early examination of the issues reveals that such an elementary approach also has some major difficulties. Here are some unique problems, which differentiate the land and marine environment, such as (Collier et al. 2001):

- The concept of *tenure* does not exist at sea
- It is not possible to use classical means of boundary demarcation offshore
- The marine environment is three dimensional–classical 2D simplifications are not adequate
- It is possible (common) for multiple (overlapping) rights to exist within a single locality
- Rights can vary with time, adding a fourth dimension to the spatial data
- The baseline to which many maritime boundaries are related is ambulatory

Consequently, the design and development of a spatial data infrastructure for the marine environment is quite different from a land-based spatial data infrastructure, and will present new challenges.

The issues of land and marine administration systems are common throughout the world but mostly in a national and local context. It is inappropriate to simply adopt a marine cadastre model from one jurisdiction and apply it to another jurisdiction. A simple example is the application of national and state legislation. Such legislation varies from country to country, and, even within one country, from state to state as in Australia. Australia operates on a State / Federal system of government under which there is a maritime zone, 3 nautical miles in width (called *Coastal Waters*) which defines the region of sovereign jurisdiction for the states and the Northern Territory. Federal jurisdiction commences at the outer limit of the 3 nautical mile zone and extends with varying rights and responsibilities out to the *Territorial Sea* at 12 nautical miles, the *Contiguous Zone* at 24 nautical miles and the *Exclusive Economic Zone* at 200 nautical miles, as illustrated at Figure 1 (Collier et al., 2001 and Robertson, 2002).

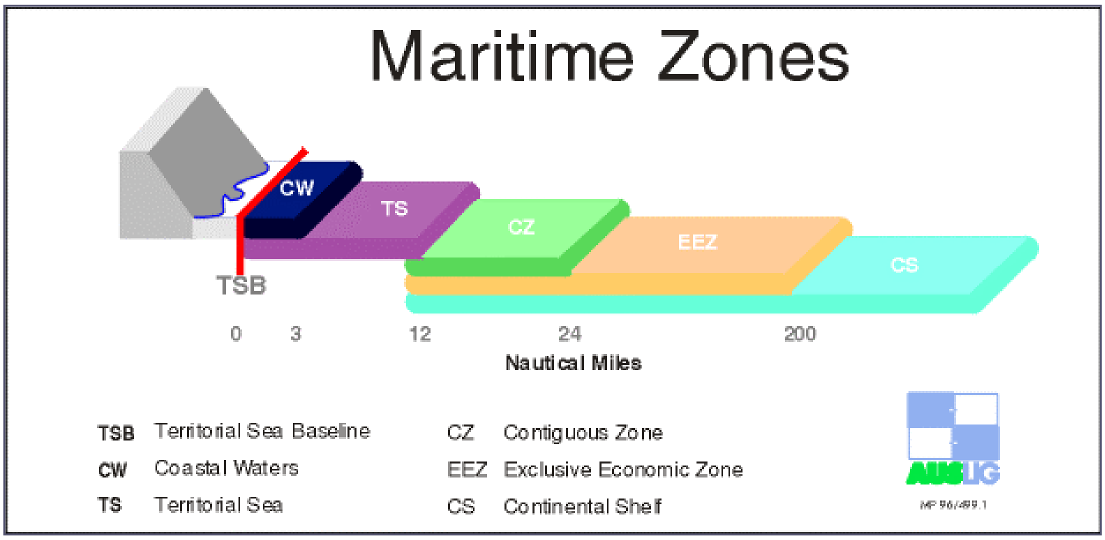


**Figure 1**: Australian Maritime Zones (AUSLIG, 1999)

The United Nations Convention on the Law of the Sea (UNCLOS) states that Australia can claim a marine area approximately 1.5 times the size of its land mass (AUSLIG, 2001). The claims of areas represent the future limits of zones that define the international jurisdictional rights and marine responsibilities. Australia is fortunate to be able to claim such a vast area in the oceans that could, in the future provide essential resources for both the economy and future generations. Hence, in Australia it is imperative to establish good governance of it. The establishment of a marine cadastre would give rise to a new branch of research that would reveal the potential of oceans under the paradigm of sustainable development.

