Building a Marine Cadastre for South Korea

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This thesis contains no material which has been accepted for the award of any other degree or diploma in any tertiary institution, and to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

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Abstract

With the enactment of Ocean Korea 21 (2000), South Korea has made a commitment towards the sustainable development of its ocean and coastal resources, based on principles of integrated and effective management.

The complexities of marine area management are highlighted in the Korean situation, with a complex legal and institutional framework, changing economic priorities, escalating conflicts related to resource use, and increasing pressure to address ecosystem problems. South Korea is in a difficult political and geographical situation, with jurisdictional conflict in its maritime regions. Consequently the need to establish an integrated marine management system is fundamentally important to South Korea.

Despite the absence of physically marked boundaries, and despite the complexity of reliable marine positioning, maritime boundaries and their associated rights, restrictions, and responsibilities are absolutely real and must be well managed and adhered to (Collier et al. 2003).

In this thesis, an examination of marine environmental, policy and information management issues, particularly in the Australian and South Korean contexts, has contributed to recommendations for a marine cadastral system for South Korea.

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Table of contents

List of figures

List of Tables

List of appendices

List of Abbreviations

ANZLIC	Australian and New Zealand Land Information Council
CGDI	Canadian Geospatial Data Infrastructure
DFO	Department of Fisheries and Oceans
EEZ	Exclusive Economic Zone
FIG	International Federation de Geometres
FGDC	Federal Geographic Data Committee
GBRMP	Great Barrier Reef Marine Park
GIS	Geographic Information Systems
GPS	Global Positioning System
HML	High Water Line
HWM	High Water Mark
LWM	Low Water Mark
MBWG	Marine Boundary Working Group
MCIS	Marine Cadastre Information System
MGDI	Marine Geospatial data infrastructure
MHW	Mean High Water
MLTM	Ministry of Land, Transport and Maritime affair
MOMAF	Ministry of Maritime Affairs & Fisheries
MPA	Marine Protected Area
NBS	New Brunswick Service
nm	Nautical Miles
NOAA	National Oceans and Atmospheric Administration
NOO	National Oceans Office
NRC	National Research Council of Canada
OAP	Oceans Action Plan
OPIS	Ocean Planning Information System
PCGIAP	Permanent Committee on GIS Infrastructure for Asia and the Pacific
SDI	Spatial Data Infrastructure
SFR	Statutory Fishing Rights
TSB	Territorial Sea Baseline
UNCLOS	United Nations Convention on the Law of the Sea

1 Introduction

1.1 Background

South Korea is a deeply maritime nation; it has over 3000 islands with 443,000 km^2 of marine area, which is 4.5 times greater than the land area, and 11,542 km of political borders dominated by maritime boundaries. Coastal and marine activity has expanded over the last few decades, includes aquaculture, tourism and recreation, mineral and energy extraction, shipping and fishing. This increase in the use of the marine environment has resulted in Korea's marine territory being more highly valued than in the past. Additionally, environmental concerns over the impacts of these activities have also increased.

Current examples that indicate the key importance, and conflicting interests, of the marine environment in South Korea are the energy industry and the tourism industry. According to the Korea National Oil Corporation, substantial natural gas deposits (about 250 billion ft^3) were discovered in the East Sea in 1998, and also the western coastline of South Korea has the potential to generate electric power using tidal energy, as this area is renowned for having some of the strongest tidal surges in the world. With the development of these resources comes substantial environmental concerns., At the same time, according to the Tourism Sciences Society of Korea, the marine tourism industry has increased its proportion of the entire tourism industries from 26% (2000) to 31.4% (2010) and expect to reach 40.8% in 2020 (Shin, 2003).

Because of the diversity of activities operating in South Korea's maritime areas, current policy and institutional frameworks for governing this marine jurisdiction are complex and overlapping. Further, the marine environment is inherently three dimensional (and increasingly needs to be viewed as four dimensional because attributes and conditions need to be related to particular times).

Part of the solution to this situation is to create an integrated system of classification and mapping for visualization. Commonly, this is known as a marine cadastral system. A marine cadastral system would integrate currently overlapping management organizations and assist in representing and managing the competing rights, restrictions and responsibilities of all possible stakeholders (Binns et al. 2003).

1. 2 Research Problems

In spite of the increasing public need for a marine cadastral system in South Korea, the development of a marine cadastre has not been addressed in a structured manner in South Korea. This is because the concept of a cadastral system for marine environments is relatively new, and because the technologies that can model a complex environment in three-dimensions are still being developed, and because of the complex relationships that exist both between stakeholders and organizations and within these groups themselves.

One significant problem relates to an absence of law to describe the marine and coastal jurisdictional boundaries for local government. As a result, conflict about maritime borders has increased dramatically (Choi et al. 2005). Currently, a local government committee addresses reconciliation, based on Local Autonomy Law; but few cases are resolved because of the complicated overlapping jurisdictions (Lee et al., 2005).

Another problem relates to uncertainties associated with establishing a coastline or tidal datum. Boak and Turner (2003:688) suggest that definitions of what constitutes a coastline, in the sense of an idealized boundary defined by the meeting of land and sea, is difficult to determine. This is because coastlines are very dynamic natural environments and shift depending on temporal and spatial variations (Boak and Turner, 2003:688). For example, Boak and Turner (2005: 689) note that coastlines are subject to "waves, tides, groundwater, storm surge, setup, run-up, etc". These variations need to be taken into account when developing a tidal or shoreline datum. In response to this problem, Boak and Turner (2005: 689) argue that "because of the dynamic nature of the idealized shoreline boundary, for practical purposes coastal investigators have typically adopted the use of shoreline indicators. A shoreline indicator is a feature that is used as a proxy to represent the 'true' shoreline position" (See Figure 1 and 2).

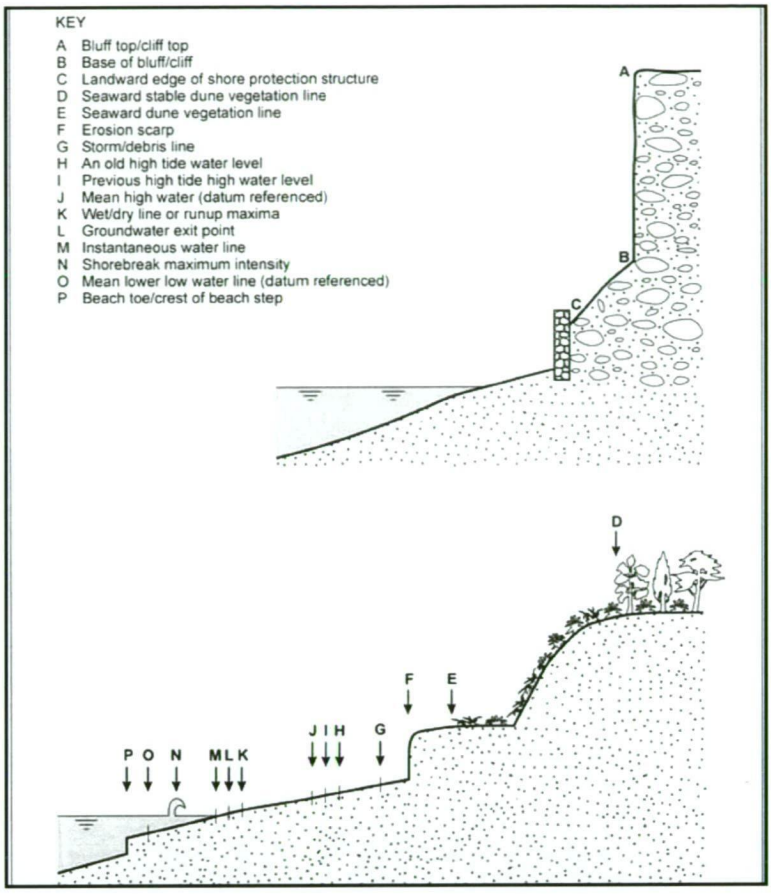


Figure 1 Spatial relationship between commonly used shoreline indicators (Source: Boak and Turner 2005)

Figure 2 A range of shoreline indicator features, Duranbah Beach, NSW (Source: Boak and Turner 2005)

In addition, the need to balance development and the exploitation of marine resources with environmental and social needs is widely accepted and must be a core objective of any marine cadastre system (Vaez et al. 2006). In this context, the significance of spatial data management for marine areas, which includes coastline changes, has been recognized for over a decade and in order to improve management of marine areas, a marine cadastral system is needed.

To summarize the main problems within developing marine cadastre system in South Korea, firstly the unclear Law of the marine boundaries to the overlapping jurisdiction which conflict between international and local government, secondly, the uncertainties associated with establishing a coastline or tidal datum (also known metadata) and the last is the balance between development and the exploitation of marine resource with environmental protection and social needs.

1.3 Research Objectives

The purpose of this study is to introduce key marine cadastral concepts that would be suitable for adoption by South Korea. The research involves an analysis of existing marine cadastral systems and considerations relating to the introduction of an integrated and highly effective new system into the unique context of South Korea's environmental and political situation.

In particular, Australia's marine cadastral systems are reviewed. Australia was chosen so as to focus specific attention on the environmental significance of marine cadastral systems, their integrative possibilities, and how such systems function to satisfy the various and often competing interests of the different stakeholders involved. In addition, a brief examination of similar developments with marine cadastres in the USA and Canada is also undertaken to provide a broader international comparison.

The objectives of the thesis are thus to establish key recommendations for a marine cadastral system for South Korea, to meet the needs for the 'change paradigm' introduced by Ocean Korea 21 (2000).

1.4 Structure of the thesis

In chapter 2, I introduce the concept of a terrestrial cadastral system which is mature and has been functionally settled for a few decades and I explore the key ingredients that make cadastral systems so useful for the management and control of not only the land, its resources and their use. I then note that the maritime environment is different to the land environment in terms of unique problems that do not apply in the case of land data but can be found in the marine environment. For examples, the concept of tenure is different in a maritime environment, and it is impossible to use classical means of boundary marking offshore. Further, the marine environment is inherently more three dimensional, and potentially more four dimensional because of its capacity for rapid change over time.

Therefore, the application of a terrestrial cadastral system to a marine environment will involve the following important considerations: three dimensional mapping, potentially four dimensional mapping, new technologies for viewing and interrogating the competing interests of different stakeholders, the mix of different jurisdictional and international laws that areas apply to marine areas.

Chapter 3 provides a background to the Australian marine environment, marine management organizations and their objectives, such as Australia's Ocean Policy and Marine Science and Technology Plan. Also the Spatial Data Infrastructure for marine area introduced, particularly the five key elements, which are: data, standards, policies, access networks, people and partnerships. In section 3.3, I divide the concept of a marine cadastre issues into three categories, legal, institutional and technical. Chapter 3 also explores some of the key issues facing Australia, including shoreline erosion, loss of coastal wetlands, loss of marine habitat and conservation for protected areas, protecting marine heritage, aquaculture, oil, gas and mineral extraction and overfishing. In the discussion, I summarize Australia's marine policy and SDI, the current key issues with the Australia's marine cadastre and marine environment and those aspects of the Australian system that could contribute to the best possible performance of a marine cadastre system in South Korea.

Chapter 4 starts with background about South Korea's geographical and

political situation. I then describe 'Ocean Korea 21' with its three basic objectives and seven specific goals. Marine related organizations are outlined in section 4.2.2, and then I focus on marine environment management and its three long term plan by the South Korean Ministry of Land, Transport and Maritime Affairs (MLTM).

There are also marine parks and reserves in South Korea. In section 4.3, I introduce coastline management and the differences between parcel boundaries and coastlines. In section 4.4, I explore the main marine cadastral issues facing South Korea at an international, national and local level, including some between Australia and South Korea.

In the chapter 5, a brief international comparison is presented, with a focus on USA and Canada. The different definitions from this international view and the operation of related organizations in the two countries are explained, including the legal, institutional and technical problems highlighted by these case studies.

In the chapter 6, I present the overall results of my research, with a summary of the research, and best practice recommendations for South Korea.

2. Applying terrestrial cadastral systems to the maritime environment

In order to understand the concept of a marine cadastral, this chapter explains the history and definitions of a terrestrial cadastre and a marine cadastre. The maritime zones defined under international law (UNCLOS), together with national, regional law of marine area are also defined and explained. Maritime and shoreline boundaries are studied in section 2.5, including a brief explanation of issues related to delineation of shoreline boundary.

Figure 3 shows the marine cadastre concepts including the link between the terrestrial and marine environments through the spatial data infrastructure (Williamson et al.2004:6)

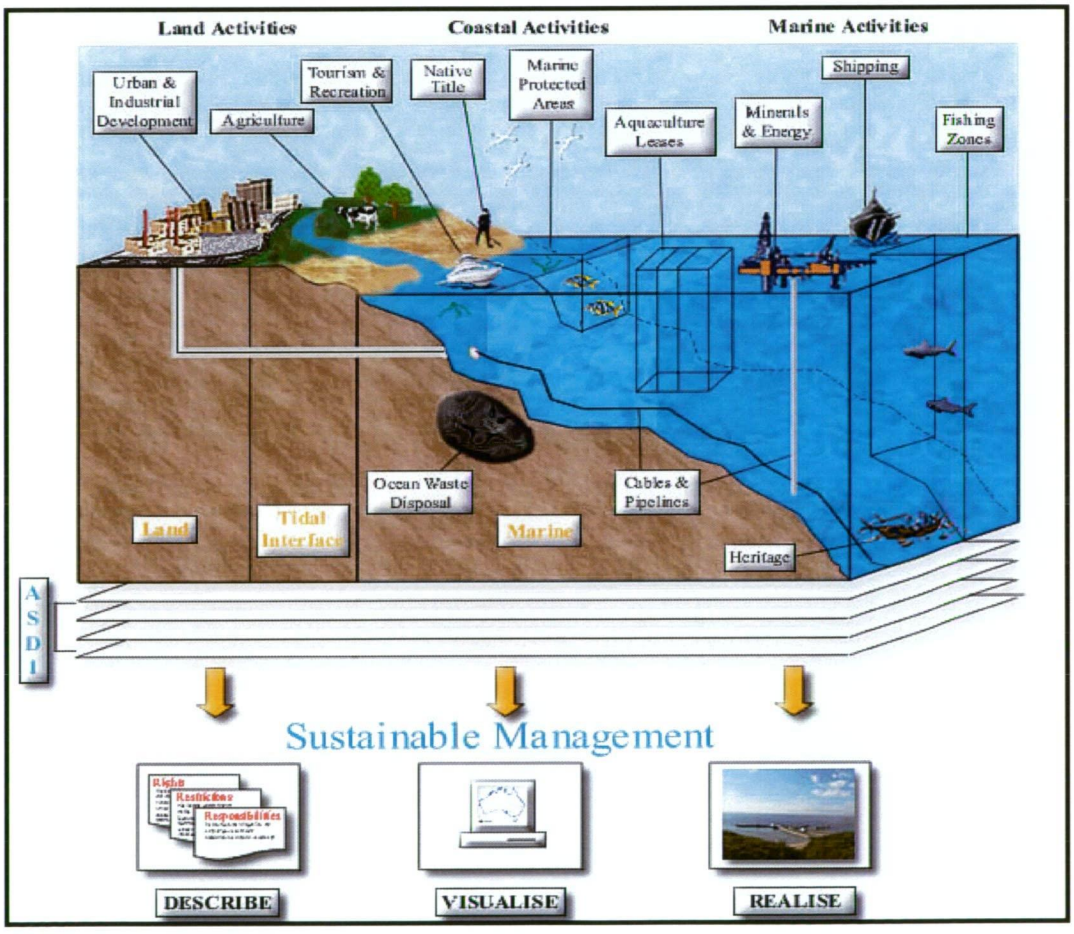


Figure 3 Marine Cadastre Concepts (Source: Williamson et al. 2004:6)

2.1 Terrestrial cadastral systems

The word 'cadastre' came from Latin *Capitastrum*, which means a register of the tax and the Greek *Katastikhon*, a list or register but literally 'line by line' with the directions and distances.

In 1995, the International Federation de Geometres (FIG) published the following statement about cadastral systems:

> A Cadastre is normally a parcel based, and up-to-date land 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 interests, the ownership or control of those interests, and often the value of the parcel and its improvements.

Modern cadastres, according to Kaufmann in the 1998 FIG publication 'Cadastre 2014' have the following key characteristics:

- they will describe the complete legal situation of land including public rights and restrictions
- the separation between maps and registers will be abolished
- cadastral mapping will be replaced by modelling
- the paper and pencil cadastre will be replaced by electronic information
- they will be highly privatized public and private sectors are working together
- the cost of maintaining the cadastre will be recoverable

2.2 Marine cadastral systems

Nichols et al. (2000) describe the marine cadastre as: 'A marine information system, encompassing both the nature and spatial extent of interests and property rights, with respect to ownership and various rights and responsibilities in the marine jurisdiction.' A marine cadastre provides the means for delineating, managing and administering legally definable offshore boundaries (Collier et al. 2003).

