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MARINE CADASTRE AND SPATIAL DATA INFRASTRUCTURES IN MARINE ENVIRONMENT

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ABSTRACT

A Cadastre is normally the basis or core of a land administration system and is defined as a parcel based and up-to-date information system containing a record of interests in land (e.g. rights, restrictions and responsibilities). It usually includes a geometric description of land parcels linked to other records describing the nature of the interest, and ownership or control of those interest, and often the value of the parcel and its improvements (FIG, 1995).

But in the marine environment, the terminology of cadastre is still unclear because there are some problems like discontinuity between land and marine cadastre, standard, technical and legal institutional aspects. A structured administration of land and marine interface area, or coastal zone, is rarely founded. United Nations Conventions on the Law of the Sea (UNCLOS) as an international regulation, then national and states legislations regulate marine related activities.

The objective of the paper is to understand and identify rights, restrictions and responsibilities in the marine environment. It also identifies the problems and needs from various users from marine stakeholders and to discuss the concept of marine cadastre. A particular focus of the research is a review of the administrational interests at the land marine interface. A pilot project will be researched and analysed by integrating its dataset to allow its stakeholders to access the dynamic information. Spatial Data Infrastructures (SDI) in the marine environment will be examined by evaluating the current initiatives and policies

KEYWORDS: marine cadastre; spatial data infrastructures; marine rights, restrictions and responsibilities.

INTRODUCTION

This paper will be much concentrated on the issues that are basic of the marine cadastre. As we all understand that marine cadastre is a very new field in cadastral system. Around the world, with Canada and the United States which are more early frontiers in establishing marine cadastre and New Zealand with its concept, there is barely any country setup the marine cadastre completely (Nichols et al., 2000; Fowler, C. and E. Treml, 2001; Grant, D. 1999). Australia has started with Australian Research Council (ARC) Marine Cadastre Project from early 2002 (Collier et al., 2001). This paper will be discussing development of cadastre and spatial data infrastructures in marine environment with particular focus at case study area.

Marine cadastre sits in a completely different situation as that on the land. The most vivid example is that there is no physical visual benchmark and boundary on the seabed. Due to the immense ocean volume and complexities of the ocean climate, there is really indeed very little done to map the ocean floor.

If geographic position has been adopted as a fundamental element in the creation of the relevant data sets and in order to achieve this desirable state of affairs, it will be necessary for a paradigm shift to occur on the part of the custodians of many of the data sets which impact on land tenancy or utilisation.

The creation of a legal coordinated marine cadastre has provided a challenging opportunity for the survey profession. The surveyors' role 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.

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 created survey operational environment within will be possible to fully investigate and test the real potential of conventional and developing technologies such as GPS and GIS, to resolve any ambiguities that will be raised when coastal or marine activities are carried out.

DEVELOPMENT OF CADASTRE

The ecological history of humankind, traditionally, reveals that most of the riots, conflicts and wars have been related to the interest of land. Even now, many newly developed wars have been related to claim of territories and expansion of rights. The concept of a land cadastre has developed to the current mature system. Currently, a cadastre could be explained as a parcel based and up to date land information system consists 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 relates to other records describing the nature of interest and ownership or control of those interests, and even 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 developer, land owners and the public authorities to ensure that benefits are maximised and costs (economic, social and environmental) are minimised. Through centuries has evolved and transformed into many other forms that continue to offer forms that continue to offer assistance in various functions for multiple people.

Current development and projects have been engaged in the area of Spatial Data Infrastructure (SDI) that builds on the concept of Geographical Information System (GIS). Then, extend the role and capability of land cadastre into a multifaceted information system that continue to offer more efficient services as well as all-rounded dynamics partnership between private and government organisations.

As the land cadastre and SDI gradually become mature and functional, however, there is also other strong belief that attempts to implement the identical management information and administration systems into the marine environment. In spite of the fact that human spend almost all time on land, but there is seen and understood gradual important increase in the marine activities. We must not neglect the fact that the oceans consist 70 percent of the earth crust while the remaining 30 percent of land has becoming overpopulated. Human beings has spent most the entire history in conquer and conquest of territories. It would be a significant achievement in the history even if the slightest efforts could be achieved in the proper management of the oceans. Researches

studies show that the vast oceans would be more spatially complex than that of land. Therefore, a newly proposed discipline called Marine Cadastre has evolved to determine, model and manage the offshore territory.