## 4. SPATIAL DATA INFRASTRUCTURES

Spatial data are items of information which are related to a location on Earth, particularly information concerning natural phenomena, cultural and human resources, topography including geographic features, places names, height data, land cover, hydrography; cadastre (property-boundary information); administrative boundaries; resources and environment and socio-economic, including demographic; (CSDC, 2001; Radjabifard, 2002). These type of data are critical in the promotion of economic development, improving the stewardship of natural resources and in protecting the environment (Executive Order, 1994). People need spatial data and its derived information to establish the position of identified features on the surface of the earth. Geographical position is important and can be viewed from different perspectives - to be used for comparisons or for mapping and decision making. Knowledge of the location of an activity allows it to be linked to other activities or features that occur in the same or nearby locations, like in fire-fighting activities. Locations also allow distances to be calculated, maps to be made, directions to be given and decisions to be made about complex, inter-related issues such as emergency services (Mapping Science Committee, 1995). Significantly more than 80% of governmental data has a locational basis (Budic and Pinto, 1999; Radjabifard, 2002).

The needs for spatial data are continually increasing and changing. In most of the developed countries it is widely acknowledged that spatial data is part of the national infrastructures and extensive efforts are being expended on this (Clarke, 2000). With this in mind, in the last two decades nations have made unprecedented investments in spatial information and the means to assemble, store, process, analyse and disseminate it. Many organisations, agencies and departments at all levels of government, private and non-profit sectors and academia throughout the world spend billions of dollars each year producing and using spatial information (FGDC, 1997).

Moreover, there are two major forces driving the development of spatial. The first is a growing need for governments and businesses to improve their decision-making and increase their efficiency with the help of proper spatial analysis (Gore, 1998). The importance of this issues ranks so highly that the Australian New Zealand Land Information Council (ANZLIC), peak coordinating body for the management of land and geographic information within these two countries, views land and spatial information as an infrastructure, with the same rational and characteristics as roads, communications and other infrastructure (ANZLIC, 1998). The second force is the advent of cheap, powerful information and communication technology, which facilitates the more effective handling of large quantities of spatial data.

The concepts and components of SDI are evolving and remain very much an innovation between different organisations and countries. Although there are many definitions of SDI, Rajabifard et al. (2000) state the important principle of SDI is to provide an environment which enables a variety of users to access and retrieve complete and consistent data sets easily and securely. The common components and attributes of SDI can be identified as:

- *Data*. The central component of SDI. There are different data types and standards based on user needs and requirements.
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- *People*. Administrators, custodians, users and value-added resellers of spatial data, individuals or organisations, small or large business representative, private or public employees.
- *Institutional frameworks*. Administration, coordination, policy and legislation components of SDI. This is important for the success for communication and partnership creation between different agencies.
- *Technology*. The access and distribution network and also the clearinghouse. The influence of the level of SDI and the focus of the technical components have an important influence on the approach taken for aligning components towards the development of SDI.

- Standards. Standards and policy which should be consistent in order to facilitate sharing, integration and distribution of spatial information.

In Australia, the development of SDI is being advanced by three key bodies - ANZLIC, the Intergovernmental Committee on Surveying and Mapping (ICSM) and the Public Sector Mapping Agency Inc. (PSMA). These three bodies are working together with six States and two Territories and the Commonwealth government to provide leadership for spatial information and various elements of SDI development nationally (Warnest et al., 2002).

## 5. MARINE SPATIAL DATA INFRASTRUCTURES

The objectives of ANZLIC are to develop a national geographic data infrastructure which includes enriching the nation's investment in spatial data and improving economic, social, environmental and defence decision making. The Australian Spatial Data Infrastructure (ASDI) will provide the mechanism to access the spatial data required to support the economic growth and social interests of the nation. It also will maximise the access, use and integration of spatial data, avoid duplication in acquisition and maintenance of spatial data, and clearly define custodianship of fundamental spatial data sets.

ANZLIC has welcomed proposals by sections of the marine data community to include marine and coastal data as fundamental data themes in the ASDI (Roche, 1997). The Commonwealth Spatial Data Committee (CSDC) and the Heads of Marine Agencies (HOMA) are committed to establishing Commonwealth leadership in the implementation of the ASDI, through the National Marine Data Group (NMDG). The Intergovernmental Committee on Surveying and Mapping (ICSM) is also working closely with ANZLIC in supporting the development and implementation of the ASDI.