The management of oceans can be expected to demand a far more diverse spectrum of information than would be provided by a marine cadastre alone, however it

must be acknowledged that a complete and current source of information relating to offshore boundaries and the rights, restrictions and responsibilities associated with those boundaries is of fundamental importance to the management of a nation's maritime interests and responsibilities (Collier et al. 2003).

In order construct a marine cadastral system, information therefore needs to be collected and collated about the physical topography of the marine environment, its environmental characteristics, as well as a registry of its natural and human-made resources (Kim, 2006). This is likely to extend from off the continental shelf to the marine-land interface. It is difficult to find examples of a structured administration of the land and marine interface area (Widodo, 2003).

2.3 Different level of maritime law

2.3.1 International maritime Boundaries

The United Nations Convention on the Law of the Sea (UNCLOS) is a very significant agreement, providing international conditions and limits concerning the use and exploitation of the earth's oceans (Binns et al. 2003). Under UNCLOS there are a number of maritime zones defined by their distance from land, or more precisely, from the Territorial Sea Baseline. According to Barry et al. (2003), a baseline is a natural ambulatory line. This means, every time the position of the baseline is changed in nautical charts due to natural or human causes, the limits which are based on it change too. The maritime zones from Australia government are displayed in Figure 4.

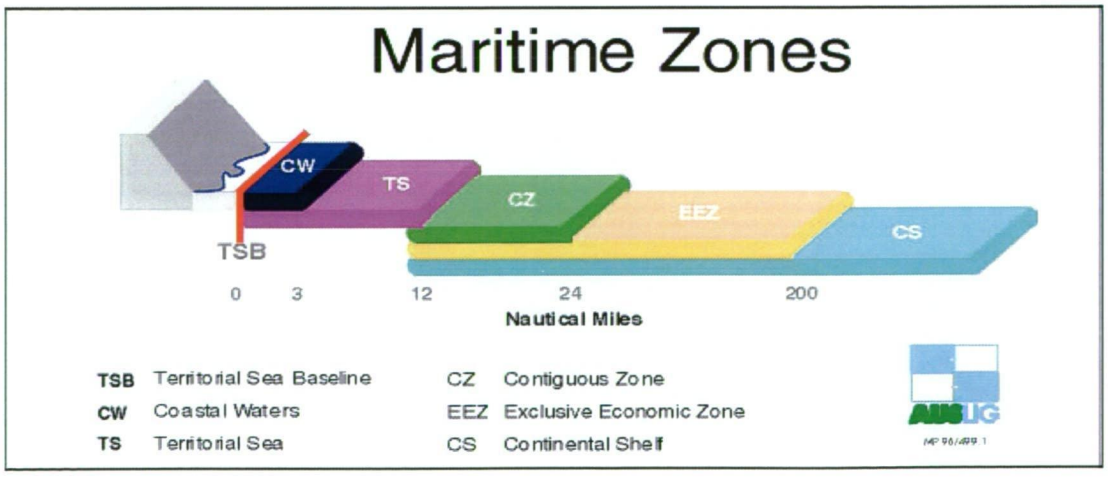


Figure 4. International Maritime Zones, (Source : AUGLIG, 1998)

Certain international legal rights correspond to these maritime zones. The Territorial Sea extends outwards from the Territorial Sea Baseline (TSB) a distance of 12 nautical miles. This area is basically an extension of the sovereign territory of the adjacent political state to which that maritime area belongs. Apart from having to allow the passage of ships from foreign countries subject to certain restrictions, known as 'innocent passage', the state has absolute jurisdiction over this area (Binns et al., 2003). The Contiguous Zone, from 12 to 24 nautical miles, is a maritime zone that allows nations to exercise rules and regulations over such things as customs, immigration and sanitation. The contiguous zone is not an automatic right conferred to a state and it has to be claimed. However, in situations were two or more countries have overlapping Contiguous Zones there are no international rules on how to resolve disputes (Binns et al., 2003).

The Exclusive Economic Zone (EEZ), which extends from 12 to 200 nautical miles, confers on states, such as Australia, the right to explore and exploit the water column and sea bed of this area. Lastly, the Continental Shelf is an area that extends from 12 to 350 nautical miles. Under UNCLOS this maritime boundary allows a country to claim sea bed rights in those situations where the continental shelf physically extends beyond the 200 nautical mile limit for the EEZ (See Figure 5) (Binns et al., 2003)

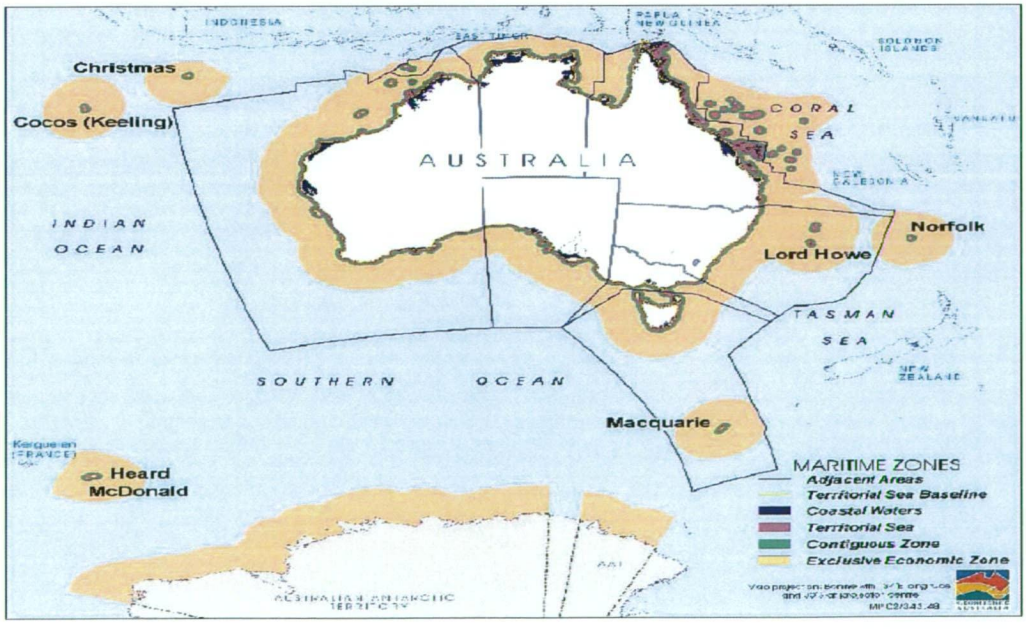


Figure 5 Australia's international maritime boundaries, (Source: Collier, 2001)

2.3.2 National boundaries defined in national and stat legislation

In addition to the international boundaries discussed above, there are a number of internal national boundaries described in domestic legislation that further segment Australia's ocean territory (Collier et al. 2003). There are two important national maritime boundaries, the 'Adjacent Area Boundaries' (see Figure 5) as defined in the 'Petroleum and Submerged Lands Act' (1967). Another important national maritime boundary is between State and Federal jurisdiction at the 3 nm limits of Coastal Waters. This boundary is shown as the black zone in Figure 5. Under national maritime legislation, all Australian States and the Northern Territory have sovereignty over Coastal Waters (Collier et al. 2003).

2.3.3 Regional boundaries defining administrative and jurisdictional limits

Underneath the level of international and national boundaries lies a complex web of administrative, jurisdictional and tenure boundaries that restrict and control activities in the marine environment. Figure 6 illustrates just some of the legal maritime boundaries from the eastern part of the Victorian coast and King Island. Some of the boundaries are used to define marine protected areas, restrict fishing zones and aquaculture leases, define petroleum exploration and mining leases, define cable and pipeline locations, and describe areas granted under native title claims (Collier et al. 2003)

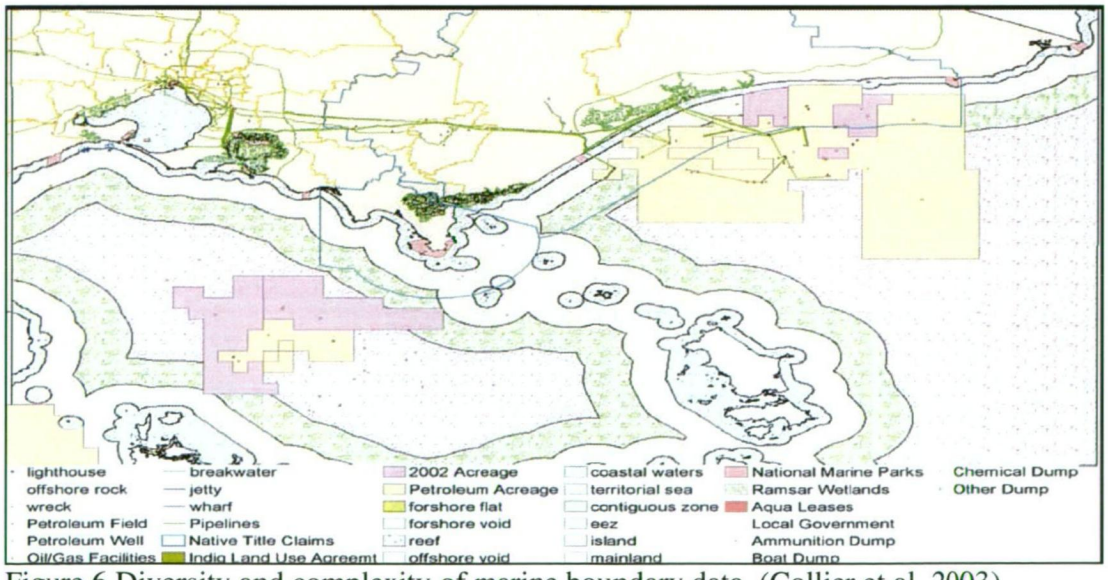


Figure 6 Diversity and complexity of marine boundary data, (Collier et al. 2003)

2.4 History of the marine cadastre

In 1609, a book named 'Mare Liberum' by Hugo Grotius declared international freedom of the seas. Grotius formulated the new principle that the sea was international territory and all nations were free to use it for seafaring trade (Strain et al. 2006). After the industrial revolution and world wars, the technology for mapping the ocean and seabed was much improved, and led naturally to a greater recognition of the economic potential provided by the marine environment.

In 1945, the USA claims resources in the continental shelf adjacent to its coastline, motivating other countries to lodge similar claims, and causing disagreement over the nature and extent of boundaries that a country was allowed. There was recognition that an international agreement or policy was needed that documented the marine jurisdiction of a country (Strain et al. 2006).

Under Article 76 of the United Nations Convention on the Law of the Sea (UNCLOS 3), maritime nations are granted jurisdiction over the Exclusive Economic Zone that extends 200 NM offshore from the coastline, replacing the older and weaker 'freedom of the seas' concept.

UNCLOS 3 emphasizes the requirement of better management of the world's oceans environmentally and socially as well as economically (Strain et al. 2006). Cockburn (2005) argues that changes in marine boundary laws under the UNCLOS have an effect on the method by which property rights, restrictions and responsibilities are managed, and the application of established and emerging technologies and spatial information management.

Strain et al. (2006) also argues that improvements in information and communication technology will affect the exchange and sharing of data for marine administration and management.

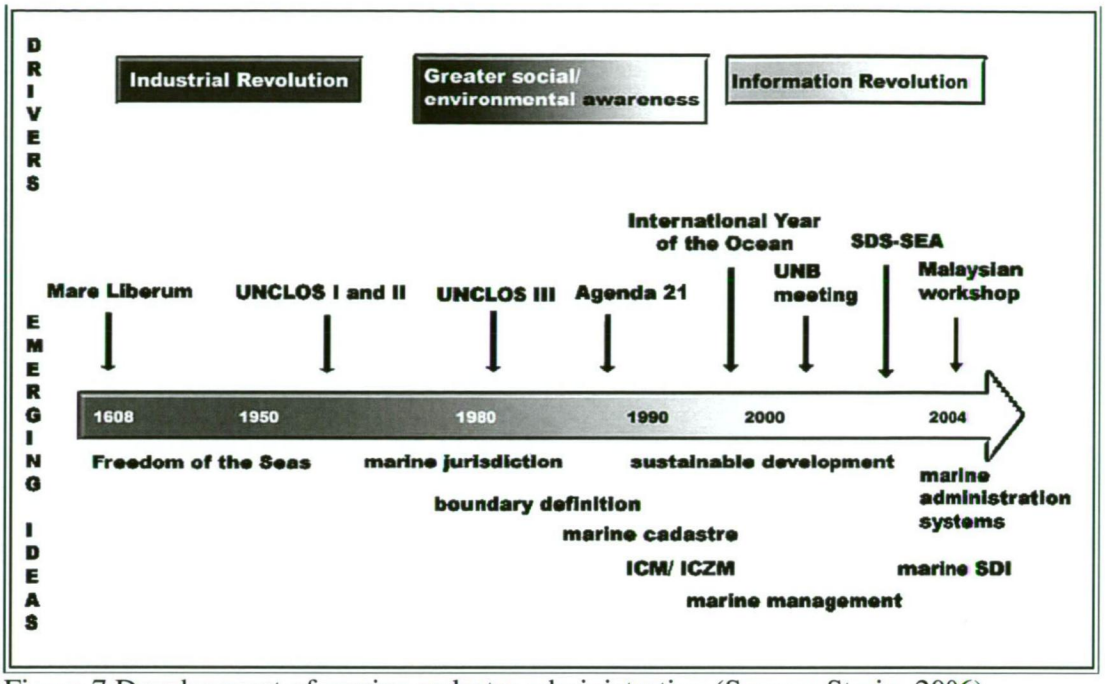


Figure 7 Development of marine cadastre administration (Source: Strain, 2006)

2.5 Defining marine and shoreline boundaries

Unlike a terrestrial cadastre, marine boundaries exist in most cases as virtual objects. Even though they have a strict legal and geometric definition and can be drawn on maps and charts, they cannot be 'seen' in the real world (Collier et al. 2003). Collier et al. (2003) go on to argue that, while the traditional view of a cadastre does not change directly when it is transported into the marine environment, the lack of demarcated physical boundaries does bring a significant challenge to both users and custodians of a marine cadastre system. Todd et al. (2003) also note that ''the definition of maritime boundaries lies in statutory descriptions and to a lesser extent, conventional survey plans'. They note that marine boundaries can be described by reference to geographical positions, meridians and parallels of longitude and latitude, geodesics, place names or natural and artificial features. They also note the importance of the 4th dimension (time) in the marine environment. Consequently, they assert the importance of high quality metadata, particularly because of the great variety of data sources that might be contributing information to a marine cadastre, and because of the uncertainty and

complexity of a marine cadastre (Todd et al. 2003).

Another key issue with marine cadastre is that the marine boundaries are normally delineated on the surface of the ocean without consideration of depth, volume or variation over time. This is in spite of the fact that delimitation of marine boundaries is often three dimensional, (Fraser, 2003). For example, defense related maritime boundaries may be defined on the sea surface, but aquaculture leases, or the migratory movement of whales, may need to be within the water column, the location of pipelines and cables or protected flora may be recorded on the ocean bed, while exploration and mining may be recorded below the ocean floor (Fraser, 2003). Similarly, some of these need to be modeled in four dimensions due to variation over time (Fraser, 2003).