The United Nations Convention on the Law of the Sea (UNCLOS) agrees that Australia can claim approximately 1.5 times greater than the size of its land in ocean (AUSLIG, 2001). The claims of areas represent the future limits of zones that define the international jurisdictional rights and responsibility in marine to which Australia lays. Australia is fortunate to be able to claim that vast area in the oceans that could very possible in future providing essential resources for both the economy and future generation. Hence, there is really an urgent task to establish active involvement in the good governance of it. The establishment of marine cadastre would give rise to a new branch of researches that would soon reveal the potential of oceans in the way leading to sustainable development.

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 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.

Furthermore, Munro-Faure (1991) stated that more than two third 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 rural-urban drift, which puts increasing pressure on these coastal areas.

The marine resource is as subject as any resource to these pressures, and 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 ideas of marine cadastre is that there are similarities between land and marine management. And there is an idea of using experience on land cadastre to be applied to the marine environment, with some adjustments. However, an early examination of the issues reveals that this elementary approach has some major differences. There are some unique problems that do not apply in the case of land data but can be found in the 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 will not be enough
- It is possible (common) for multiple (overlapping) rights to exist in 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 infrastructures for the marine environment will be quite different and have more new challenges.

The issues of land and marine administration systems are common on an international basis but mostly country and even locally specific. It is impossible to adopt a marine cadastre model from other jurisdiction and apply it in other 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. In further, 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 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.

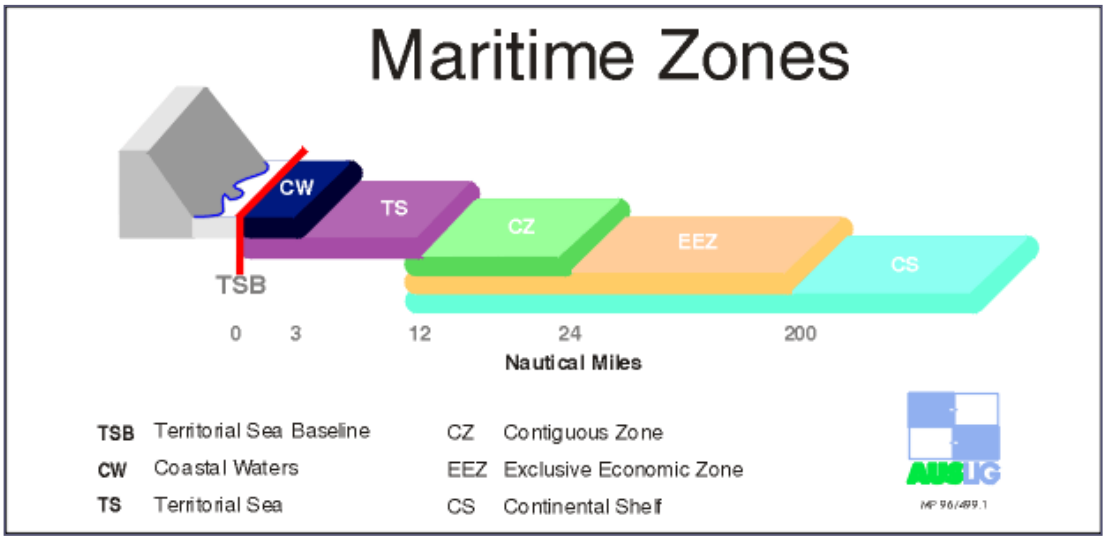

Figure 1: Australian Maritime Zones (AUSLIG, 1999)

SPATIAL DATA INFRASTRUCTURES

Spatial data are items of information which can be related to a location on the Earth, particularly information on natural phenomena, cultural and human resources such as topography including geographic features, places names, height data, land cover, hydrography; cadastre (property-boundary information); administrative boundaries; resources and environment; socio-economic including demographic; etc. (CSDC, 2001; Radjabifard, 2002). These type of data are critical to promote economic development, improve our stewardship of natural resources and to protect 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. Position is important and can be viewed from different points. First, 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. Second, locations allow distances to be calculated, maps to be made, directions to be given and decisions to be made about complex, inter-related issues (Mapping Science Committee, 1995). And more than 80% of governmental data has a locational basis (Budic and Pinto, 1999; Radjabifard, 2002).