ICSM comprises the heads of Australia's Commonwealth, State, Territory and Defence surveying and mapping agencies and also includes the New Zealand Surveyor General. ICSM's role in developing and implementing the ASDI involves participation in all components of ASDI, especially in defining and resourcing fundamental data sets.

The Australian National Marine Data Group (ANMDG) is responsible for the development and promotion of improved standards and processes for the interchange of Marine Data in the Australian Marine Jurisdiction. The ANMDG was formed by the Heads of Marine Agencies (HOMA) in August 2001 and comprises representatives of major agencies with interests in Spatial Data and Oceanographic Data in Australia. The ANMDG program is implemented through Technical Working Groups (TWG) focussed on data standards and protocols in the following areas: Marine Cadastre, Bathymetry, Habitat and Species, Physical Oceanography and Meteorology and Coastal Zone. At present the ANMDG committee are working to implement TWGs to address each of the themes and to develop data interchange standards and protocols within each theme and across the marine environment (ANMDG, 2002).

The Federal Government launched Australia's Marine Science and Technology Plan (MS&T Plan) in 1999. It addresses existing and emerging issues and priorities for Australian marine science, technology and engineering, including those defined in Australia's Ocean Policy. The plan also highlights the need for a better-coordinated national strategy for marine data. The existence of the ANMDG will coordinate national efforts to collect, preserve and make available basic data on Australia's marine environment (Hirst and Robertson, 2001).

There is a recognition that spatial data infrastructures and land administration do not stop at the High Water Mark (HWM) but extend to the marine environment and as a result there is increasing attention being paid to the development of marine cadastres and marine spatial data infrastructures.

## 6. AUSTRALIAN MARITIME BOUNDARIES INFORMATION SYSTEM

AMBIS is a geographic information system containing a national coverage of Australia's maritime limits. AMBIS 2001 is a data product, derived from AMBIS, providing access to the data for Australia' Territorial Sea Baseline (TSB) and maritime zones (AUSLIG, 2001).

AMBIS will be used to facilitate the meeting of specific international obligations as set out in the United Nations Convention on the Law of the Sea (UNCLOS). Australia ratified the Convention on 5 October 1994 and became legally bound when it entered into force on 16 November 1994. AMBIS also provides an important source of information with respect to national maritime legislation.

A major component of AMBIS is the baseline from which the outer limits of the various maritime zones are measured. The Territorial Sea Baseline is used for this purpose and consists of several components including normal baselines, straight baselines and bay and river closing lines.

Using digital mapping and charting data supplied by a number of Commonwealth and State government authorities, the National Mapping Division of Geoscience Australia (formerly AUSLIG) has validated the position of the TSB around the entire Australian coastline. The aim of the validation process was to produce a baseline data set which is totally consistent with the data supplied by those authorities and also with the requirements of UNCLOS. Validated baseline data was then used to define the outer limits of a number of maritime zones, including the 3 nautical mile width of coastal waters, the 12 nautical mile territorial sea, the 24 nautical mile contiguous zone and the 200 nautical mile Australian Exclusive Economic Zone. Base points that generate the zone boundaries are supplied in separate files and an extensive user guide provides useful background information. All data coordinates are supplied in the Geocentric Datum of Australia (GDA 94), which is effectively identical to the WGS 84 datum and make it immediately compatible with global coordinates obtained from the Global Positioning System (GPS).

AMBIS has positional accuracy which varies dependent on the source of the data. It is generally better than + 150 metres. In this regard, AMBIS would be a fundamental part of a national marine spatial data infrastructure (Hirst and Robertson, 2001).

## 7. CASE STUDY

In order to gain a better understanding of the issues involved in designing and developing a marine cadastre and how an SDI could support this research, a case study has been used. The case study area is intended to limit the geographical area, which is chosen with consideration to the different stakeholders occuring in the area.