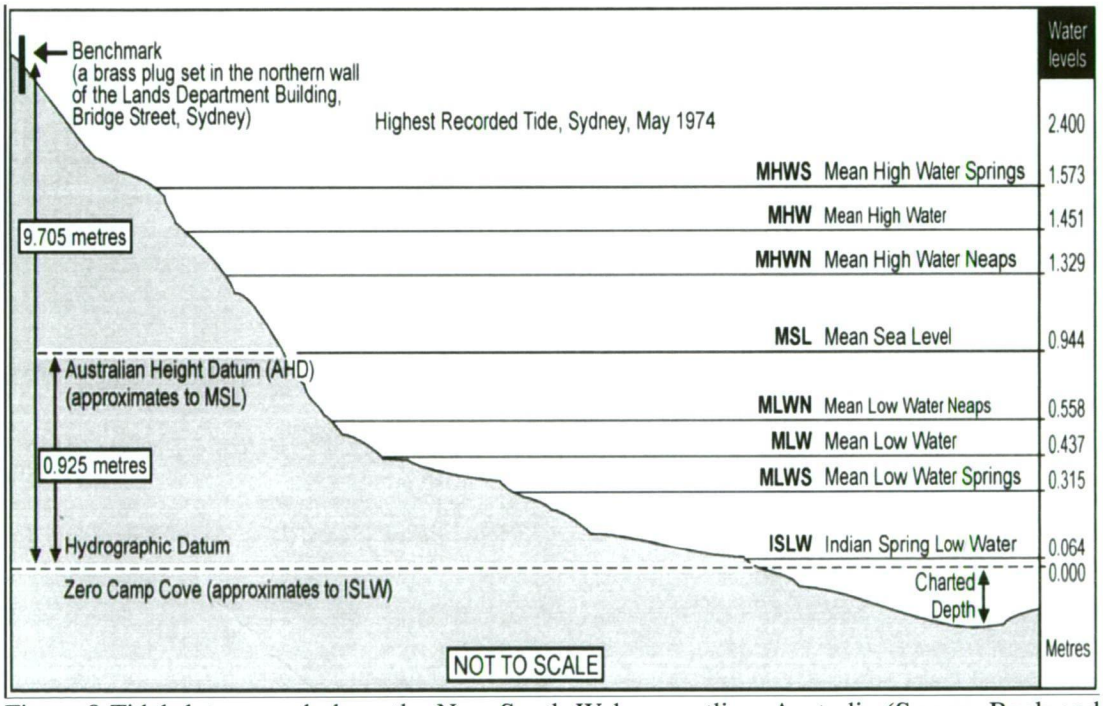


Figure 8 Tidal datum used along the New South Wales coastline, Australia (Source; Boak and Turner, 2005)

Boak and Turner (2005) indicate that the High Water Line can be identified by 12 different features from visually detected storm/debris line to seaward edge of vegetation (See Figure 8). They also mentioned the source of data, in other words, coastline detection methods variation such as historical land-based photographs, coastal maps and charts, aerial photography, beach surveys, GPS shorelines, remote

sensing by satellites imagery, airborne light detection and ranging technology, microwave sensors, video imaging (Boak and Turner, 2005).

2.6 Summary and discussion

When I introduced the concept of marine cadastre, I considered the difference between the terrestrial cadastre and the marine cadastre but also their similarities. Section 2.1 defined a terrestrial cadastre and its objectives: effective access to information about land, land resource capacity, land tenure and land use (FIG 1995).

I then described the international, national and regional boundaries that apply in the maritime zone. In section 2.4, the history of marine cadastre was briefly outlined, particularly because the UNCLOS has a significant role and impact in the marine environment. This is because ratification of UNCLOS affected the management of rights, restrictions and responsibilities in the marine environment and also the application of emerging technologies, such as those used for spatial information management (Cockburn 2005).

As noted in chapter 1, there can be uncertainty regarding the spatial definition of a coastline. Section 2.5 briefly addressed some of the physical aspects of a shoreline, and the defining aspects of a marine/land boundary that need to be taken into account when defining that boundary.

3. Current issues of marine cadastre in Australia

3.1 Background

Under UNCLOS 3, Australia holds rights, restrictions and responsibilities over 16,000,000 km^2 of marine area (CGA, 1998). Australia's maritime zone is home to an enormous number of activities and (Strain 2006). With over 75 per cent of the population living within 50 km of the Australian coastline and with 8% of Gross Domestic Product (GDP) coming from marine industries (CGA, 1998), Australia is a strongly maritime nation.

The economic value of Australia's marine environment is well recognized. Oil and natural gas exploration are just two of the major sources of revenue for both government and private sector, with competition increasing for access to the marine areas with huge stores of natural resources (Widodo, 2003, Binns et al., 2003). This significant situation makes the effective management and delimitation of Australia's coastal area increasingly important. With global recognition of the importance of sustainable development, a project named 'Defining and Developing a Marine Cadastre for Australia' began in early 2002. The important objectives of the project were to create a comprehensive spatial data infrastructure, whereby rights, restrictions and responsibilities in the marine environment can be assessed also administered and managed (Williamson et al., 2004).

3.2 Related organization and objectives of Marine management in Australia

Australia operates under a State and Federal system of governance. States manage health, education and land administration while the Commonwealth government administers monetary, defense, foreign affairs immigration and trade issues.

The Australian government has policy guidance for oceans planning and management, to help apply the principles for ecologically sustainable ocean use when developing and implementing planning and management arrangements for Australia's oceans. Australia's Oceans Policy was released in 1998 by the Commonwealth

Government and continues to guide the direction of Australian programs in the marine environment (CGA, 1998)

The policy provides national coordination and consistency for marine planning and management, while allowing for regional diversity. The policy is also intended, in association with more specific national and regional objectives, to provide the basis for reporting and performance assessment in the implementation of Australia's Oceans Policy. For example, the policy has sections that deal with the following issues:

- Maintenance of ecosystem integrity
- Integrated oceans planning and management for multiple ocean use
- Promotion of ecologically sustainable marine-based industries
- Governance
- Managing for uncertainty
- Application of the precautionary principle
- User-pays and other economic instruments
- Reporting, monitoring and assessment
- Duty of care and stewardship
- Interests and responsibilities of indigenous peoples
- Broader community participation
- Regional and global responsibilities.

The Commonwealth Department of Industry, Science and Resources has released another plan related to the ocean called the Marine Science and Technology Plan (1999). Australia's Marine Science and Technology Plan (Commonwealth of Australia, 1999: 5) provides:

- "a strategy for integrated and innovative science and technology, conducted in the national interest to guide the exploration and ecologically sustainable development and management of the

marine resources under our jurisdiction, to understand and predict climate variability and change, and to guide the development of sustainable maritime industries;

- a key to a better understanding of the marine environment and its living, mineral and energy resources; and
- an effective framework for well focused, concerted action in both the short and long term by the Australian marine science, technology and engineering community, adding value by creating opportunities for significantly increased cooperation."

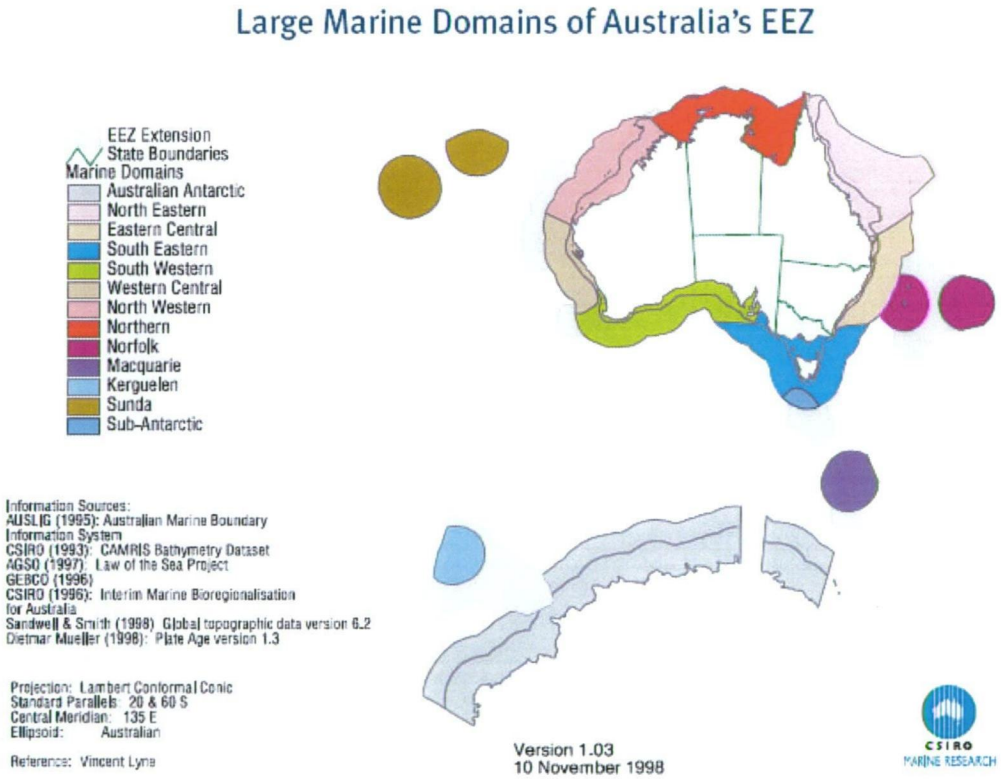


Figure 9 Large Marine Domains of Australia's EEZ (Source: Australia's Marine Science and Technology Plan an Overview (1999))

3.3 Spatial Data Infrastructure for Australia's marine area

Williamson et al. (2004) noted that research was required in order to establish a broad Spatial Data Infrastructure for Australia's marine environment, with rights,

restrictions and responsibilities that can be assessed, administered and managed. To achieve this object, Australia requires a seamless spatial data infrastructure that links between the terrestrial and marine area.

Even though there are many definitions of spatial data infrastructure, the important principle of SDI are to provide an environment which enables a variety of users to access and retrieve complete and consistent datasets with easy and secure (Rajabifard et al. 2000). According to Strain et al. (2006), in order to apply the principles of Spatial Data Infrastructure to the marine environment, five common components and attributes of an SDI should be examined. These five core component of SDI can divided into two categories: people and data in first category, and the technological components of standards, policies and access network in the second category (Rajabifard and Williamson, 2001). In order to access datasets, the users must go through the technological components (See Figure 10).

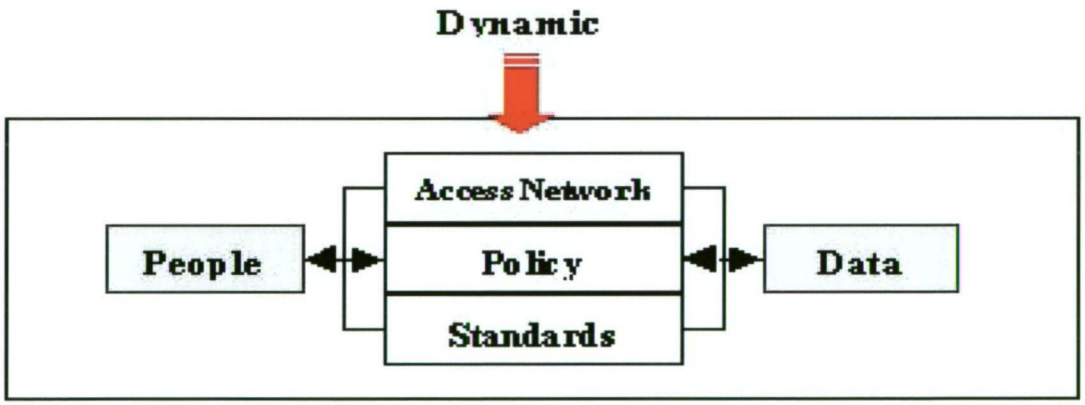


Figure 10 Nature and relations between SDI components (Source: Rajabifard and Williamson, 2001)

3.3.1 Data

The marine environment is dynamic and multi dimensional, hence the data collection and updating can be more difficult than land related data (Strain et al. 2006). Two important key issues for a marine SDI can be data availability and interoperability. Strain et al. (2006) note that marine related data collection tends to be scattered, as data collection is generally project-based, and data is rarely shared between different organizations. In order to solve these problems,

Strain et al. (2006) suggest the fundamental datasets be identified for marine SDI. For example, in the terrestrial context, the State of Victoria has geodetic control, cadastral, address, transport, administrative boundaries as fundamental datasets in their terrestrial SDI. Strain et al. (2006) suggest the following fundamental datasets for a marine area:, bathymetry, marine protected areas, political boundaries, oceanography, sea level, waves, water quality, sea floor composition, meteorological conditions, and biodiversity regionalization (Strain et al., 2006).

3.3.2 Standards (Metadata)

The International Standards Organization Technical Committee 211 (ISO TC/211) has recently developed a set of 40 Geographic Information related standards, most of which are focused on terrestrial spatial data. Another important standard called XML (extensible markup language) is being developed and used by the Australian Oceanographic Data Centre (AODC) for marine related information. The XML is an exchange data format used on internet and also well known as one of 'the building blocks that house data' (Strain et al. 2006)

3.3.3 Policies

Australia's marine science and technology plan for marine spatial data (Australia's Marine Science and Technology Plan an Overview (1999)), sharing and management is intended to prevent duplication, ensure date correspondence, improve access to data, and improve coordinated data management (Strain et al. 2006). Australia's current Spatial Data Infrastructure policies are capable of support access, data custodianship, data conformity, quality, content, industry engagement, avoidance of duplication and sensitivity (ANZLIC, 1998). However, due limitations in the quality of the Australia's marine data that follow from limited collection and the complexity of the marine environment, data quality can be difficult to achieve at the same grade as terrestrial data (Strain et al, 2006).

3.3.4 Access Networks

Access networks normally comprise data warehouses, data portals, one stop shops, on-line atlases, or similar. For these access networks to support interoperable and coordinated data they must comply with the standards and policies specified by the SDI (Strain et al. 2006). For example, when accessing bathymetry for navigation, the rights and restrictions attached to a particular location, or sea surface temperatures or currents in a search and rescue operation, it may be that the technology that will allow data transfer and access onshore will not be appropriate for use offshore and so alternatives such as wireless data transfer will be needed (Strain et al., 2006).

3.3.5 People and partnerships

People in spatial data infrastructure are the data providers, value-adders and data users (Strain et al. 2006). Binns (2003) argues that 'the immature institutional arrangements and the reluctance of many organizations to share their data' are the primary impediment to development of a marine SDI. The key to success in SDI initiatives is partnerships within and between organizations involved in marine administration and spatial information (Strain et al, 2006)

3.4 Issues for the marine cadastre system in Australia

3.4.1 Legal Issues

Even though Australia has one of the most advanced marine management system in the world, the complex web of legislation and the ambiguity of coastline boundaries (e.g. high watermark) are still an impediment to progress. Binns (2003) illustrates the legal problems in the management of marine territories in Australia, noting that marine legislation includes not only UNCLOS but also over 50 international treaties and conventions, and that Australia has over 100 laws and policy instruments addressing aspects of the management of the marine environment (NOO, (2002a), in Binns 2003). From

the complex web of legislations, there are several significant laws related to marine rights, such as;

Sea and Submerged Land Act
Harbours Board Act
Petroleum Act
Coastal Water Act
Great Barrier Reef Marine Park Act
Crimes at Sea Act

Australia's international initiatives include a National Oceans Policy implemented by the Commonwealth and applied to Commonwealth jurisdictions (Harward et al. 2006), and a legal tool called the Offshore Constitutional Settlement (OCS), the purpose of which is to share the offshore jurisdictional responsibility between the states and Commonwealth. The OCS can be used to set up joint management arrangements, for example in the case of offshore mining, with the relevant Commonwealth Acts applied but with day-to-day administrative responsibilities managed by the states (Rothwell and Haward, 1996, in Binns et al, 2003).

Australia also currently has the Marine Titling Standards to protect and manage of marine rights, which includes exploration of oil and gas, mining of mineral and aquaculture and fishing. Particularly the fishery rights divided into private and state and commonwealth jurisdictions. The marine titling standards sample is shown in Appendix 1.

A further problem with marine management is the ambiguity of coastline boundary definition (Binns, 2003); for example, as mentioned in Chapter 2, the complexity and uncertainty of defining high water (Binns 2003). The application of legislation can be compromised the spatial descriptions of boundaries are not accurate or are not well understand by stakeholders. For legislation to be effective, up-to-date and accurate boundary information is needed.

3.4.2 Institutional Issues

The problems from the institutional side can be summarized as competing rights, restrictions & responsibilities, lack of spatial certainty and interface jurisdiction between terrestrial and marine area (Binns, 2003). Australian organizations with jurisdictional interests in Australia's marine environment include the National Oceans Office, the Australian Institute of Marine Science and the Australian Maritime Safety Authority. Organizations with a direct interest from an SDI viewpoint include the Australian and New Zealand Land Information Council (ANZLIC), the Intergovernmental Committee on Surveying and mapping (ICSM), and state-based spatial information councils (Kim, 2006).

Due to the complex nature of marine area, overlapping of competing rights, restrictions and responsibilities has occurred. Cooperation between managing agencies does not always occur. On the contrary, there is evidence that such agencies too often operate in isolation from one another and do not have clear certainty of each other's rights, restrictions and responsibilities (Binns, 2003). Confusion about the management of the land-sea interface is also a problem. While local governments managing land to High Water Mark (HWM), state governments manage the near shore marine environment from Low Water Mark (LWM), leading to confusion where there is overlapping interests in coastal zone management (Binns, 2003).