The needs for spatial data dare 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 unprecedented investments in information and the means to assemble, store, process, analyse and disseminate it. Many organisations, agencies and departments in 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 data. 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 is so high that the Australian New Zealand Land Information Council (ANZLIC), which is the 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 facilitate 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 relative to its context, Rajabifard et al. (2000) state the important principle that SDI are intended 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 its needs and requirements.

- *People*. Consists of administrators, custodian, users and value-added resellers of spatial data. It can be individuals or organisations, small or large business, private or public.
- *Institutional framework*. Consists of administration, coordination, policy and legislation components of SDI. This is important for the success of communication and partnership between different agencies.
- *Technology*. Include the access and distribution network and also clearinghouse. The influence of the level of SDI and the focus for the technical components have an important influence on the approach taken for aligning components towards the development of SDI.
- *Standards*. Include standards and policy which should be consistent 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 eight States and Territories and the Commonwealth government to provide leadership for spatial information and various elements of SDI development nationally (Warnest et al., 2002).

MARINE SPATIAL DATA INFRASTRUCTURES

The objectives of ANZLIC are developing a national geographic data infrastructure include 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. The ASDI will maximise the access, use and integration of spatial data, avoid duplication in acquisition and maintenance of spatial data, and clearly define custodianship of principal 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 working closely with ANZLIC in supporting the development and implementation of the ASDI.

ICSM is comprised of 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 development and promotion of improved standards and processes for 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, 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) on 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 ANMDG will coordinate national efforts to collect, preserve and make available basic data on Australia's marine environment (Hirst and Robertson, 2001).

The recognition that spatial data infrastructures and land administration do not stop at the High Water Mark (HWM) but extend to the marine environment. As a result there is in creasing attention to marine cadastre and marine spatial data infrastructures.

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 and 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 baseline, straight baselines and bay and river closing lines.

Using digital mapping and charting data supplied by a number of Commonwealth and State government authorities, 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 varies dependent on the source of the data. It is generally better than $\pm$ 150 metres. In this regard, AMBIS would be a fundamental part of a national marine spatial data infrastructure (Hirst and Robertson, 2001).

CASE STUDY

In order to gain a better understanding of the issues in marine cadastre and how an SDI could support this research, a case study has been located. The case study area is intended to limit the geographical area, which is chosen with considerations of the different activities by different stakeholders.