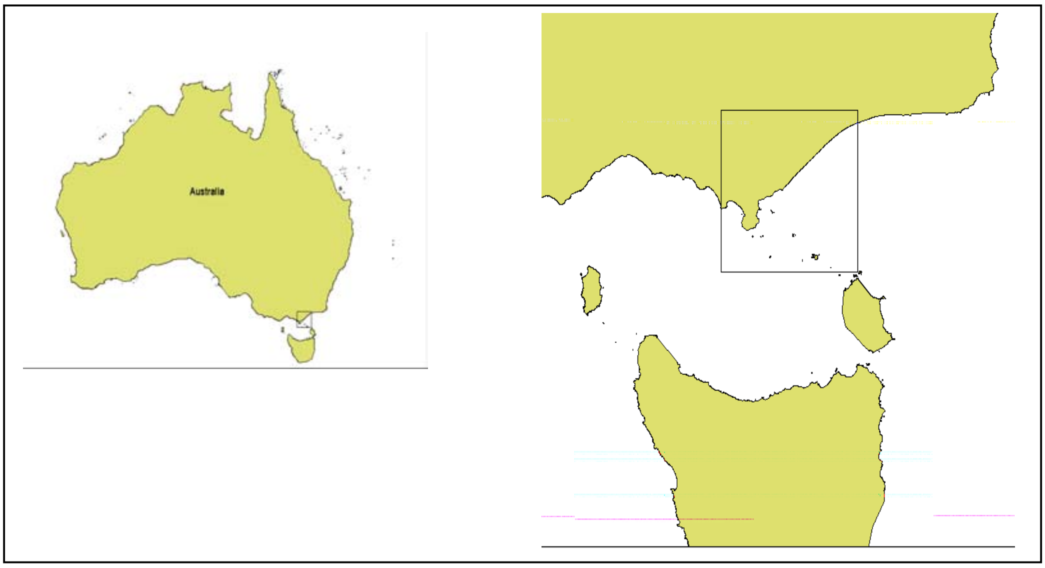


**Figure 2a**: Case Study Location

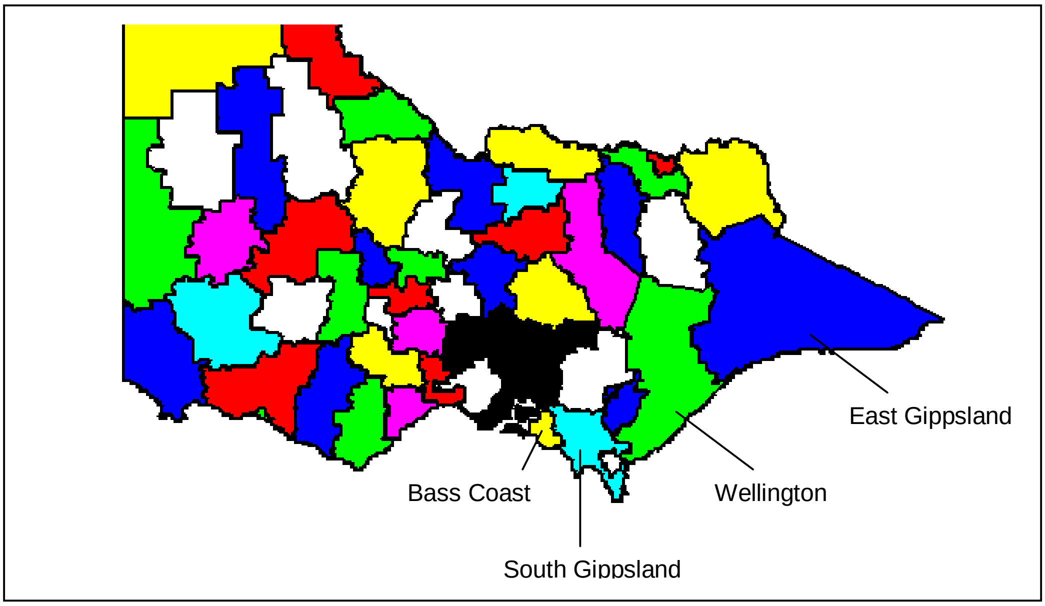


**Figure 2b**: Case Study Location (modified from MAV, 2002)

The pilot study area is located on the area of the Gippsland coasts. And as a region, Gippsland has four local councils or shire councils (which have the coastlines): Bass Coast, South Gippsland, Wellington and East Gippsland. This region has a population of 128,549 in 2000 and has coverage of 34,628 sq km. Gippsland is part of Victoria and lies between Melbourne and the New South Wales border in the far east of the State. Gippsland is a region of great variety and interest, rich in natural resources and containing some of the most fertile farmland in the State of Victoria (MAV, 2002)

The Gippsland coastline is unique, spectacular and largely unspoiled providing an extremely valuable environmental and economic resource. Development pressures on the Gippsland coast are increasing. A large proportion of the land is publicly owned (e.g. national park) and this provides a perfect opportunity for all management agencies to work together, with the community, to identify the planning and management actions required for effective management (National Ocean Office, 2001).