If an effective marine cadastre system is to be implemented, it needs to be compatible with its land based equivalent. This means bridging the boundary between the terrestrial and marine environments. Prime examples of where this is required include:

- Development planning for various types of urban, industrial and tourism activities;
- Waste disposal management from local farms, coastal residents, tourist or recreational users, which have outlets into the marine environment;
- Public health and safety issues involving oil companies, local residents and other marine users;

- Environmental issues between local residents, fisheries and environmental organizations
- Commercial and recreational fishing activities within and around marine parks;
- Commercial harvesting of living and non-living natural resources. (Widodo, 2003)

To address some of these problems, Binns (2003) suggested the creation of an integrated agency with responsibility for creating an overall control framework for Australia's oceans and to provide guidance on access to spatial information (Binns, 2003). Strain (2006) also noted the need for a lead agency, and commented on the institutional inability or unwillingness to adopt common standards and policies to share data through common access network.

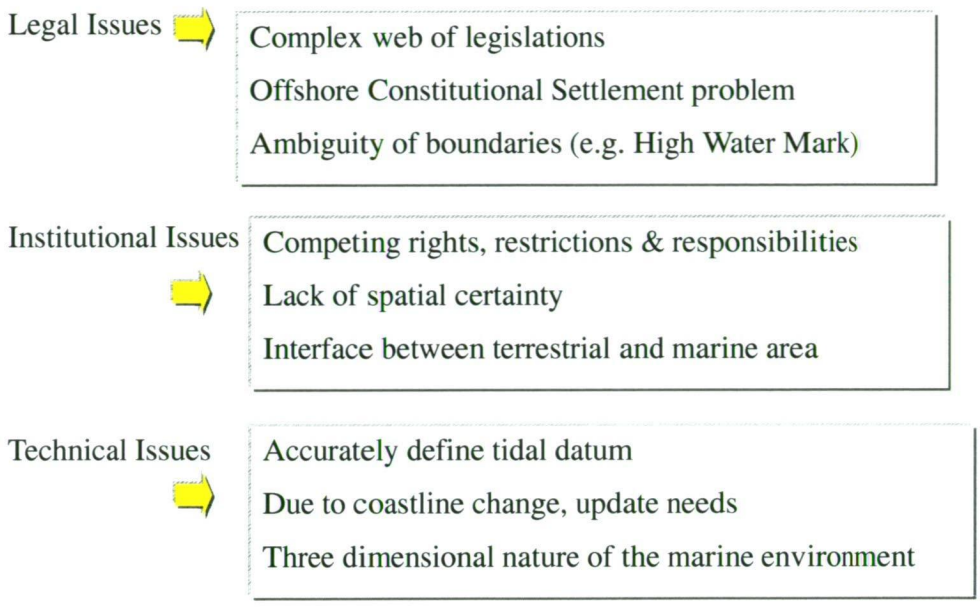
3.4.3 Technical Issues

The primary technical issues in marine management are accurate definition of a tidal datum, timely and efficient updating of coastline change, and the technical aspects of representing the three dimensional nature of the marine environment (Binns 2003). The definition of tidal datum is significant for determine the coastal and shoreline boundaries. Tidal ranges can change from almost zero, to hundreds of meters in shoreline areas such as Western Australia and the Northern Territory. The Low Water Mark is known as Australia's Territorial Sea Baseline (TSB). The ambulatory nature of the TSB needs to be consistently updated because of the coastline changes (Binns, 2003).

The three dimensional nature of the marine environment is also an important technical issue. The modeling of 3D spatial characteristics is a major hurdle to the development of a true spatial representation of rights, restrictions and responsibilities in the marine environment (Binns 2003).

Strain (2006) notes the problems in Australia with inconsistent data formats, scales, and reference frames and lack of standards regarding metadata.

In this section these three categories' issues can be summarized as below:



3.5 Current key issues in the Australian marine environment

According to Zann (1995), the main strategies for marine environmental management in Australia include:

- Maintaining water quality through controlling disposal of wastes and emissions entering catchments, the atmosphere and the sea;
- prohibiting or regulating destructive and unsustainable activities;
- protecting important habitats and areas;
- zoning for particular uses to separate and control incompatible uses;
- requiring environmental impact studies to minimize effects of developments;
- protecting certain organisms, particularly vulnerable and threatened species and
- regulating fisheries through licenses, size limits, quotas (total allowable catches)

3.5.1 Shore line erosion and loss of coastal wetlands

Coastal cliff and beach erosion is a serious problem with a global

impact. Coastal change threatens public safety as well as public and private property. The problem will only increase given projections of sea level rise, ranging from 9 to 88cm by 2100 (IPCC 2001). The Intergovernmental Panel on Climate Change (IPCC) (IPCC 2001) estimated that half of the world's population lives in coastal areas. The coastal population of Australia has increased from 6.1 million in 1971 to about 9.9 million in 2001 (ABS, 1971, 2002). Coastline change monitoring and hazard management are becoming fundamentally important activities, involving a variety of technology and techniques including monitoring of sea level rise (Williamson et al., 2002).

Wetlands are a particularly important and vulnerable form of coastal habitat. Current threats to Australian wetlands include (Finlayson and Rea, 1999):

- drainage of wetlands for agriculture, horticulture and forestry
- reclamation or modification of wetlands for other commercial developments
- extraction of groundwater and draw-down of water levels
- construction of barrages and diversion of water for flood mitigation
- regulation of rivers through channel construction, walling of banks
- surface mining in wetlands
- use of wetlands as evaporation basins for highly saline irrigation water
- landscaping of wetlands in urban areas
- weed invasion
- application of chemicals and drainage for insect control
- grazing by and watering of stock in wetlands
- inappropriate recreational activities
- wildfires
- degradation of water quality due to pollutants
- intensive uses such as aquaculture, dredging and shipping port infrastructure.

3.5.2 Legislated protection of marine biodiversity

According to Department of Sustainability and Environment (2003), coastal waters and oceans in Australia contain one of the greatest arrays of marine biodiversity in the world. The marine area includes more than 4000 fish varieties and tens of thousands of species of invertebrates, plants and micro-organisms, with around 80% of southern marine species occurring nowhere else in the world (Department of Sustainability and Environment, 2003. A Marine Protected Area (MPA) is any area of intertidal or sub tidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features,

that has been reserved by law or other effective means to protect part or all of the enclosed environment (Zann, 1999). Australia is a world leader in using MPAs for marine conservation and management and has 24% of the total number of MPAs in the world (Zann, 1999). In 1992 Australia had 303 MPAs totaling an area of 463,200 square kilometres which cover about 5.2 per cent of Australia's marine environment. MPAs conserve natural values, protect commercial fisheries resources, protect human heritage, and supply tourism, recreation, education and research opportunities (Zann 1999). Significant Australian MPAs are summarized in Table 1 below. The key uses and environmental issues are for these important regions are summarized in this table.

Marine protected area	Area, Activities, environmental issues
Torres Strait Protected Zone	Torres Strait is a 150 km wide, shallow passage between Cape York and Papua New Guinea. It contains many reefs, over 100 islands and cays, and has a population of 6,300 Torres Strait Islanders. It has major populations of dugongs and turtles. Major environmental issues: possible heavy metals contamination from Papua New Guinea mines; threats of oils spills from shipping; offshore oil in Papua New Guinea; effects of prawn trawling. Major uses: shipping; prawn and rock lobster fisheries.
Great Barrier Reef Marine Park	The GBRMP is the world's largest reef complex, the largest multiple use Marine Park Area and a World Heritage Site. It is 2,500 km long and comprises 2,900 separate reefs and 940 islands. It was established under the Great Barrier Reef Marine Park Act 1975 and is managed by the Commonwealth GBRMP Authority, with the Queensland Department of Environment and Heritage responsible for day-to-day management. Major uses: tourism (2 million visitors to GBR and coast each year); commercial and recreational fisheries; shipping. Economic value over $1 billion per annum. Major environmental issues: water quality (especially elevated nutrients) in inshore areas; outbreaks of crown-of-thorns starfish; effects of trawling on sea floor biota; effects of fishing on reefs; threat of oil spills from shipping; effects of tourism.

The Ningaloo Marine Park	Australia's longest fringing reef and the third largest MPA, Ningaloo Marine Park was established in 1987 in State and Commonwealth waters. It extends along 260 km of coast and has an area of 4,572 square km. Ningaloo is an ecologically unique mainland fringing coral reef and contains significant populations of dugongs, humpback whales, shore birds, turtles, and whale sharks. Ningaloo Marine Park is managed by the WA Department of Conservation and Land Management. Major uses: tourism and recreational fishing. Major environmental issues: outbreaks of coral-eating Drupella snails; increasing tourism; risk of pollution from oil production outside the marine park and from shipping.
Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve	Shark Bay Marine Park (7,487 sq km) and the adjacent Hamelin Pool Marine Nature Reserve (1,320 sq km) were gazetted in 1990. The seagrass meadows and the calcareous sand banks of Shark Bay are amongst the world's most extensive. Shark Bay Marine Park contains the most southerly resident populations of dugongs and green turtles, the internationally famous bottlenose dolphins of Monkey Mia, and important nursery areas for several valuable recreational and commercial fisheries. The Hamelin Pool Marine Nature Reserve includes unique stromatolites and Holocene coquina deposits. Together with equally significant terrestrial features, the area is now included in the World Heritage. Major uses: commercial and recreational fishing; tourism (mainly at Monkey Mia and Hamelin Pool, but general nature-based tourism is increasing). Major environmental issues: no major threats but will require management of fisheries (including aquaculture) and tourism. The major long-term issue is protection of unique stromatolites and sea grass.
Solitary Islands Marin Reserve	A unique area of tropical/temperate overlap which includes coral communities, mangroves, rock platforms and rocky reefs. The Reserve extends along 70 km coast north of Coffs Harbour and has an area of 950 square kilometres. It inclu State and Commonwealth waters and is managed by NSW Department of Fish and the Australian Nature Conservation Agency (ANCA). Major uses: commercial and recreational fishing; tourism (diving and water sports). Major environmental issues: alteration of catchments and eutrophication of estuarie recreational fisheries; tourism development
Jervis Bay National Park	A relatively pristine bay with diverse estuaries, dunes, seagrass beds, sand flats, and rock platforms and reefs. The land area in the Park is 6,312 ha and the marine area is 840 ha. It is part of the Commonwealth's Jervis Bay Territory

	and is managed by the Australian Nature Conservation Agency. NSW Fisheries is currently preparing a management plan for the remainder (93%) of the bay. Major uses: commercial and recreational fisheries; recreation and tourism; naval activities; scientific research; educational activities. Major environmental issues: Aboriginal fishing rights; effects of shipping; nutrients from discharges and run-off; tourism and recreational use.
Australian National Nature Reserves	(1) Coringa-Herald and Lihou National Nature Reserves (2) Ashmore Reef National Nature Reserve (3) Elizabeth and Middleton National Nature Reserve (4) Mermaid Reef National Nature Reserve and Rowley Shoals Marine Park
Australian Antarctic Territory	The Antarctic is uniquely managed through international treaties and conventions. Australia has a leading international role in research and environmental management. The region is one of the least polluted places on earth and is the last great wilderness. Major uses: fishing; scientific research. Major environmental issues: past overhunting of the great whales and changes in food chains; global pollution effects; tourism; localised pollution from research stations.
Territory of Heard Island and McDonald Island	This remote group of islands lying close together in the southern Indian Ocean features essentially undisturbed ecosystems, dramatic glaciated landscapes and Australia's only active volcano, Big Ben. It is a Commonwealth external territory managed by the Australian Antarctic Division. Major uses: scientific research. Major environmental issues: maintenance of an undisturbed environment and preventing introductions of non-indigenous species.

Table 1 Major, multiple-use marine protected areas around Australia (Source: Zann, 1995).

Key related legislation includes the Environmental Protection and Biodiversity Conservation Act 1999 (Commonwealth), National Parks (Marine National Parks and Marine Sanctuaries) Act 2002 (Vic), 1996 Protocol to the London Convention (for dumping at sea, permit), Environmental Protection (Sea Dumping) Act 1981 (Commonwealth) (Binns, 2003).

3.5.3 Legislated protection for marine cultural heritage

The Australian Federal, State and Territory Governments have been

implementing programs for the protection and management of underwater cultural heritage for over 25 years. This includes aboriginal and Torres Strait Island heritage under the Aboriginal and Torres Strait Island Protection Act 1984, which is intended to protect and preserve areas or objects that are of significance to Aboriginals within Australia and Australian waters (Binns, 2003).

The UNESCO Convention is the first specific international legislation to apply to underwater cultural heritage in international waters (Jeffery, 2002). The UNESCO Convention has application to sites and objects located in waters under Australia's jurisdiction, and so must be considered in conjunction with Australia's domestic legislation and operations.

Key related legislation includes the Native Title Act 1993 (Commonwealth), Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth), National Native Title Tribunal, Aboriginal Affairs Victoria *Federal Legislation;* Historic Shipwrecks Act 1976, Navigation Act 1912, Torres Strait Islander Heritage Protection Act 1984, Australian Heritage Commission Act 1975, Environment Protection and Biodiversity Conservation Act 1999, Protection of Movable Cultural Heritage Act 1986. Appendix 2 shows the details of legislation from the States and Territories (Jeffery, 2002).

3.5.4 Aquaculture

Growing world population, particularly in countries with high seafood consumption, is resulting in a growing gap between demand and supply for seafood. Australia's wild fisheries catch volume has been decreased, and so only aquaculture can meet the growing demand for seafood (Binns 2003).

In 2003-2004, the Australian aquaculture industry was valued at $732 million, and accounted for almost one third of the total gross value production of the seafood industry. Most of the aquaculture species in Australia are high value species aimed at export markets (DAFF, 2009). The top five species groups include tuna, pearl oysters, salmon, edible oysters and prawns which (DAFF, 2009).

To continue to realize these significant economic returns, aquaculture needs ongoing improvement in farming technology and practices (Binns 2003). The current research effort is directed towards environmental issues, health and disease management, reducing costs of production and increasing production efficiency. Research priorities vary depending on the species involved. For example, marine farming is an important rural industry in coastal bays and estuaries of Tasmania. The two main species cultured are the introduced Pacific oyster and Atlantic salmon (Crawford, 2003).

Legislation has been introduced to assist the development of aquaculture for environmental management, such as baseline assessments and routine monitoring of leases. Local impacts on the seabed around salmon farms are monitored using video footage, analysis of benthic invertebrate in fauna, and chemical measures (Crawford, 2003).

Key related legislation is State based rather than Commonwealth, such as the Fisheries Management Act 1995 (Vic), under section 43 of the Fisheries Act 1995 (Vic); Aquaculture (Crown Land) License and Aquaculture (Crown Land) License - Type A License (Binns, 2003).

3.5.5 Oil, gas and mineral extraction

According to the National Ocean Office (2002), the key regulatory controls over oil, gas and mineral extraction are the Submarine Cables and Pipelines Protection Act 1963 (Commonwealth), the Petroleum (Submerged Lands) Act 1967 (Commonwealth, which included permits, licenses, and leases), and State based legislation and regulation such as the Exploration Permit and Retention Lease, Production License, Infrastructure License, Petroleum (Submerged Lands) Act 1982 (Vic).

Oil and natural gas exploration and extraction are major sources of revenue for both government and private industry, with very major areas of exploration centered off the North West and South East coasts of Australia. The Commonwealth Government is responsible for managing the major legal and administrative boundaries for the oil and gas industry. According to Binns

(2003), exploration licenses in Australia are well documented, including specification of rights, restrictions and responsibilities. However, it is clear that the oil and gas industry needs access to a wide variety of information such as shipping, native title areas, waste sites, heritage, and fisheries for effective management (Binns 2003).

Key related legislation is the Submarine Cables and Pipelines Protection Act 1963 (Commonwealth), the Petroleum (Submerged Lands) Act 1967 (Commonwealth), and State based legislation such as the Exploration Permit, Retention Lease, Production License, Infrastructure License, Petroleum (Submerged Lands) Act 1982 (Vic) (Binns, 2003)

3.5.6 Over fishing

Like many other countries, Australia is facing the problem of over-exploitation of fish resources. In Australia, 11 target species in Commonwealth fisheries are classified as over fished, 11 as fully fished and a further 35 classified as uncertain (Bureau of Rural Sciences 2002, Fisheries Status Report). Even though amongst the best managed fisheries in the world, over fishing in Australia occurs because of a lack of information about the distribution and abundance of the stocks and because of inadequate management.

Under the Fisheries Management Act 1991 (Commonwealth), there are two main rights to fish; they are Statutory Fishing Rights (SFR) and Fishing Permits. SFRs are only distributed under a management plan and granted only for the period of the plan, enabling SFR boundaries to be spatially defined. Fishing Permits have different rules, which specify compliance conditions for the permit holder and specify the area of operation for the permit. FP's are usually renewed on a yearly basis (NOO, 2002a; Binns 2003). The two rights can be freely traded (NOO, 2002a). The status and location of Commonwealth-managed fisheries are shown in Figure 11 (Caton, 2001).