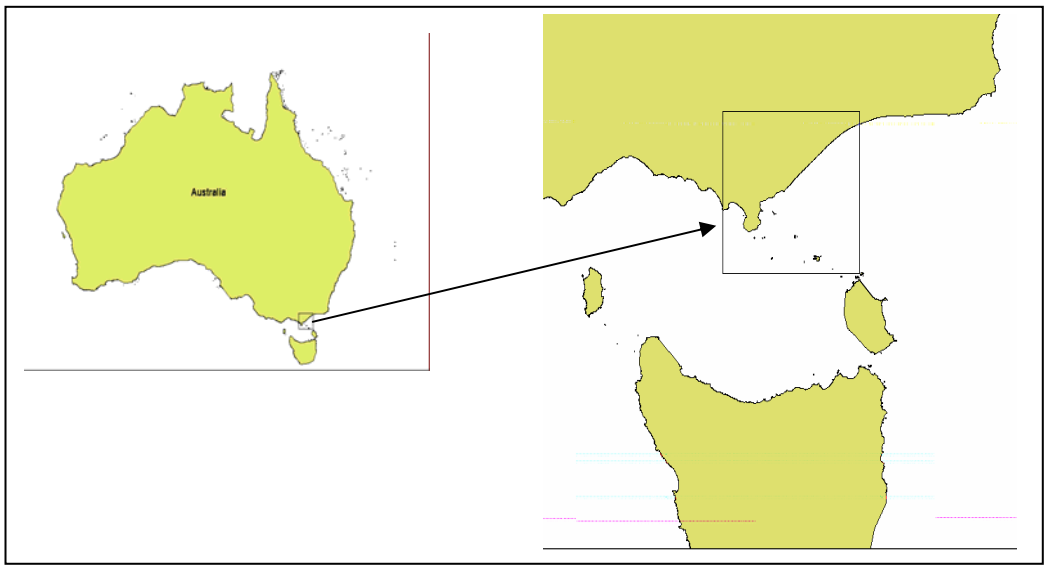

Figure 2a: Case Study Location

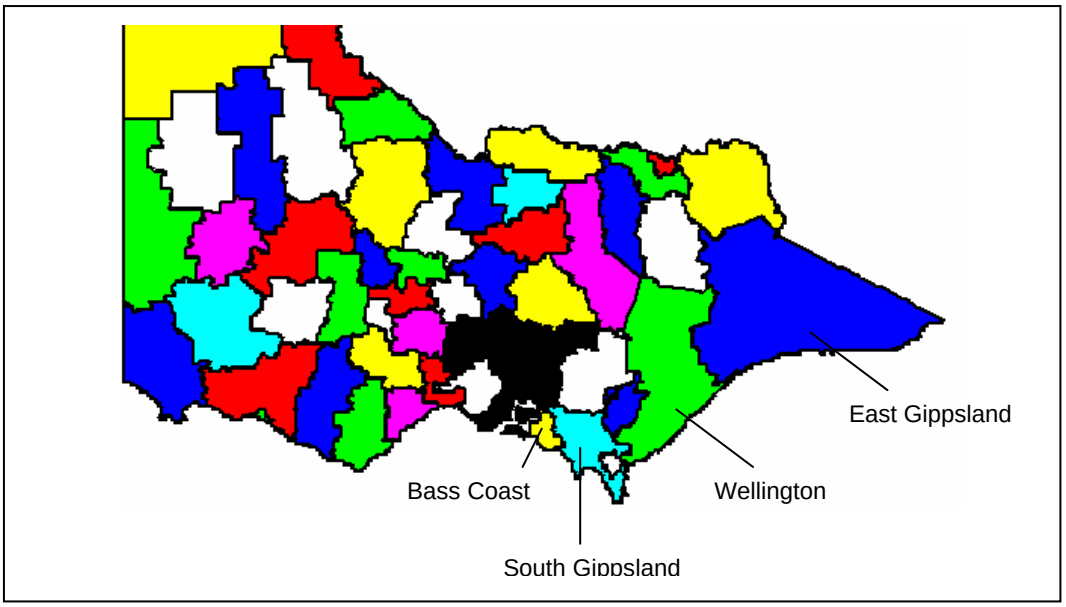

Figure 2b: Case Study Location (modified from MAV, 2002)

In this case study, Gippsland as a region has four local councils or shire councils which have the coastlines; Bass Coast, South Gippsland, Wellington and East Gippsland. This region has population number of 128,549 in 2000 and has coverage of 34,628 sq km. Gippsland is part of Victoria that lines 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 the involved agencies to work together, with the community, to identify the planning and management actions required for effective management (National Ocean Office, 2001).

The range of issues varies across shire councils, although there are similar regional issues and local issues. Tourism, fishing, agriculture are the most popular activities which can be found at every councils (Table 1). While issues such as marine or coastal park, shipwreck, indigenous rights and mineral exploration are local, it means that the activities only can be 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, include 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 only stop at the High Water Mark (HWM) but have big interest in what happens beyond this point.

Refer to Figure 1, the State Government has jurisdictional rights at Coastal Waters, 3 nautical miles width beyond coastlines. There are many cooperative arrangements between State and Federal Government (e.g. mineral exploration, fisheries). The Federal jurisdiction begins from 3 nautical miles onwards which is also legal limit of Australian sovereignty out to the Territorial Sea at 12 nautical miles. Australia has almost full rights although has to allow innocent passages. At Contiguous Zone, until 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, 12 to 200 nautical miles called Economic Exclusive Zone (EEZ) sea bed and water column rights.

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

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

Then, the integration of spatial data of Gippsland coastal area which are available from different providers:

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

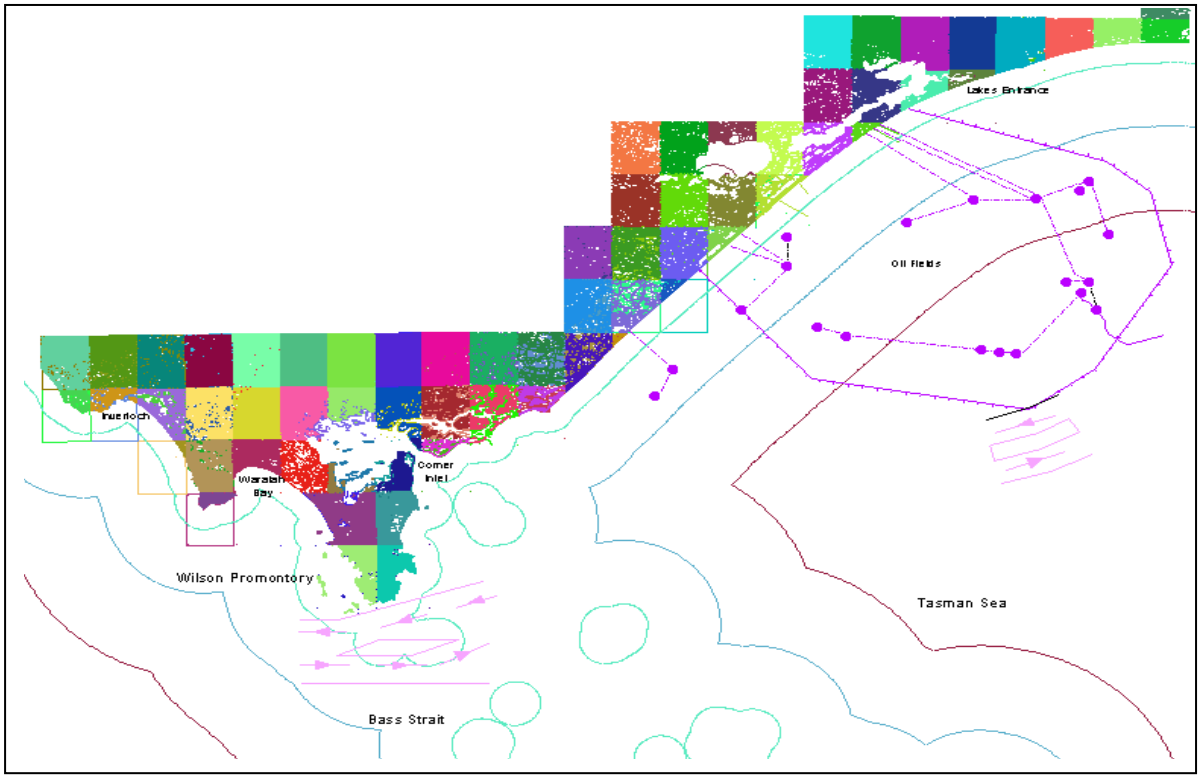

Figure 3: Integration of spatial information of case study area

Figure 3 illustrates integration of both land and marine data sets at the area. VicMap Property and Topography is the current state wide data sets which combined with related aspatial data (e.g. information of parcel or property). These data can be used for asset and facilities management, property identification, local government authority planning and real estate transaction management. Seafarer geotiff 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. While AMBIS delimited Australian maritime boundaries into different maritime zones as discussed before.

By using spatial data as a tool and source of information, we could have preliminary information about the current spatial condition. Obviously, there is a discontinuity of land and marine management in the area. In regard to that condition, it created some 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 people
- 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.

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

The different perceptions, usage and interests which could lead to conflicts are such big issues at the area. This is due to different institutions with different responsibilities involved in the issues. Discontinuity between land and marine cadastre in the coastal zone created ambiguity and such situations usually lead to competition and conflict of interest between user groups. Stakeholders should have clear spatial and legal certainty of their rights, restrictions and responsibilities.

MARINE CADASTRE CONCEPT AND DIAGRAM

To acknowledge the idea of marine cadastre, an understanding of interests between stakeholders in different perspectives is important. Conceptualisation of marine cadastre can be drawn as a simple unsolved puzzle where each puzzle represents an issue, jurisdiction, rights, restriction and responsibility. The irregular shapes of each puzzle represent the differences of the issues. Though it looks simple in puzzle, but it is very complex and difficult in reality because 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 co-exist in the same area.

Furthermore, the fixed puzzles illustrate the perfect and ideal concept of 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 the 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 diagram below (Figure 4) may add the discussion:

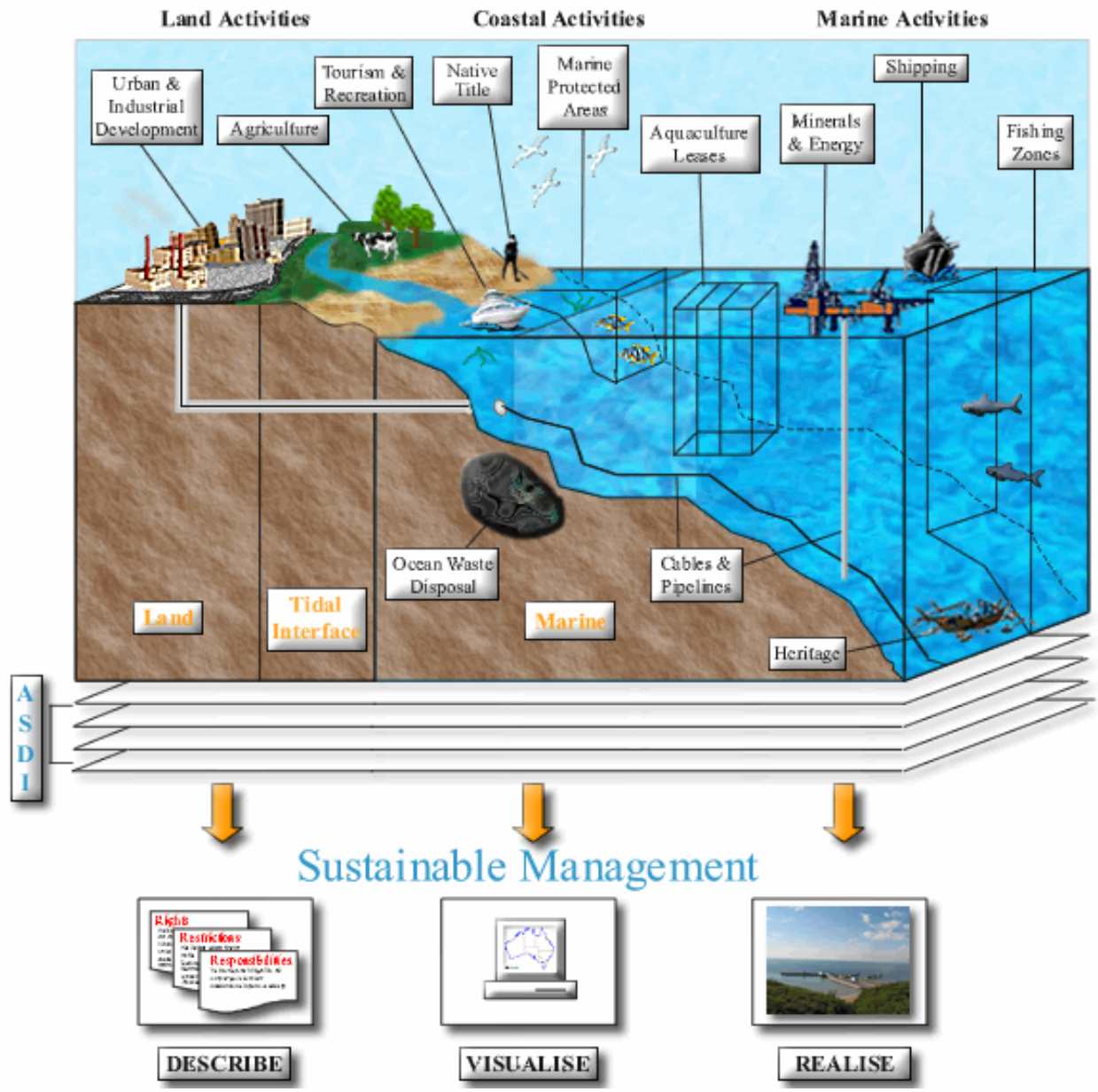

Figure 4: Marine Cadastre Diagram (ARC Marine Cadastre, 2002)

The concept of the entire terminology can be expanded in reality. 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 marine cadastre. From 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 on ocean surface, in the ocean, beneath the seabed, across the water column, private and public access and so on. The three dimensional spatial characteristic and the generation of a proper model for marine cadastre is extremely difficult while each and every right, responsibility and jurisdiction has to be taken care of. 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 concerns about introducing a marine cadastre.

Australian Spatial Data Infrastructure (ASDI) is the fundamental or underlying initiative to essential data. It aims to ensure that users of a 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. At this context, ASDI has included 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 of marine stakeholders and its activities at different levels and all levels at community. The variety of marine stakeholders which have different backgrounds need standard and 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 in 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.

CONCLUSION

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

Spatial information technology can be use as a tool served to enhance input, edit, store and visualise the spatial information. Spatially, it also can be used to illustrate problem areas and alternative solutions. In the case study, spatial information used to identify boundaries, different kind of issues, competing uses and interest between stakeholders.

There should be more research on marine cadastre, especially on its complexity of legal institutional, technical standards and reference. Currently, the concept of cadastre is still evolving and will be unique for a specific jurisdiction regarding to its characteristics, stakeholders and legal institutional aspects.

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