**Table 1:** Summary of marine and coastal related activities within pilot area (Widodo and Binns, 2002)

| | **Bass Coast** | **South Gippsland** | **Wellington** | **East Gippsland** |
|---|---|---|---|---|
| Main Stakeholders | Tourism<br>Fishing and diving activities<br>Agriculture<br>Fishing industry | Tourism<br>National / Coastal Park<br>Agriculture<br>Fishing<br>Oil and gas activities<br>Aquaculture<br>Shipwrecks | Oil and gas activities<br>Agriculture<br>Tourism<br>Fishing activities (both recreational and industry)<br>Gippsland Water | Tourism a<br>Agriculture<br>Oil and gas activities<br>Fishing (mostly locals)<br>Gippsland Port |
| Rights, restrictions and responsibilities | Rights is only related to legislative rights<br>Some overlap rights of fishing and tourism activities<br>Fishing limitation<br>Boats restricted rights<br>No indigenous rights issues | Fishing club license<br>Freehold land with some overlap issue<br>Agriculture vs fishing<br>Caravan park vs Vegetation<br>Indigenous rights issue<br>Oil and gas activities brings money to the community | Oil and gas activities have good relationship with adjacent; warning signs and information | No data |
| Problems | Environmental and coral reef<br>Indigenous vegetation<br>Waste disposal | Waste or dump activities threat, especially from rigs | Safety and pollution aspects<br>Impacts of environmental degradation<br>Lack of tourism | Agricultural waste disposal<br>Erosion<br>Environmental and park issues<br>Marine park issue in communities |

The range of issues varies across shire councils, although there are some similar regional and local issues. Tourism, fishing and agriculture are the most popular activities which can be found in every council (Table 1). Table 1 is based on discussion with Planning and GIS Officers at four local councils and the Gippsland Coastal Board. Issues such as marine or coastal parks, shipwrecks, indigenous rights and mineral exploration however are local, meaning that they are only found at specific councils. Every council has common problems with waste management and environmental problems, mainly caused by stakeholder activities.

The State Government creates policies on the coastal area of Victoria, including Gippsland, through the Victorian Coastal Board. At this policy creation, the shire council has no direct input but is able to comment and make suggestions on policy through the Gippsland Coastal Board. The councils planning scheme stops at the High Water Mark (HWM) but they also have big interest in what happens beyond this point.

Referring to Figure 1, the State Government has jurisdictional rights at Coastal Waters, 3 nautical miles width beyond the coastline. There are many cooperative arrangements between State and Federal Governments (e.g. mineral exploration, fisheries). The Federal jurisdiction begins from 3 nautical miles onwards which is also the legal limit of Australian sovereignty out to the Territorial Sea at 12 nautical miles. Australia has almost full rights in its Territorial Sea although it must allow innocent passages. Within the Contiguous Zone, up to 24 nautical miles, Australia may exercise control necessary to prevent and punish infringement of its customs, fiscal, immigration or sanitary laws and regulations within its territory or territorial sea. Then, from 12 to 200 nautical miles the Economic Exclusive Zone (EEZ), Australia has sea bed and water column rights.

There were several different providers of spatial data for the Gippsland coastal area which are listed below:

1. Australian Maritime Boundaries Information System (AMBIS), National Mapping Division of Geosicence Australia (formerly AUSLIG);
2. VicMap Property and Topography, Land Victoria, Department of Natural Resources and Environment (DNRE), Victoria;
3. Seafarer Geotiff, Australia Hydrographic Office (AHO).

Figure 3 illustrates the integration of both land and marine data sets in the case study area. VicMap Property and Topography data combined with related aspatial data (e.g. information of parcel or property) can then be used to assist in asset and facilities management, property identification, local government authority planning and real estate transaction management. Seafarer geotiff, raster data from the Australian Hydrographic Office (AHO), can be used for any application that is not used for navigational purposes. Information updates of seafarer geotiff include previously uncharted features or altered features that may be hazardous to navigation. It provides basic and important offshore data such as pipeline data rigs construction and shipping lanes. AMBIS has also delimited Australian maritime boundaries into different maritime zones as discussed before.