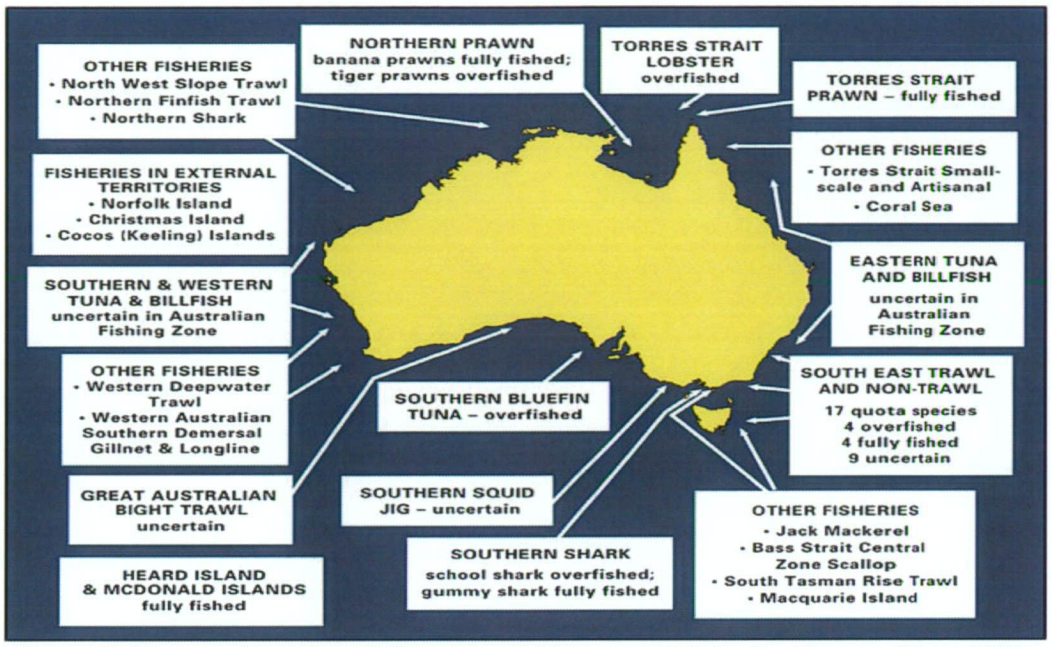


Figure 11 Status and location of Commonwealth-managed fisheries (Source: Caton, 2001)

Key related legislation is the Fisheries Management Act 1991 (Commonwealth), Fisheries Administration Act 1991 (Commonwealth), and State based legislation such as the Fisheries Act 1995 (Vic) and the Fisheries Regulations 1998 (Vic) (Binns, 2003).

3.6 Discussion

In order to discuss the current issues driving the development of a marine cadastre in Australia, the marine management organizations and their objectives, such as Australia's Ocean Policy and Marine Science and Technology Plan, have been described in this chapter. The Australia Ocean Policy has 12 objectives that seek to provide a broad basis for reporting and performance assessment for the implementation of ocean management. The Marine Science and Technology Plan (1999) proposes a strategy for managing marine resource exploration and ecologically sustainable development. It also provides an effective policy framework for better understanding the marine environment and for conducting well focused marine science.

The model of a marine cadastre provided by the University of Melbourne, known as the Marine Spatial Data Infrastructure, identifies five elements which are critical to any marine cadastral system. These are data, standards, policies, access

networks, people and partnerships.

In section 3.3, I divided the main marine cadastre issues into three categories: legal, institutional and technical. The recognized problems for each group are, 1) legal issues: a complex web of legislation, offshore constitutional settlement problems and ambiguity of boundaries (e.g. absence of baseline standards), 2) institutional issues: competing rights, restrictions & responsibilities, lack of spatial certainty, and lack of definition of the interface between the terrestrial and marine area, 3) technical issues: accurate definition of a tidal datum, the need to monitor coastline change, and the problems of defining and managing a three dimensional or four dimensional cadastre.

Environmental issues of particular importance in Australia shoreline erosion, loss of coastal wetlands, loss of marine habitat, conservation for protected areas, protection of marine heritage, over fishing, management of increasing aquaculture activities, and management of oil, gas and mineral extraction.

In this discussion, I summarized Australia's marine policy and MSDI, and the current issues connected with a marine cadastre and the marine environment. Even though there are many definitions of SDI, the important common important principles of an SDI are to provide an environment which enable a variety of users to easily and reliably access and retrieve complete spatial datasets.

4. Current issues for the marine cadastre in South Korea

4.1 Background

South Korea is a deeply maritime nation, with over 443,000 km^2 of marine area which is 4.5 times greater than the land area, and 11,542 km political borders dominate by maritime boundaries. South Korea has 3153 islands and the area off the continental shelf is 3 times larger than the land area. South Korea has 2,393 km^2 of tidal land which is occupies 2.4 per cent of the entire land, with the economic value of the tidal land ecosystem estimated to be about 8 billion US dollars per year (Shin 2003). South Korea's fishery industries produce over 3 million tons of marine products, which supply about 40 per cent of the animal protein for the people of South Korea (Ocean Korea 21, 2000). While the maritime area has been mainly used by the fishing industry, over the last few decades the use of the area for leisure and sightseeing activities has been dramatically increasing. Traditionally South Korea's tourism policies have focused on inland development at the level of local government. In spite of the country's abundant marine resource potential, marine tourism has generally been downplayed. In recent years, however, there is a lot of evidence suggesting that marine tourism has rapidly increased, owing to an increase of leisure time and an increase in disposable incomes. In 2010 it is expected that maritime sightseeing will represent 26 per cent of the total amount of sightseeing conducted in South Korea. It is thought that this percentage will increase by 2020 to be over 40 per cent (Shin 2003).

South Korea is located in Northeast Asia, and as such is considered a critical and centripetal point in world trade distribution. Over 99 per cent of South Korea's total import and export freight is transported by oceanic means (Shin 2003). In part, this is due to the fact that the only land border for South Korea is that with North Korea, across which very little passes. Very little freight, apart from people, is transported via air (Shin 2003).

4.2 Objectives of marine management in South Korea

4.2.1 Ocean Korea 21

A governmental organization, the Ministry of Land, Transport and Maritime Affairs (MLTM), was established in 2008 to oversee and integrate the management of land and marine areas in South Korea. In 2000, the South Korean government officially announced an integrated ocean policy, named *Ocean Korea 21*, and MLTM was designed to strengthen this ocean policy and advance marine management more generally. *Ocean Korea 21* proposed a plan for marine development that had three basic objectives:

1. The creation of living oceans
2. The establishment of knowledge-based marine industries
3. The sustainable development of marine resources.

To achieve these objectives *Ocean Korea 21* has seven specific goals, consisting of 100 special projects. The seven goals for the environmental management of South Korea's ocean regions are as follows:

1. Undertaking a paradigm shift from localised resource extraction to the sustainable management of ocean economic space with an awareness of the global significance of the region.
2. Preservation of a clean and safe ocean environment.
3. Promotion of knowledge-based ocean industries.
4. Enhancement of international competitiveness in ocean service industries and infrastructure.
5. Remodelling fishing structures and communities.
6. Efficient utilization of marine resources.
7. Strengthening international cooperation and South – North Korea collaboration.

To achieve these seven goals, the South Korean government is working to optimize the national coastal management system by integrating smaller management systems and pursuing coastal maintenance projects. It is also conducting scientific research projects on the marine resources in its exclusive economic zone. The South Korean government is particularly interested in working to conserve coastal ecosystems by mapping estuaries and passing laws

to create tideland conservation areas. These areas are important to the larger health of the marine ecosystems and they also support very productive fisheries (for example, oysters and scallops). In addition, the management of South Korea's marine area is intended to support research being carried out by marine-biotech industries, to build on existing market-oriented resource management systems, and is also focused on the development of tidal power plants.

4.2.2 Organization

In February 2008, the Ministry of Land, Transport and Maritime Affairs (MLTM), with the launching of the new government, was organized to accomplish the following objects: a) establish a small but competitive government; b) raise the value and utilization of the territory by combining the control of land and ocean resources and supporting infrastructures. Ministries and/or business functions consolidated to this Ministry were the Ministry of Construction and Transportation, the Ministry of Maritime Affairs and Fisheries' Ocean Logistic, Port & Sea Environment, the Ministry of Government Administration and Home Affairs' Land Register Business (MLTM, 2008).

The establishment of MLTM shows that the South Korean Government realized the significance of integrated management of the nation's land and marine area. In the MLTM organization chart, marine relate departments are as shown below.

Marine Policy Bureau	- Marine Policy Division - Marine R&D Division - Coastal Planning and Management Division - Marine Territory Division
Director General for Marine Environment Policy	- Marine Environment Policy Division - Marine Conservation Division - Marine Ecology Division
Office of Logistics and Maritime Affairs	- Logistics Policy Division - Logistics Facility and Information Division - Logistics Industry Division - Port Logistics Division - Port management Division

Director General for Shipping Policy	- Shipping Policy Division - International Shipping Division - Coastal Shipping Division - Seafarers and Labour Policy Division
Director General for Maritime Safety Policy	- Maritime Safety Policy Division - Maritime Technology Division - Navigational Safely and Information Division - Maritime Traffic Facilities Division - International Maritime Affairs Division
Director General for Port Development Policy	- Port Policy Division - Port Development Division - Port Private Investment Division - Port Construction and Technology Division - Prot Re-development Division

In addition, there are several support organizations in the marine management area, including the National Fishery Science Institute, National Maritime Research Institute, National Fisheries Research & Development Institute, National Oceanographic Research Institute, National Fisheries Products Quality Inspection Service, Fisheries HRD Institution, Korea Cadastre Survey Corporation, National Parks Management, Korea Tourism Organization, and Korea Rural Community Corporation (Kim 2006)

Amongst these organizations, the Korea Cadastre Survey Corporation has been successfully driving to create a proper land cadastral system based on the Terrestrial Cadastre Law, and has been working to build a marine cadastral system from coastline survey to register. The roles of a survey organisation is made clear by Williamson et al. (2005), who note the clear role for land surveyors to work with the marine industries to provide better solutions to defining and managing boundaries in the marine environment. It is not about hydrographical surveying but using the skills of the cadastral surveyor in marine environment (e.g. coastline surveys) (Williamson et al. 2005).

4.2.3 Marine environment management

MLTM established an 'Integrated Marine Environment Information System' with several related organizations, including the National Fishery

Research & Development Institute, Korea Ocean Research & Development Institute, National Oceanographic Institute, Korea Coast Guard, Ministry of Environment of Korea, Korea Meteorological Administration (MLTM, 2008). One of the main projects of this organisation is to establish a National Marine Environment Survey Web with three development stages planned between 1996 and 2015.

The first stage (1996-1998) includes permanent establishment of a coastal area contamination condition survey, with 280 locations for a water quality investigation network. The second stage (1999-2007) sees the expansion of that network to 363 locations, permanent establishment of contamination survey specification expansion (4 items), investigation of sea deposit and marine habitat, 40 locations of habour environment condition survey, estuary survey (Sum-Jin River). Finally the last stage will include 80 locations for harbour environment condition surveys, monitoring of rivers (100 locations from 13 rivers), reinforcement of the survey of sea deposits, together with automatic and real-time survey of water quality in contaminated marine areas (MLTM, 2008).

However, again there are conflicting views between government departments regarding marine boundaries. According to Lee (2005), while the Ministry of Government Legislation (MGL) and MLTM approved boundaries on the topographic map from the 'National Geographic Information Institute' (NGI) as marine boundaries, NGI declared that their marine boundaries for the location of islands cannot be used to identify jurisdictions. At the present, there is no clear law to determinate the marine boundaries (Lee 2005).

4.2.4 Marine parks and reserves

The 1967, the Natural Park Act made it possible to establish a number of marine national parks. The objectives of the Natural Park Act are twofold: (1) to conserve ecosystems, and conduct survey research on natural and historical scenery; and (2) to promote the sustainable use of South Korea's national parks. Since the Act of 1967, South Korea has established four marine-coastal national parks. These marine parks are listed below in Table 2

Name of park	Established	Park Area (Km^2)	Marine area (Km^2)
Hal yeo Marine	31 Th Dec, 1968	545.627	395.479 (72.5%)
Taean Coast	20th Oct, 1978	326.574	289.543 (88.5%)
Dadohae Marine	23 th Dec, 1981	2,321.512	1,986.684 (85.6%)
Byeonsan Peninsula	11th Jun, 1988	154.715	9.196 (6%)
Total		3,348.428	2,680.902

Table 2, South Korean Marine and coastal Parks (Source: Korean National Parks)

There are several issues with management of National parks to be considered. These include management of existing damage to the natural environment of protected coastlines and ecosystems, the conflicting uses and objectives of fisheries and environment organizations, the rights associated with of iindigenous aquacultural practices in park areas, together with the perennial problems of the management by many organizations, lack of specialized management plans, and limited available budgets.

South Korea also actively participates in international collaboration to ensure the sustainable use of adjoining oceans, particularly regional cooperation to support developing countries and to improve the ocean environment plus various other programs such as disaster preparedness (for example, by contributing to the recently established ocean observation network). South Korea publically states its willingness to take responsibility befitting its status as a country with an integrated marine administrative system and leading national strategies.

4.2.5 Nautical Chart and Nautical Publications in South Korea

There are marine related maps called 'Nautical Chart' and 'Nautical Publications' produced by South Korea. The nautical chart is a graphic representation of a maritime area and adjacent coastal regions. They may show the depths of water and heights of land, natural features of the seabed including navigational hazards. The additional information can be tides and currents, local details of the Earth's magnetic field and man made structures such as horbours, buildings and bridges. Nautical charts are used for marine navigation and take

the form of charts on paper or computerised (Kim, 2006).

Depending on usage, the nautical chart can be classified as a Navigation Nautical Charts, Submarine Topographical Map, or Fishery Information Map (See Figure 12). These publications are essential to protect the marine jurisdiction and fishery rights for all stakeholders.

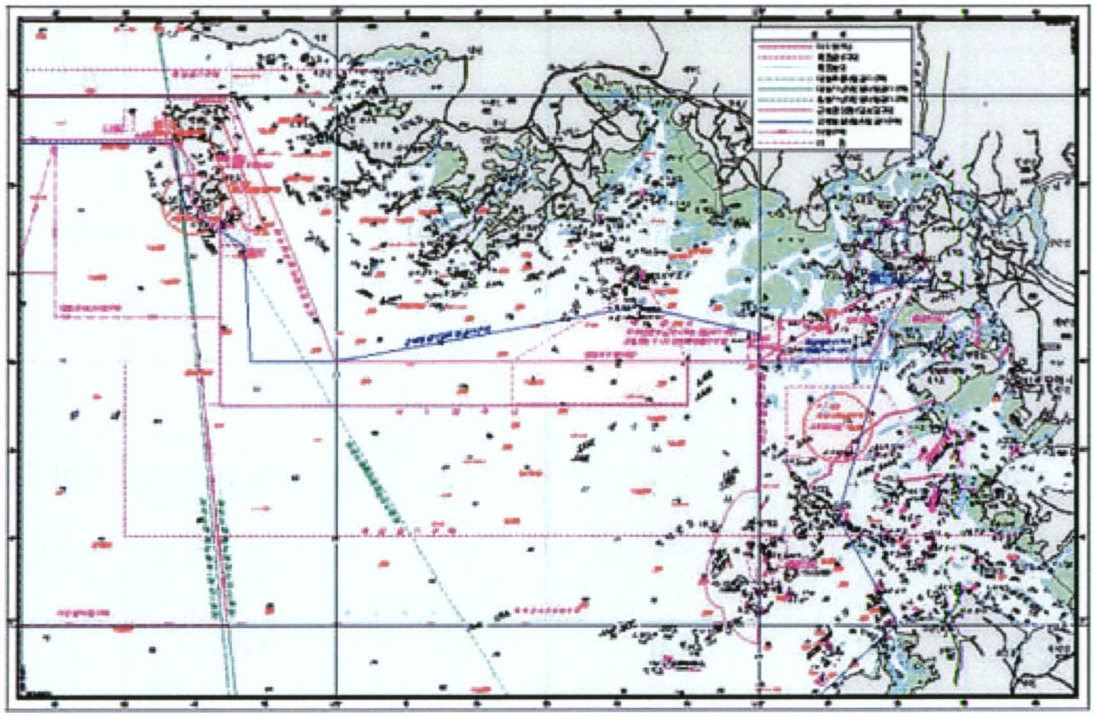


Figure 12 an example of Fishery Information Map from west coast in South Korea
(Source: National Oceanography Institute http://www.nori.go.kr/news/work_wway_fishery.asp)

4.3 Coastline management in South Korea

The South Korean coastline has become increasingly important in terms of land use and natural environment conservation. Due to insufficient title registration along the coast, it is currently difficult to resolve land ownership disputes (Choi et al. 2006). An integrated marine cadastral system must support management of the marine/land interface and so incomplete data in the land cadastre along the coast will also impact on the effectiveness of the marine cadastre. This is, therefore, and additional current issue for South Korea.