Spatial data could be utilised to identify a preliminary information of the current spatial condition of the case study area. It can also as be used as a tool and source of information to delimitate the various rights, restrictions and responsibilities. Obviously, there is a discontinuity of land and marine management in the area which can leads to the creation of different issues and conflicts within the coastal area. The following are examples of different kind of issues and conflicts between different users:

- various types of urban, industrial and tourism development;
- waste disposal management from local farms, coastal residents, tourist or recreational users;
- public health and safety issues between oil companies and local residents;

- environmental issues between local residents, fisheries and environmental organisations;
- fishing activities and marine parks issues;
- commercial harvesting of living and non-living natural resources.

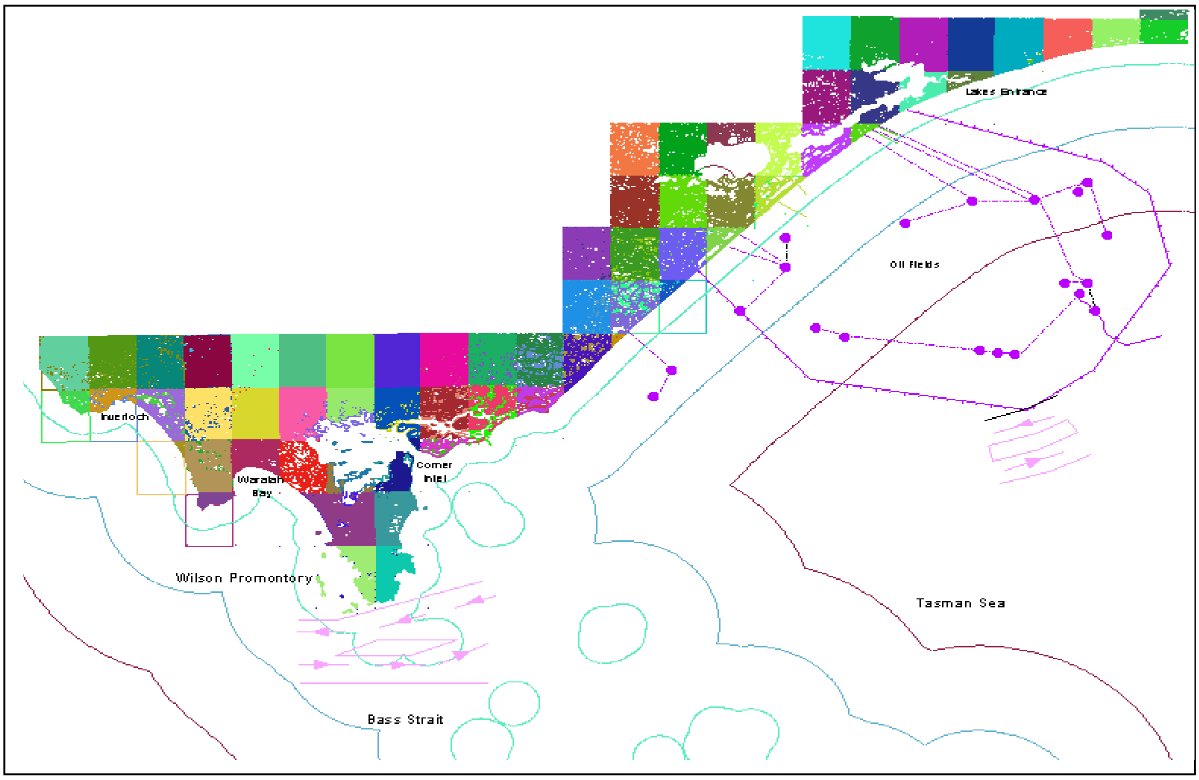


**Figure 3**: Integration of spatial information of case study area

The preliminary information is very important for planning purposes. Further information should also be available to the public and to support the decision making process.

A big issue is a difference in perceptions, usage and interests in the pilot area which can lead to conflicts due to the varying institutional responsibilities involved. Discontinuity between the land and marine management in the coastal zone creates ambiguity and such situations usually lead to competition and conflict of interest between user groups. To minimise this, stakeholders should have clear spatial and legal certainty of their rights, restrictions and responsibilities.

## 8. MARINE CADASTRE CONCEPT AND DIAGRAM

To acknowledge the idea of a marine cadastre, an understanding of interests between stakeholders in different perspectives is important. Conceptualisation of the marine cadastre can best be seen as a puzzle where many components comprising issues, jurisdictions, rights, restrictions or responsibilities have to be brought together in an organised way. In other words creating order out of chaos. The irregular shapes of each component represent the differences of the issues. Though it looks simple in theoretically it is very complex and difficult in reality because it involves different interests. In order to solve this puzzle, we have to carefully examine the shape and order of these puzzles and prevent the ambiguities when they co-exist in the same area.

Furthermore, the fixed puzzles illustrate the perfect and ideal concept of a marine cadastre. The fixed puzzles represent an ideal integrated marine cadastre where all the issues, jurisdictions, rights, restrictions and responsibilities fit into proper spatial locations without any ambiguities and confusions. To support this, a marine cadastre can be a spatial information system, encompassing both the nature and spatial extent of the interests and property rights, with respect to ownership, value, and use in a maritime perspective. The roles of the marine cadastre will be listed as followed:

- Allocation within society and among government organizations of rights of use,
- Ownership, and stewardship to marine resources;
- Regulation of these rights of use, ownership and stewardship;
- Monitoring and enforcement of these regulations by the appropriate authorities;
- Provision of effective means to prevent and adjudicate disputes.

The concept of the entire terminology can be expanded in reality. A marine cadastre is a whole new spatial management system that exercises its role from the coastal boundary between the sea and the land. This separation of land and marine or rather termed as the interface discontinuity is one of the main issues. The interface discontinuity or tidal interface has been identified to be the very fundamental problem in the development of a marine cadastre. From the figure above, there are various stakeholders and activities in the marine environment such as inland development, coastal activities, agriculture, tourism related activities, native title or indigenous issues, marine parks or protected areas, aquaculture, oil and gas exploration, shipping, waste management, cables and pipelines and shipwrecks.

There are many different activities occuring on the ocean surface, in the ocean, beneath the seabed, across the water column, private and public access and so on. The three dimensional spatial characteristics and the generation of a proper model for a marine cadastre is extremely difficult as each and every right, responsibility and jurisdiction has to be taken into account. Otherwise conflicts that arise could be very complex and difficult or almost impossible to resolve. The complexities and difficulties of the issues create a growing demand and concern about introducing a marine cadastre.

The Australian Spatial Data Infrastructure (ASDI) is the fundamental or underlying initiative to essential data. It aims to ensure that users of national spatial data will be able to acquire consistent datasets to meet their requirements, even though the data is collected and maintained by different authorities. The implementation of the ASDI requires a solid infrastructure based on policy and administrative arrangements, technical standards, fundamental datasets, and a means by which spatial data is made accessible to the community. In this context, the ASDI has included the marine environment and encouraged the availability of spatial data to the community.

In order to support sustainable development, the United Nations Convention on the Law of the Sea (UNCLOS) has stated that each Nation is responsible for the “exploitation; exploration; conservation and management” of its marine environment (UNCLOS, 1997). This convention touches all marine stakeholders and activities at different levels and all levels at community. The variety of marine stakeholders which have different backgrounds need standards and a similar understanding of definitions. Todd (2001) identifies a definition has three elements in description, visualisation and realisation. The importance of fundamental spatial data infrastructures will be introduced with particular reference to providing clear and unambiguous legal descriptions for each marine area, visualisation of those areas on maps and or on a computer, include its updating process and realisation of the marine boundaries in the physical marine environment.

The diagram is an evolving concept which might be changed based on discussions, debates and development on the ground.

## 9. CONCLUSION

Currently, the marine cadastre concept is still evolving and will be unique for a specific jurisdiction, in regards to its characteristics, stakeholders, technical, legal and institutional aspects.

A marine cadastre should be considered as part of a spatial data infrastructure, considering its importance for coastal and marine stakeholders. Then, spatial data could be easily accessed to get the basic dynamic information.

Spatial information technology can also be used as a tool to enhance the input, editing, storage and visualisation of spatial information. Spatially, it can also be used to illustrate problem areas and alternative solutions. In the case study, spatial information was used to identify boundaries, different kind of issues and competing uses and interests between stakeholders. Stakeholders should have clear spatial and legal certainty of their rights, restrictions and responsibilities.