4.3.1 Coast land registration

4.3.1.1 Land and forest's initiative registration (1910~1924)

Under Japanese colonization, the priority for land registration was to meet fiscal targets and for this reason many coastal land areas of low value were not surveyed or registered. For example, only 537 of over 3000 islands in South Korea, were surveyed (Won, 1981). Much of the coastal land was not registered until the independence of Korea (Choi et al. 2006).

4.3.1.2 Following the Korean War

Most of the coast land was considered to be state land or public land when registration by the Korean government occurred in 1950. The land was generally not surveyed, but boundaries defined by gaps between the registered parcels. For this reason, and because of ambiguity in the definition of the coastline, there were substantial discord problem between mapped parcel boundaries and the physical reality (Choi et al. 2006).

4.3.1.3 Current management of coast land

In 1960, many harbor developments and land reclamations were initiated. Even though the coastline policy was successful in terms of economic benefits, there were marine environmental problem caused and which were recognised from the early 1970's. In response, the South Korean government established marine related regulations as follows:

- The Law of Ocean and River (1971)
- The Promotion of Marine Transportation Act (1971)
- The Marine Reserve Area from the Land Use Management Act (1972)
- The Prevention of Marine Pollution Act (1977)

A second Basic Plan for Land Development period was developed with a greater focus on the marine environment and with active participation from international Marine organizations. With the

coming into effect of UNCLOS (1994), the South Korean government established the Ministry of Maritime Affairs and Fisheries to deal with the new international Law of marine areas. Additionally, MOMAF (Ministry of Maritime Affairs and Fisheries) has regulated to reduce large scale reclamation by drainage and to create ecological conservation areas for tideland and fauna and flora in the coastal zone (Choi et al. 2006)

4.3.2 Desirable coastal land registration and management

A study by Choi *et al.*, (2006) showed that unregistered coastland represented up to 13 per cent of the entire coastland, that the accord with the coastline and the current cadastre information system was only 7 per cent, and that an average of approximately 15– 20 m width of coastland was recorded as offshore (Choi et al. 2006). These facts clearly showed the differences between the record contained in the cadastre under the terrestrial cadastre law standards and the reality. To achieve a desirable coast land management, there are several objectives:

- A tidal standard is needed in order to allow rational coast land registration for future rather then a temporary measurement by stakeholders.
- There needs to be allowance of indirect survey methods such as aerial photography, LiDAR, satellite remote sensing and marine acoustic (sonar) surveys. This is because of the cost and other limitations of direct survey methods in the marine environment (Choi et al., 2006). South Korean law currently only allows for direct survey by GPS, total station or traditional survey.

4.4 Marine Cadastre registration in 3D – a case study

To better illustrate the role of these indirect mapping techniques, this section describes some recent acoustic remote sensing of the seabed, which is one of the

elements recommended to provide for a marine management system.

The investigation area was undertaken off the western coastline of South Korea (See Figure 13) using a Single Beam Echo Sounder, a Multi-beam Echo Sounder (see Figure 14) and a Side Scan Sonar, in order to provide knowledge regarding an optimal solution (Lee et al., 2008:14).

According to Anderson et al. (2008:1004), the science of acoustic seabed classification (ASC) is just started, but they also take that view that a rapid evolution of the knowledge will lead to the significant new developments in coming years.

Figure 13 Location of investigation; Gunsan province (Source: Lee et al. 2008)
Figure 14 Multi-beam Echo Sounder (Source: Lee et al. 2008)

When acoustic sonographs were invented, they had low resolution and were only used to detect large physical targets like shipwrecks. Recently, rapid developments in acoustic electronics have allowed high resolution images of the seabed, of almost photographic quality, to be obtained. Further, software applications now offer greater data control functions with most systems now supporting real-time visualization of sonar data (Kenny et al. 2003:411-412).

4.4.1 Acoustic remote sensing of the seabed

In the case study, a single beam echo sounder, multi-beam echo sounder and the side scan sonar detector were used. According to Lee et al., (2008:15). the echo sounder has disadvantage with errors, particularly due to the fact that the sampling resolution on the seabed is low. This error is illustrated in Figure 15.

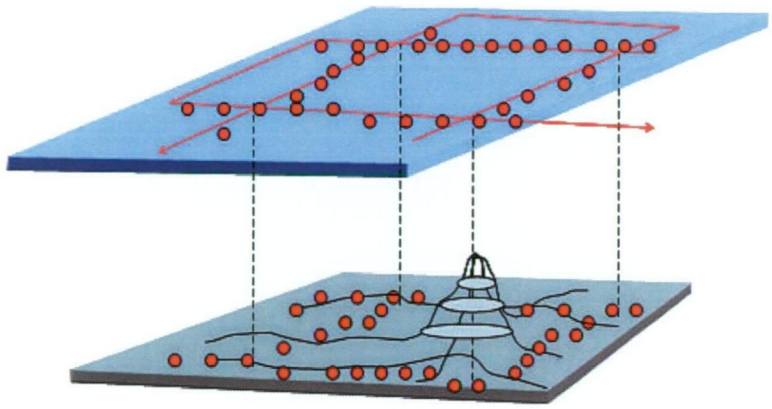


Figure 15 Survey limitation of Echo sounder

Multi-beam echo sounder is widely used to provide a nautical charts and nautical publications. Side scan sonar detectors provide a capacity to acquire acoustic image of the seabed with very high resolution (Lee et al., 2008:16). Interferometric side scan sonar (ISSS), using two channels on a side scan sonar, makes it possible to map area with total coverage and to very effectively detect and map complex three dimensional dataset representing features such as underwater pipes and cables and underwater structures (Lee et al., 2008:16).

4.4.2 Result of the investigation

The survey was implemented with an objective to survey the underwater topography and structure of the seabed with resolution of 6 cm x 6 cm (Lee et al, 2006) Received images can be geolocated using Differential Global Positioning System (DGPS) techniques. After processing, seabed height and location can be measured. This topographical information can be exported to three dimensional modelling software data, as shown in Figure 16.

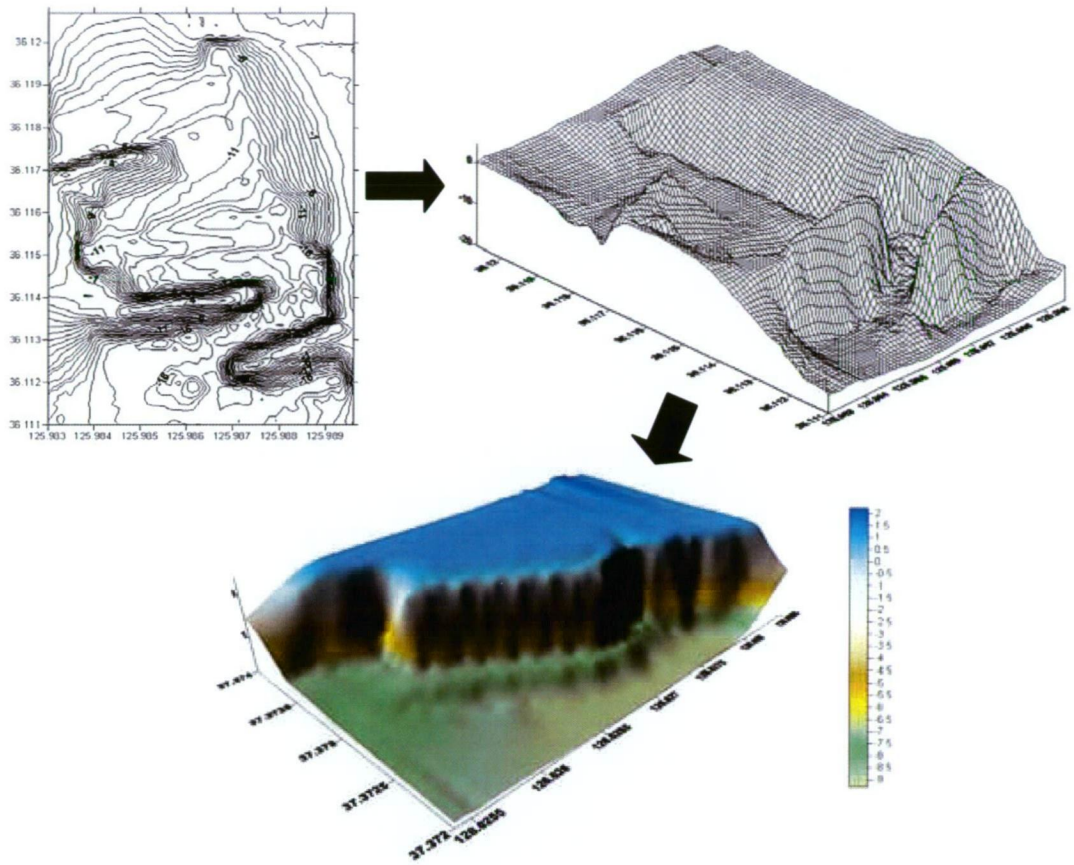


Figure 16 Three dimensional modeling results from Gunsan province (Source: Lee et al. 2008)

This acoustic remote sensing technology can be used to detect breakwaters, shore reef, underwater topography, pipelines, cables, underwater tunnels, and these objects can be registered in a marine titling system. According to Lee *et al.* (2008:24), the result from this investigation were first, a contour map of underwater topography with high resolution three dimension information; second, the modeling of three dimensional marine configuration for registration marine cadastre. They also suggest that, as for the terrestrial cadastre system, information such as this from a marine cadastral system can be provided to users through online delivery, with corresponding spatial and attributes information.

4.5 Issues Affecting the Marine Cadastre in South Korea

4.5.1 International and national level

The declaration of a 200 nautical mile limit (Exclusive Economic Zone - EEZ) by South Korea and Japan, and China's announced intention to do the same, have raised tension in North-east Asia and drawn the attention of high-level policy-makers. Such extensions of maritime jurisdiction are being superimposed onto a transitional and unstable geopolitical environment. Ideological and political adversaries in the region appear to be pursuing their maritime affairs without much concern for their neighbours, particularly those across hundreds of kilometres of open sea. Particular, current, issues within the marine area around South Korea are Dokdo Island (proprietary rights disputed between South Korea and Japan), fisheries conflict within Chian and South Korea, and the issue of naming East Sea (Japan Sea).

The two neighbours (South Korea and Japan) have been at odds over drawing a clear line for their EEZ, as Japan has laid claim to South Korea's easternmost islet between the neighbours, Dokdo Island. Dokdo is 92 kilometres east of South Korea's Ulleung Island, and 160 km west of Japan's Oki Island (See Figure 17)

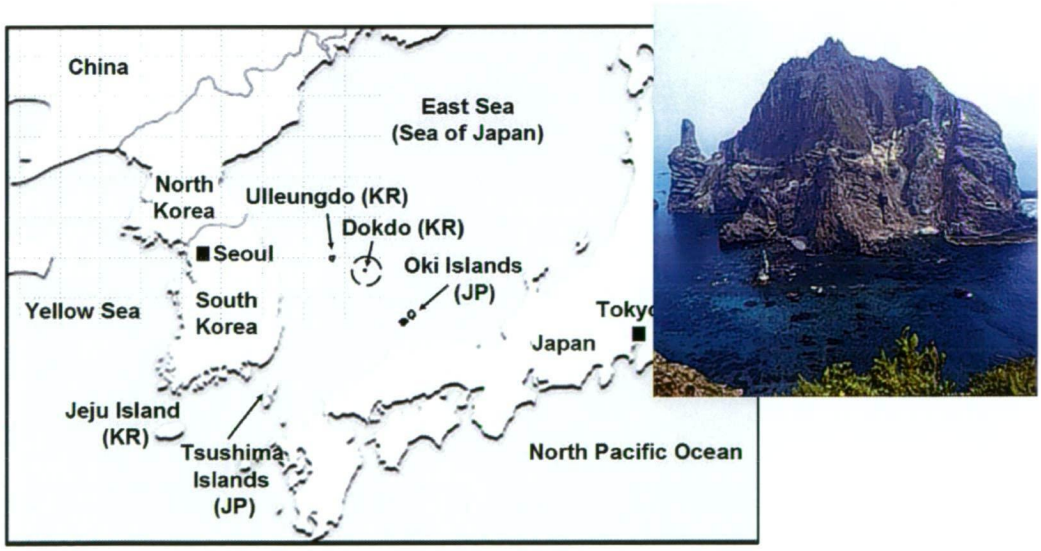


Figure 17 Location of Dokdo Island (Source: http://www.geocities.com/mlovmo/page4.html)

Almost no marine area is left unclaimed these days, and many areas are claimed by two or more countries. Many nations are unexpectedly finding

themselves adjacent to unfriendly or uncooperative neighbours (Valencia 1997).

According to the Valencia (1997), under the UNCLOS, the overlapping EEZ and continental shelf problems have generated many disputes. For example, Tok-do/Takeshima in the Sea of Japan (East Sea), the Senkakus/Diaoyu in the East China Sea, and the Spratlys and the Paracels in the South China Sea. Other maritime boundary disputes are concerned with unusual claims. For example, in the Yellow Sea, China apparently claims a continental shelf reaching to the furthest extent of the silt eroded from China's hinterland – the 'silt line'. Historical and trans-boundary issues could thus become politicised, with maritime frontiers in particular becoming dangerous no-man's lands, and island and maritime disputes re-emerging as 'hot spots'.

All Asian nations that have extended their jurisdiction now have to delimit the sea boundaries in order to identify and pursue their national interests in the oceans (Valencia 1997). Although maritime issues are generally a relatively minor part of the regional strategic picture, given the tenuous relations between many of the states and the likelihood of petroleum in disputed continental-shelf areas, such maritime issues could influence international relations (Valencia 1997)

4.5.2 Local level

Due to the absence of law about certain marine boundaries for local governments, conflict related to maritime borders has increased rapidly. An example is disputes following land reclamation. In this case, a committee of local government reconciliation with local autonomy is meant to have authority to resolve the dispute; however, with complicated overlapping jurisdictional problems, most local governments do not accept the decisions of this committee and bring an action before the Supreme Court, which generally means there are long delays before there is resolution (Lee, 2005)

4.5.2.1 Legal issues

Firstly, there is duplication of, or contradictions between, legislation. Maritime activities can be divided into maritime, coastline

and inland activity, and there is overlapping regulation in areas such as Fisheries legislation and the Fishing Ground management rules (Kim 2006). Secondly, there is complication caused by hierarchical legislation, particularly complex international and national laws about marine areas. For example, UNCLOS and local government's laws are discordant in terms of the definition of the "outer edge of continental margin". As mentioned in chapter 3, Australia has over 600 legislative elements affecting in marine areas. South Korea has much the same situation and many problems caused by confusion and misapplication of the law because of excessive laws of marine management (reference needed). Lastly there is insufficient protection of rights derived from marine activities. There are many rights related to marine areas, such as right of fishery, approach, development, operation, sea navigation, mining, use of seabed, disposal, and so on. Under the current register system in Korea, only fisheries and mining are protected by authority.

4.5.2.2 Institutional issues

Due to lack of a properly organized policy structure and marine cadastre, particularly between the central and local government, the distribution of marine management is seriously duplicated among the governments. This is compounded by a lower capacity in terms marine specialists when compared to other advanced countries; hence the recent establishment of an integrated organization (MLTM).

4.5.2.3 Technical issues

It is generally assumed that technical issues can be more easily addressed than the legal and institutional issues. However, in the context of a marine cadastre, the technical issues can be as complex as the others.

The first problem is the uncertainty of the baseline for marine boundaries (Kim 2006). As mentioned in chapter 2, the baseline concept has very broad spectrum and South Korea has uncertain

jurisdiction guidelines with coastline, territorial sea baseline, coastal waters, territorial sea, contiguous zone, exclusive economic zone, continental shelf by the UNCLOS.

The second problem is an inadequate coastline management system. The coastline management system should provide effective and up to date information suitable to record and monitor the environmental condition and changes along the coast. This is not currently the case (Kim 2006).

The third problem is the absence of marine maps. With some exceptions that account for only a small proportion of marine activity, such as some fisheries and aquaculture boundaries and some military managed areas, reliable maps are not available.

4.5.3 Other Issues

Shipping traffic has been increasing recently along South Korean coastal waters, as mentioned in chapter 4, over 99 per cent of South Korea's total import and export freight is transported by ship (Shin, 2003). However, the major concern for the marine environment can be dangerous goods carriers such as chemical tankers (Moon, 2009). Boisterous weather, tropical storms and dense fog can cause marine accidents. For example, in 1995, a large spill took place near Sorido Island when the tanker Sea Prince spilled about 5,000 tons of crude oil and bunker-C, and is the region is not expected to recover from the damage for hundreds of years. In spite of many efforts to prevent oil spill internationally, other large spill accidents from the tankers Erika, Nakhodka and Prestige have recently occurred, highlighting the seriousness of oil spills to coastal nations (Moon, 2009)

4. 6 Discussion

In the unique political and geographical situation of South Korea, the

significant of maritime area can be extraordinary, with high potential value from fishery, marine tourism, shipping and much more. Through Ocean Korea 21, the South Korean Government recently declared three basic objectives; the creation of living oceans; the establishment of knowledge-based marine industries; and the sustainable development of marine resources. These objectives and related goals were introduced to improve marine environment management.

A new organization, MLTM, was established in 2008, in order to integrate land and marine management organizations such as the Ministry of Construction and Transportation, the Ministry of Maritime Affairs & Fisheries Ocean Logistic, Port & Sea Environment and the Ministry Government Administration & Home affair's Land register Business. Among the support organizations, the Korea Cadastre Survey Corporation has possibilities to take a certain role, specifically to build a new marine cadastre system which would include using the professional skills and service capacity from a long history of terrestrial cadastre survey. The South Korea government also has an education plan for improved understanding of the marine environment. The plan includes establishment of the APEC Marine Environmental Training & Education Centre (AMETEC) in Korea Marine Institute (Ocean Korea 21).

This chapter reviewed one case study on coastline management, specifically a mapping application. The key issues with the case study were 1) realization of coastline with account for variation over time; 2) the legislation issues with difference characteristics from terrestrial cadastre; 3) the complexity of the marine environmental management information and its objectives. South Korea's coastland registration history and future plans were also described with two desirable objectives identified: 1) a tidal standard is needed to meet rational coastland registration for future rather then the temporary measurement by stakeholders; and 2) allowance by law of indirect survey methods such as aerial photography, LiDAR, satellite remote Sensing and acoustic (sonar) surveys.

In section 4.4, the application of acoustic remote sensing technology was illustrated. ISSS was shown to be capable of detecting breakwaters, shore reef, underwater topography, pipelines, cables, and underwater tunnels – all elements that support marine titling standards. The result from this particular investigation were, 1) a contour map of underwater topography with high resolution three dimensional

information; 2) the modelling of three dimensional marine configuration for marine cadastre registration; 3) evidence that a marine cadastral system can be provided as a service through online technology with marine spatial and attributes information.

The last section of this chapter described some of the international and national conflicts around South Korea, and the legal, institutional, technical issues for Korea. The key issues can be summarized as 1) a complex web of legislation; 2) insufficient protection of marine rights due to the absence of a marine titling standards system; 3) a need accurately defined tidal datum; 4) excessive expectation of a marine information system, due to the lack of knowledge of the marine environment.

Therefore, Kim (2006) suggests the role of a marine cadastre in South Korea should be to support:

- Clear distribution of user rights between governments and communities
- Ownership and stewardship of marine area resources
- Regulation of the rights to own, use and look after marine area resources
- Performance and monitoring of law by appropriate organizations
- An effective way to regulate disputes and prevent boundary conflicts.

5. International comparison

In spite of the significant need for a marine cadastre because of its geographical situation on the Korean peninsula, South Korea has not yet established a specialized and proper marine cadastral system. In order full consider the issues and opportunities for a marine cadastral system in South Korea, we can look to other advanced countries as comparison targets.

In order to understand the marine cadastral system for one nation, we should first have a basic knowledge of the marine environment in that country, since the legal, institutional and technical aspects of any one country's marine cadastre will be influenced by that environment (Kim, 2006).

The following brief comparison focuses on three aspects: firstly, comparative definitions of the marine cadastre in each country, secondly how the organizational operation of the marine cadastre systems in each country, and lastly, the key motivations or advantages identified by each country.

5.1 Different definition from an international viewpoint

In the USA, according to the National Oceanic and Atmospheric Administration (NOAA):

> The U.S. Marine Cadastre is an information system, encompassing both the nature and spatial extent /of interests in property, value and use of marine areas. Marine or maritime boundaries share a common element with their land-based counterparts in that, in order to map a boundary, one must adequately interpret the relevant law and its spatial context. Marine boundaries are delimited, not demarcated, and generally there is no physical evidence of the boundary. As a result, there can be confusion, disagreement, and conflicting versions of marine boundaries (NOAA, 1998a).

In Canada, the definition of Marine Cadastre is:

> 'A marine information system, encompassing both the nature and spatial extent of interests and property rights, with respect to ownership and various

rights and responsibilities in the marine jurisdiction' (Nichols et al. 2000).

Todd (2001) touched on the core of marine cadastre definition as below:

> 'The importance of fundamental spatial infrastructure will be introduced with particular reference to providing clear and unambiguous legal descriptions for each maritime area, visualization of those areas on maps and within computer information systems and the realization of those areas in the physical maritime environment.

The international comparisons are made between USA and Canada only because of the complex nature of marine cadastre system and because those two countries has considerable achievement in marine management and the marine cadastral development (although, according to Neely *et al.* (1998), the USA's marine resource management methods have been described as *"fragmented, complex and poorly understood"*).

5. 2 Marine cadastre system operation and related organizations

5.2.1 U.S.A : Ocean Planning Information System (OPIS)

In order to develop an ocean planning information system (OPIS, since 1998), the Coastal Centre of the National Oceanic and Atmospheric Administration (NOAA) has various industries, academic and government associates. OPIS is one of the first applications that applies cadastral data toward integrated ocean planning. Developed in 1998, the main tasks of the system are to examine existing boundaries, their spatial accuracy and how these boundaries are used in offshore regulations (Fowler and Treml, 2001).

The system has an overall goal 'to provide easy access to comprehensive ocean related data and information that will enhance regional, integrated approaches to coastal and ocean resource management' (NOAA 1998a). See Figure 18 below,

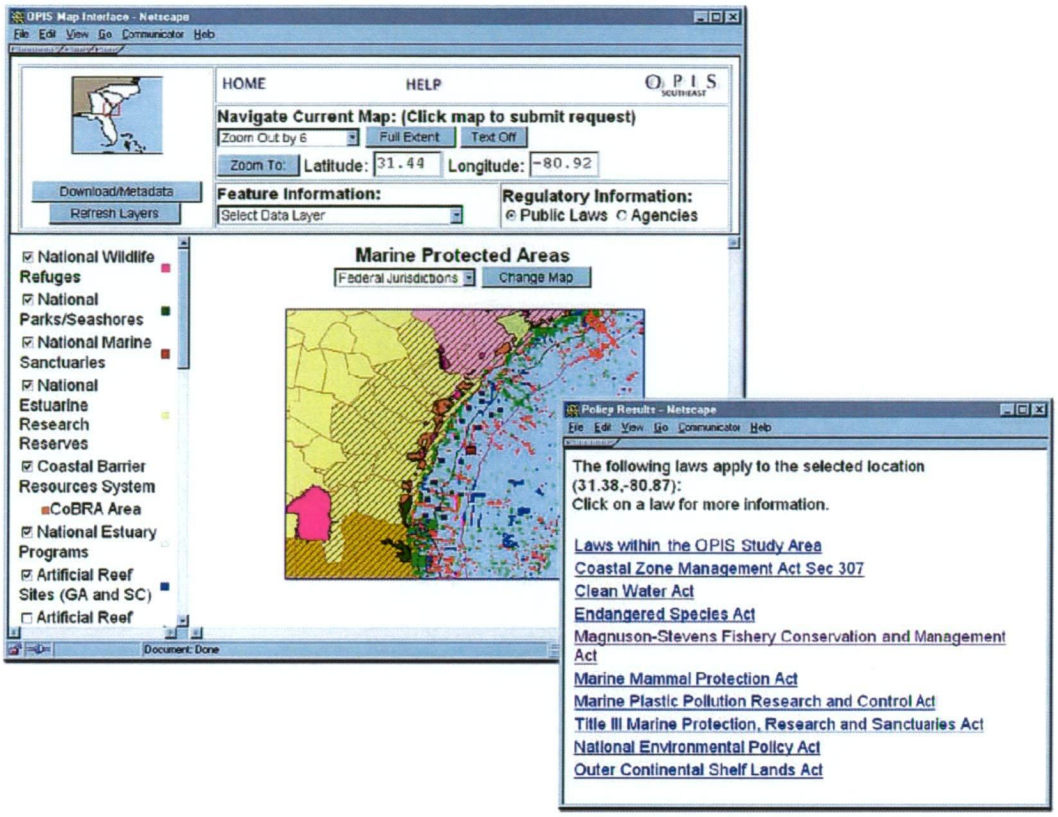


Figure 18 Ocean Planning Information System (OPIS) (Source: Fowler & Treml, 2001)

The OPIS was developed as a web-based regional tool, with consideration given to Federal and State policy frameworks. A bridge between the policy and the geography was created through the formation of a marine cadastre (NOAA, 1998a). The OPIS provides marine spatial information such as dredged material disposal sites, artificial reefs, sand resources, beach nourishment project, by county, National Marine Sanctuaries, National Estuary Program sites, data buoys, shoreline, bathymetry, major waterways, and outer continental shelf active lease sites (Fowler and Treml, 2001:9)

The system's major features include an interactive mapping application, marine and coastal spatial data download tools, associated metadata and legal summary pages (Fowler and Treml, 2001:10).

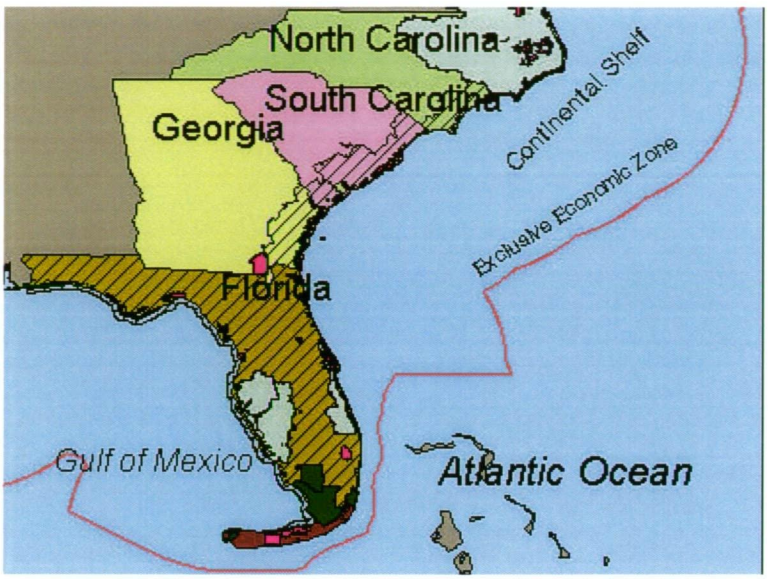


Figure 19 OPIS area of operation (Source: NOAA, 1998)

Fowler and Treml (2001) also indicate the two major problems with the operation of OPIS in USA. The first problem is a lack of understanding of mapping principles and technologies, and a reliance on legal descriptions that are inadequate to develop a mapping solution. Precise coordinates are needed in the GIS field, but the fundamental cartographic concepts are not considered in many circumstances. Not just in the USA but for all other countries, both policy and understanding of important technical concepts is essential. The other problem is related to three-dimensional claims that are difficult to understand, and implement. In the chapter 4, the case study for visualizing of three dimension of Gunsan province in South Korea was reviewed in order to illustrate this problem. Fowler and Treml (2001) also mention the ambiguity of marine boundaries and the significance of new legislation and regulations with metadata that provide enough precision to create the spatial data layer adequately. It is possible for overlapping rights to exist in a single locality and the rights can change with time (Widodo, 2002). It is necessary to remove the ambiguities with a policy regime which contains the metadata and clear definitions. According to Fowler and Treml (2001), the governing agencies are critical for the advancement to legally accurate cadastral information systems.

5.2.2 Canada : Marine Geospatial Data Infrastructure (MGDI)

Canada ratified UNCLOS in 2003 and the Oceans Action Plan (OAP) was announced in Halifax in 2005 by the Minister of Fisheries and Oceans (DFO) which outlines the opportunities for the sustainable development of Canada's oceans (Ricketts and Harrison, 2007:14). The OAP identifies several key challenges including;

- failing oceans health, including some declining fish stocks and increasing fluctuations of stocks, increasing numbers of marine species at risk and invasive species, marine habitat loss and declining biodiversity;
- growing ocean user conflicts and administrative, jurisdictional and regulatory complexities, and lost or delayed investments; and
- an oceans industry sector that is significantly weaker than its potential (DFO, 2005).

A *Canadian project*, initiated in 2001 within the Department of Geodesy and Geomatic Engineering at the University of New Brunswick, focuses on the demarcation of ocean territory to the limit of the continental shelf, as well as the definition and maintenance of existing and future rights. The objectives of the *Canadian project* include,

> first, to identify and evaluate boundary information requirements for good ocean governance; second, to investigate spatial data uncertainty and its impact on data integration and boundary delimitation; to develop and enhance prototype visualization tools for marine boundary delimitation (Ng'ang'a et al., 2001a).

The main issues of the project are multiple and unclear jurisdictional boundaries; co-management arrangements between state and federal governments; no agency managing offshore rights and boundaries; indigenous title rights, and enormous maritime areas to manage.

At the same time, a project undertaken in Canada has focused on identifying marine limits and boundaries from which a framework for good

ocean governance can be developed. According to Ng'ang'a *et al.*, (2001) this framework has been given the title of a multipurpose marine cadastre, from which other biological, economic and environmental information can be linked. There is also a project underway within Canada to develop a Marine Geospatial Data Infrastructure (MGDI) within the framework of the Canadian Geospatial Data Infrastructure (CGDI).

A possible dataset suggested by Nichols et al. (2000), to ensure the sustainable development and good governance of coastal and marine resources, includes,

Living and non living resources	Bathymetry
Spatial extents (Boundaries)	Shoreline Changes
Marine Contaminants	Seabed Characteristics
Water Quality	Property rights

Nichols et al. (1999) and Ng'ang'a et al. (2002) also indicate that cadastral information in the marine space that can be represented with boundaries might include,

- Limits of private and public ownership on upland property
- Limits of private rights below high water
- Local, provincial and territorial limits of jurisdiction and administration
- National and international boundaries including national coastal baselines
- Government departmental limits
- Environmental protection areas
- Military limits
- Pipeline and cable rights of way.

Sutherland and Nichols (2006) have argued that good governance is based on recognition of the interests of all stakeholders and inclusion whenever possible. Governance involves setting priorities that may establish hierarchies of interests but the basis is recognition of what is excluded as well as what is given priority in certain situations. The governance of any geographical area, including

marine spaces is actually the management of stakeholder relationships with regard to spatial temporal resource use in the pursuit of many sanctioned economic, social, political and environmental objectives.

5.2.3 Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP)

According to the Rajabifard et al. (2003), the aims of the PCGIAP are to maximize the economic, social and environmental benefits of geographic information by providing a conference for nations across the region to cooperate in the development of the Asia-Pacific Spatial Data Infrastructure and also contribute to the development of the global infrastructure. The PCGIAP consist of 55 nations which are represented on the committee by directorates of national survey and mapping organizations and equivalent national agencies (Rajabifard et al., 2003:5). The organizational structure of PCGIAP includes a plenary body, working groups and a secretariat to facilitate and implement outcomes. There are four working groups to undertake projects in each division. The cadastral working group is working group three (See Table 3)

Working Group 1: **Regional Geodesy**	Responsible for the implementation of a regional, precise geodetic network and coordinating regional geodetic campaigns.
Working Group 2: **Regional Fundamental Data**	Responsible for establishing regional fundamental datasets and mechanisms for sharing the data and understanding of the benefits in using regional fundamental data.
Working Group 3: **Cadastral Working Group**	Responsible for facilitating discussion on cadastral and land administration issues, and marine cadastres.
Working Group 4: **Institutional Strengthening**	Responsible for facilitating member involvement, education, training and sub regional programs.

Table 3: Working groups of the PCGIAP (Source: Rajabifard et al. 2003)

5.3 Comparison summary

To summarize the international comparison of marine cadastral system in two countries, key issues are categorized into legal, institutional and

technical aspects and brief summarized in Table 4.