The primary focus of many surveyors worldwide has been on land-based issues. The marine cadastre concept presents an opportunity for surveyors to widen their horizon and work more closely with their hydrographic surveying colleagues.

The diagram below (Figure 4) may add to the discussion:

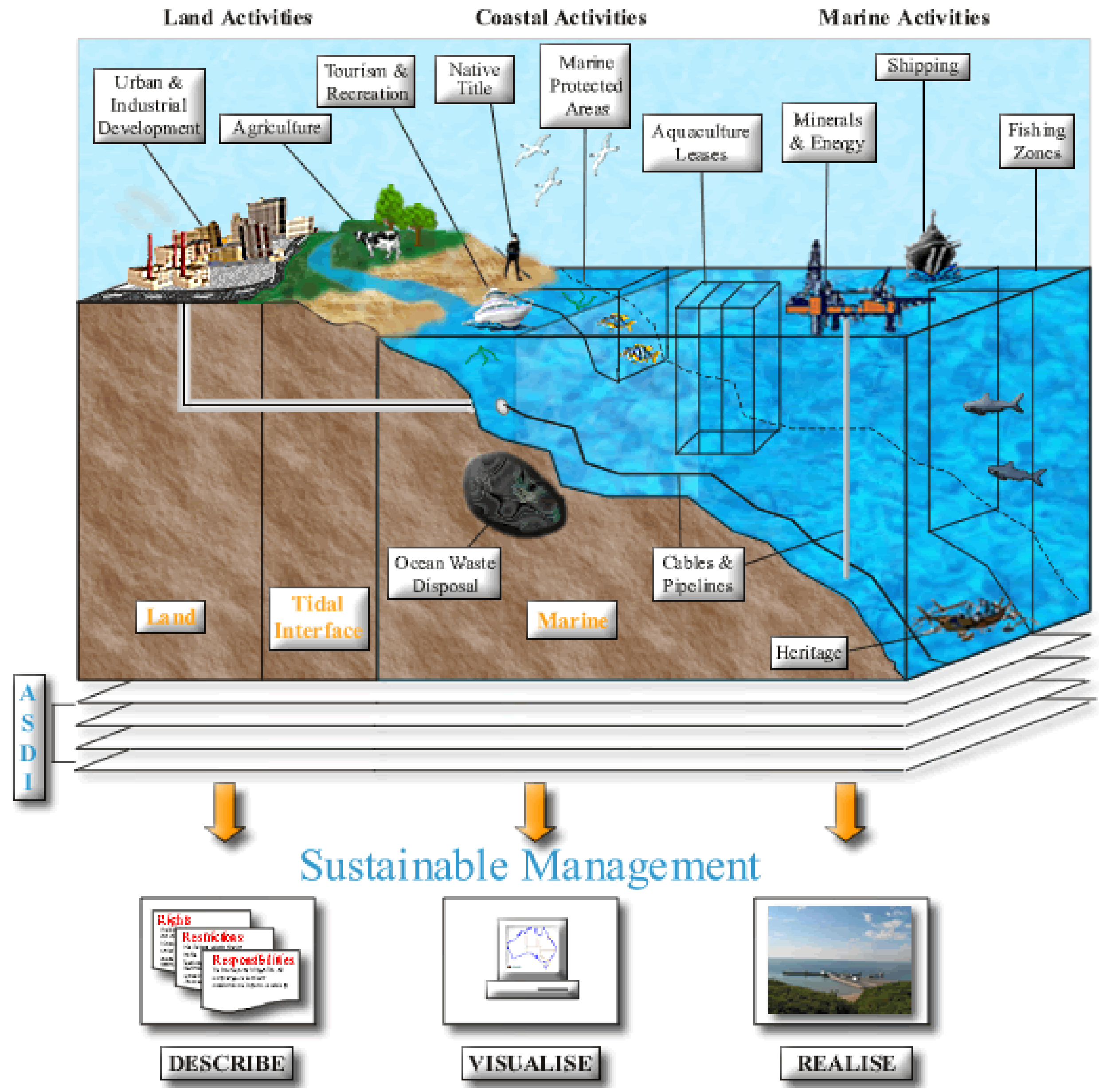


**Figure 4**: Marine Cadastre Diagram (ARC Marine Cadastre, 2002)

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