Section		United States	Canada
Legal	Main Legislation	UNCLOS Submerged Lands Act Outer Continental Shelf Lands Act Coastal Zone Management Act Marine Mammal Protection Act National Environmental Policy Act	UNCLOS Canada Oceans Act Canada Lands Surveys Act Canada Oil and Gas Operations Act Canada Petroleum Resources Act Canada Environmental Protection Act Canada Fisheries Protection Act
	Registration	Rights, Restrictions, Responsibilities Mining Lease Block management	Rights, Restrictions, Responsibilities Marine Protected Area
Institutional	Policies	Main role of Marine Boundary Working Group	Marine Protected Area & Sustainable management objectives
	Organizations	NOAA (National Oceanic and Atmospheric Administration) FGDC (Federal Geographic Data Committee) MBWG(Marine Boundary Working Group)	DFO (Department of Fisheries and Oceans) NRC (National Research Council of Canada) NBS (New Brunswick Service)
	Boundaries	Mean Lower Low Water as Baseline States jurisdiction; Coastal water, Federal government jurisdiction; territorial sea, contiguous zone, EEZ	Low Water Line Baseline jurisdiction; territorial sea(12nm), contiguous zone(24nm), EEZ(200nm)
Technical	Information Infrastructure	MCIS (Marine Cadastre Information System) OPIS (Ocean Plan Information System)	MGDI (Marine Geospatial data infrastructure) Musquash Marine Protected Area
	Survey methods	GPS, Satellite Imagery, Aerial Photography, LiDAR	GPS, Satellite Imagery, Aerial Photography, LiDAR
	Nautical Chart	Continental Shelf Grid System General Nautical Chart	Fishery Nautical Chart

Table 4 Summary of international comparison with USA & Canada (Source: Kim 2006)

5. 4 Discussion

The objective of this chapter has been to benchmark other marine cadastre systems in USA and Canada, in order to inform decisions about marine policy, organizational structure and marine boundaries management. In the case of these two

countries, there are long term marine policies established for marine cadastre systems. However there are several issues we should consider. I indicate the three main findings from this chapter. Firstly, the legal regimes have a complexity of legislation in marine environment management, due to the excess of related law. Each country has exceedingly diverse and different laws, however basic integrated law is currently unavailable.

Secondly, in each institutional region, there are different baselines to apply the same maritime zone under UNCLOS. In spite of the similarity of the maritime zone in USA, Canada and Australia, the standard of baseline is set differently in each country. For example, USA has Mean Lower Low Water, and Canada set the standard with Lower Water Line from the UNCLOS' guideline, while Australia has Lower Water Mark and Indonesia has Low Tide Shoreline.

Thirdly, the marine survey methods are closely similar, but the marine cadastre applications can be varied. For example, OPIS, MGDI and Australia SDI have initially attempted to link terrestrial cadastre concepts to the marine area. For example, Australia has been using the marine titling standards (Appendix 2) which can provide information about property, use, third party property, and the compliance aspects to protect right of marine area's stakeholders with effective marine management. These three countries have similar problems in relation to effective management of marine boundaries, overcoming the multiple and unclear jurisdictional limits, various co-management arrangements, dealing with the fact that no single agency manages offshore rights and boundaries, issues related to indigenous title, and the enormous maritime areas that need to be managed (Nichols et al. 2000)

As mentioned in Chapter 2, the realization of maritime boundaries, especially the coastline is a significant challenge to both users and custodians of marine cadastre system, in part due to the fact that marine environmental characteristics are virtual objects rather than the land cadastre (Collier et al. 2003).

6 Key characteristics of the best practice marine cadastre for South Korea

In this final chapter I outline what would constitute characteristics of a best practice marine cadastral system for South Korea. This is the outcome of two broad research questions. First, this thesis has reviewed marine cadastral systems from three nation-states, with particular emphasis on the marine cadastral environment being developed in Australia. This review of specific issues and contexts, within the three marine cadastral systems examined, has allowed the identification of a number of general features. It is possible to design and implement a marine cadastre for South Korea on the basis of international marine cadastre initiatives as these provide a good guide to some of South Korea's current problems and issues. However, the second objective of this research has been to identify what is specific to the development of a marine cadastral system in South Korea, in terms of that country's unique environment and political situation. The thinking here is that it is not desirable to just adapt these systems directly to South Korea. Rather, key elements of the environmental and political situation characterizing South Korea need to be taken into account in order to takes advantage of international current research so as to build an appropriate and superior marine cadastral system.

6.1 Summary of Research

Chapter 2 set the context of cadastral systems in both land and marine environments. There are certain similarities but also a few differences. One of the distinct difference is the three dimensional marine boundaries. which expand to the overlapping rights in a single locality and which vary over time (Widodo, 2002). Maritime zones are defined by international, national, regional boundaries under the UNCLOS. In section 2.5 the realization of marine and coastal boundaries was explained with their inherent uncertainties and ambiguities.

Chapter 3 introduced the current issues affecting the marine cadastre in Australia, particularly by describing the marine management organizations and their objectives and policies.

The marine spatial data infrastructure (MSDI) presented by the University of Melbourne was introduced, to identify which elements are critical to a marine cadastral system. These are data, standards, policies, access networks, people and partnerships. In section 3.3, I divided the main marine cadastre issues into three categories, legal, institutional and technical issues. The recognized problem for each of these groups are 1) legal issues: the complex web of legislation, offshore constitutional settlement problems, and the ambiguity of boundaries (e.g. absence of baseline standard); 2) institutional issues: competing rights, restrictions & responsibilities, lack of spatial certainty and the interface (interruption) between terrestrial and marine areas; and 3) technical issues: accurately definition of a tidal datum, coastline change, updating needs, and the three dimensional nature of the marine environment.

Marine environmental issues such as shoreline erosion, loss of coastal wetlands, loss of marine habitat, conservation for protected area, protecting marine heritage, aquaculture, oil, gas and mineral extraction and over fishing were introduced in order to understand drivers marine cadastral reform in the Australian context.

Chapter 4 described the unique political and geographical situation of South Korea and the Korean Government's stated intention to initiate a paradigm change in the marine area. The recently declared Ocean Korea 21 initiative, and its three basic objectives (the creation of living oceans; the establishment of knowledge-based marine industries; and the sustainable development of marine resources) was described. The new South Korean integrated organization, MLTM, was introduced.

I also reviewed a case study on coastline registration management. The key issues within the case study were 1) realization of coastline that varied over time; 2) the legislation issues that were characteristically different from those of a terrestrial cadastre; 3) the complexity of marine environmental management information and its objectives. In that section, I indicated the desirable coastline management with two objectives, being 1) a tidal standard in order to meet rational coast land registration for future rather then the temporary measurement by stakeholders 2) allowance by law for indirect survey methods such as aerial photography, LiDAR, satellite remote sensing

and acoustic (sonar) surveys.

In section 4.4, acoustic remote sensing technology was described and its efficacy demonstrated. The results from this investigation were, 1) high quality maps of underwater topography with high resolution three dimension information; 2) the modelling of three dimensional marine configurations in a spatial format and with an accuracy that could prove suitable for marine cadastre registration; 3) evidence that a marine cadastre system could be provided as a service with online access and comprising both spatial and attributes information.

The last section summarized the issues that the South Korean marine cadastre, such as, 1) the complex web of legislation, as was the case in Australia; 2) insufficient protection of marine rights due to the absence of marine titling standards system; 3) the need to accurately define the tidal datum; and 4) excessive expectations of a marine information system.

The aim of chapter 5 was to find significant points of excellences from USA and Canada's marine environment management to improve marine policy, organization structure and marine boundaries management in South Korea. In the case of these two countries, there are some long term marine policies established to support their marine cadastre systems in a structured manner. But, at the same time, there are several problems that we should consider.

Firstly, the legal regimes in USA, Canada and Australia have a complexity of legislation in marine environment management, due to the excess of related law. Each country has exceedingly diverse and different laws, however the basic integrated law is currently unavailable.

Secondly, the different baselines are applied to measure the same maritime zone under UNCLOS. In spite of the similarity of the maritime zone in USA, Canada and Australia, the standard of baseline has been set differently in each country. For example, USA has Mean Lower Low Water, and Canada set the standard with Lower Water Line from the UNCLOS' guideline, while Australia has Lower Water Mark and Indonesia has Low Tide Shoreline.

Thirdly, the marine survey methods are closely similar, but the marine cadastral applications are varied. Structures such as OPIS, MGDI and Australia SDI have initially attempted to link terrestrial cadastre concept to marine area. As mentioned in Chapter 2,

the realization of maritime boundaries, especially the coastline is a significant challenge to both users and custodians of a marine cadastre system, due to fact that the marine environmental is characterized by virtual objects.

6.2 Recommendations for Best Practice for South Korea

6.2.1 Integrated Terrestrial and Marine management system

In the circumstance of the integrated organization that has been established, an integrated terrestrial and marine management system has the capacity to manage and to solve some significant problems with the currently inefficient coastline management. The National Land Information System (NLIS) is already successfully established, with strong support from organizations such as the Korea Cadastre Survey Corporation (KCSC) and South Korean Government.

Moreover, the legitimizing of digital spatial boundaries by governing agencies is critical for the advancement to legally accurate cadastral information systems. (Fowler and Treml., 2001). When discussing capacity building, Rajabifard et al. (2005) argued that spatial information technologies for managing coastal and marine information are now well established within most nations, however the knowledge required to use them appropriately and effectively is not, especially within Asia and the Pacific. Institutional reform, capacity building, education and training all need to be developed to address this gap. In chapter 5, it was noted that Fowler and Treml (2001) argued that, due to a lack of understanding of mapping principles and technologies, the legal description can be inadequate to develop a mapping solution. Precise coordinates are needed in the GIS field but the fundamental cartographic concepts are not considered in the many circumstances. Not just in the USA but for all other countries, policy supported by strong understandings of important technical concepts is essential. It is also desirable that the management of the marine environment should be integrated with land information systems, for

example for dealing with problems like marine pollution from land (Binns, 2004)

In view of the results so far achieved, integrated governing agencies are critical to build an effective marine cadastre system and, for capacity building, the land surveyors and the marine scientist need to work together to build efficient land-marine cadastre system.

6.2.2 Metadata establishment to solve the uncertainties of tidal datum

Participation on the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) working group 2 is recommended, to establish global standards on tidal datum or international marine boundaries. In the study of conflicts between the neighbourhood countries, regional legislation limited capacity to solve these international problems. If we can remove uncertainties related to the coastline boundaries, the building of marine cadastre system can be a lot easier than present situation. Besides the advantage of simplicity, efforts to develop advanced marine cadastre system built on common definitions and standard, from United Nations organization like PCGIAP, may generate substantial advantages in the future.

6.3 Future Research

The work reported in this thesis has outlined some key issues for consideration as South Korea moves to develop a marine cadastre, and has made some key recommendations. The future development of this work should include:

- protocols for the development of an effective and seamless coastline management system,
- protocols for mapping the three dimensional marine environment using appropriate mapping technologies,
- research to support sustainable marine management to meet the public and users' needs for balance between the competing interests of development and exploitation,

and protecting the marine environment,

- The development of metadata standard, include definition of a fundamental dataset of marine environment and definition of marine boundary standard.
- data access and management guidelines for remote (web based) access to marine cadastral information.

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Appendix 1 Marine Titling Standards

Property Aspects	
Resource	Clear identification of the resource involved
Property nature	Statement that the title is property and what type
Proprietary extent	Definition of proprietary characteristics
Application process	Statement of the criteria, who will make the judgment, payment, issuing authority, entitlement to apply, limits on applications and processes of prioritization of competing applications
Access	Statement of the nature of access exclusive or shared. Statement of access limitations vis-à-vis other activities
Use aspects	Defined opportunities to use, to consume to "Waste"
Fees and royalties	Statement of the fees, royalties and payments required, and the means of increasing them from time to time
Transfer	Statement of terms if any upon which the title can be transferred
Third party property aspects	
Overriding claims	Statement of overriding claims – native titles, recreational fishing, prior rights
Security	Statement of whether the title can be mortgaged and opportunities of lender for gaining, possession, selling or foreclosing, and priorities among serial lenders
Title Aspects	
Name	Lease, concession or license, preferably a name the public understand
Pro formats	Provision a pro-form "lease" in plain language in digital, Web available, and hard copy, easy print, versions preferably established by subordinate legislation
Grant	Authoritative description of the grant process, particularly identifying when property exists
Time period	Beginning and end dates clearly specified
Renewal	Renewal arrangements specified, including whether renewal is available after expiration of the title
Conditions	Statement of all the special conditions applying to the title
Trading mechanisms	Guide to standard transactions; negotiated, resource banks, auction, reissue to new owner
Trading information	Provision for trades and prices to be publicly available
Equity constraints on transfer	Limits on transfers, limits on ITQ transfers across vessel size (Colby 2000, 649)
Depletion of resource	Retirement policy if resource is depleted or if management considerations require moratorium or suspension of access, including opportunities to claim compensation
Forfeiture	Statement of situations in which forfeiture is available
Termination	Situations in which title is ended other than forfeiture
Link use with resource	Program for linking opportunities to use with available supply, methods of assuring public good supply
Bond or security	Statement of bond, security or guarantee given to ensure compliance
Compliance aspects	
Work plan/ activity	Clear statement of the activity required
Reports	Specification of nature of information returns including form and timing
Insurances	Statement of insurances required, and information to be provided
Cessation of title	Statement of condition of site on relinquishment and forfeiture of bone or security
Enforcers	Identification of the agencies and officers able to enforce
Entry of enforcers	Identification of opportunities for officers to access site
Enforcement officer powers	Inspection of site, books and records, taking statement
Enforcement incentives	Fines, penalties, reduction of next year's permit, revocation

Appendix 2 Marine Heritage related legislations (Jeffery, 2002)

Federal Legislation

- *Historic Shipwrecks Act 1976*
- *Navigation Act 1912*
- *Torres Strait Islander Heritage Protection Act 1984*
- *Australian Heritage Commission Act 1975*
- *Environment Protection and Biodiversity Conservation Act 1999*

Currently a new bill is under review to replace the Heritage Commission Act, being the *Environment and Heritage Legislation Amendment Bill (No.2) 2000* and this bill will also amend the *Environment Protection and Biodiversity Conservation Act 1999.*

- *Protection of Movable Cultural Heritage Act 1986*

State and Territory Legislation, related agencies and registers

NEW SOUTH WALES

- *Heritage Act 1977*
- *National Parks and Wildlife Act 1974*

* Heritage Council of NSW
* National Parks and Wildlife Service
* Environment Protection Authority
* NSW Heritage Office
* NSW State Heritage Inventory

NORTHERN TERRITORY

- *Heritage Conservation Act 2000*
- *Northern Territory Aboriginal Sacred Sites Act 1989*

* Heritage Advisory Council
* Aboriginal Areas Protection Authority
* Museums and Art Galleries of the Northern Territory
* Parks and Wildlife Commission of the Northern Territory
* NT Heritage List
* NT Shipwrecks Database

QUEENSLAND

- *Queensland Heritage Act 1992*
- *The Cultural Record (Landscapes Queensland and Queensland Estate) Act 1987*

* Environment Protection Agency
* Queensland Museum
* Queensland Heritage Council
* Queensland Heritage Register

SOUTH AUSTRALIA

- *Heritage Act 1993*
- *Historic Shipwrecks Act 1981*
- *Aboriginal Heritage Act 1988*

* Heritage South Australia
* Parks and Wildlife
* Aboriginal Affairs
* South Australian Register of Aboriginal sites
* SA State Heritage Register
* SA Register of Historic Shipwrecks, Historic relics and protected zones

TASMANIA

- *Historic Cultural Heritage Act 1995*
- *Historic Cultural Heritage Amendment Act 1997*

* Tasmanian Heritage Council
* Department of Primary Industries, Water and Environment
* Tasmanian Heritage List

VICTORIA

- *Heritage Act 1995*
- *Archaeological and Aboriginal Relics Preservation Act 1972*

* Heritage Victoria
* Natural Resources and Environment
* Aboriginal Affairs Victoria
* Victorian Heritage List WESTERN AUSTRALIA
- *Heritage of Western Australia Act 1990*
- *Aboriginal Heritage Act 1972–80*
- *Maritime Archaeology Act 1973*

* Heritage Council of Western Australia
* Department of Indigenous Affairs
* WA Maritime Museum
* Department of Conservation and Land Management
* Department of Contract and Management Services
* Department of Environmental Protection
* Western Australian Register of Heritage Places
* WA Register of Aboriginal sites
* WA Register of Shipwrecks and Relics