

MARINE CADASTRES

– CHALLENGES AND OPPORTUNITIES FOR LAND SURVEYORS

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Ian Williamson's teaching and research is concerned with cadastral, land and geographic information systems, land administration and spatial data infrastructures, in both developed and developing countries. He has undertaken research or consultancies world-wide including for AusAID, the United Nations, the Asian Development Bank and The World Bank. He is a Member of the Order of Australia (AM), a Fellow of the Academy of Technological Sciences and Engineering Australia (FTSE), a Fellow of the Institution of Surveyors Australia Inc., a Fellow of the Institution of Engineers Australia, an Honorary Fellow of The Mapping Sciences Institute and the Spatial Sciences Institute Australia, and an Honorary Member of the International Federation of Surveyors (FIG). He was Chairperson of FIG Commission 7 (Cadastral and Land Management) 1994-98 and Director United Nations Liaison for the FIG from 1998 – 2002. He is currently a member of the Executive of the United Nations sponsored Permanent Committee for GIS Infrastructures for Asia and the Pacific (PCGIAP) and Chair of its Working Group 3 (Cadastral). At Melbourne he has been President of the Academic Board and Pro-Vice-Chancellor, and is currently Head of the Department of Geomatics and Director of the Centre for Spatial Data Infrastructures and Land Administration. He was awarded the Centenary Medal by the Prime Minister for service to Australian society in research and geomatics engineering and surveying 2003.

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Lisa Strain completed a Bachelor of Geomatics Engineering and a Bachelor of Environmental Science in 2003. During undergraduate study Lisa demonstrated for practical classes in first year engineering and geomatics surveying subjects. She also undertook vacation work for the Civil Contractors Federation, and for Hobsons Bay City Council. Lisa is currently a Masters student under the ARC marine cadastre research grant with cooperation with Land Victoria, Geoscience Australia, Department of Land Administration WA, Department of Lands NSW and Land Information New Zealand.

ABSTRACT

This paper describes the marine cadastre concept, and reviews both the current and future directions of international and national marine cadastre initiatives. This includes an overview of the incentives, objectives, principle tasks and results of current research as well as reporting on the outcomes of the PCGIAP-International Workshop on administering the marine environment held in Malaysia in May 2004. The paper then endeavours to briefly explore the relevance of the marine cadastre concept to land surveyors.

There has been international recognition of the need to improve administration of the marine environment, in particular focussing on managing the different and overlapping maritime boundaries and the need for access to marine related spatial data. Decision-makers in both the land and marine environments will need access to this information to make effective and reliable decisions supporting marine administration.

With this in mind, the Department of Geomatics at the University of Melbourne is involved in a number of national and international collaborative projects with a marine focus. One of the major projects is sponsored by the United Nations supported Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP). The main objective of this project is to define the issues to be considered in developing a set of guidelines appropriate to the Asia and Pacific region for administering the marine environment.

The Department of Geomatics has also initiated research into problems relevant to the development of an Australian marine cadastre. The current project sponsored by the Australian Research Council focuses on four major research areas including resolving ambiguities in the definition of the tidal interface; using natural rather than artificial boundaries in a marine cadastre; expanding the Australian SDI to a support marine dimension; and legal and security issues intrinsic to the development of a marine cadastre. The outcomes from this research have generic application to other countries worldwide that have marine boundaries.

INTRODUCTION

There are complex relationships and interactions between overlapping and often competing rights, restrictions and responsibilities, both in the marine environment and at the land-sea interface. In recent years there has been an increasing awareness of the importance of spatial data relating to the marine environment and the need for a structured and consistent approach to the definition, maintenance and management of offshore legal boundaries. It is within this context that the concepts of a marine spatial data infrastructure (Marine SDI) and a national marine cadastre have gained increasing prominence.

Taking this into the account, and also considering the diversity and extent of a nation's ocean resources, there is a fundamental requirement to manage, explore and exploit the nation's ocean territories in a way that will maximise benefit to the nation, while at the same time protecting the delicate ocean environment. With this in mind, the Department of Geomatics at the University of Melbourne is involved in a number of marine focused international and national collaborative projects.

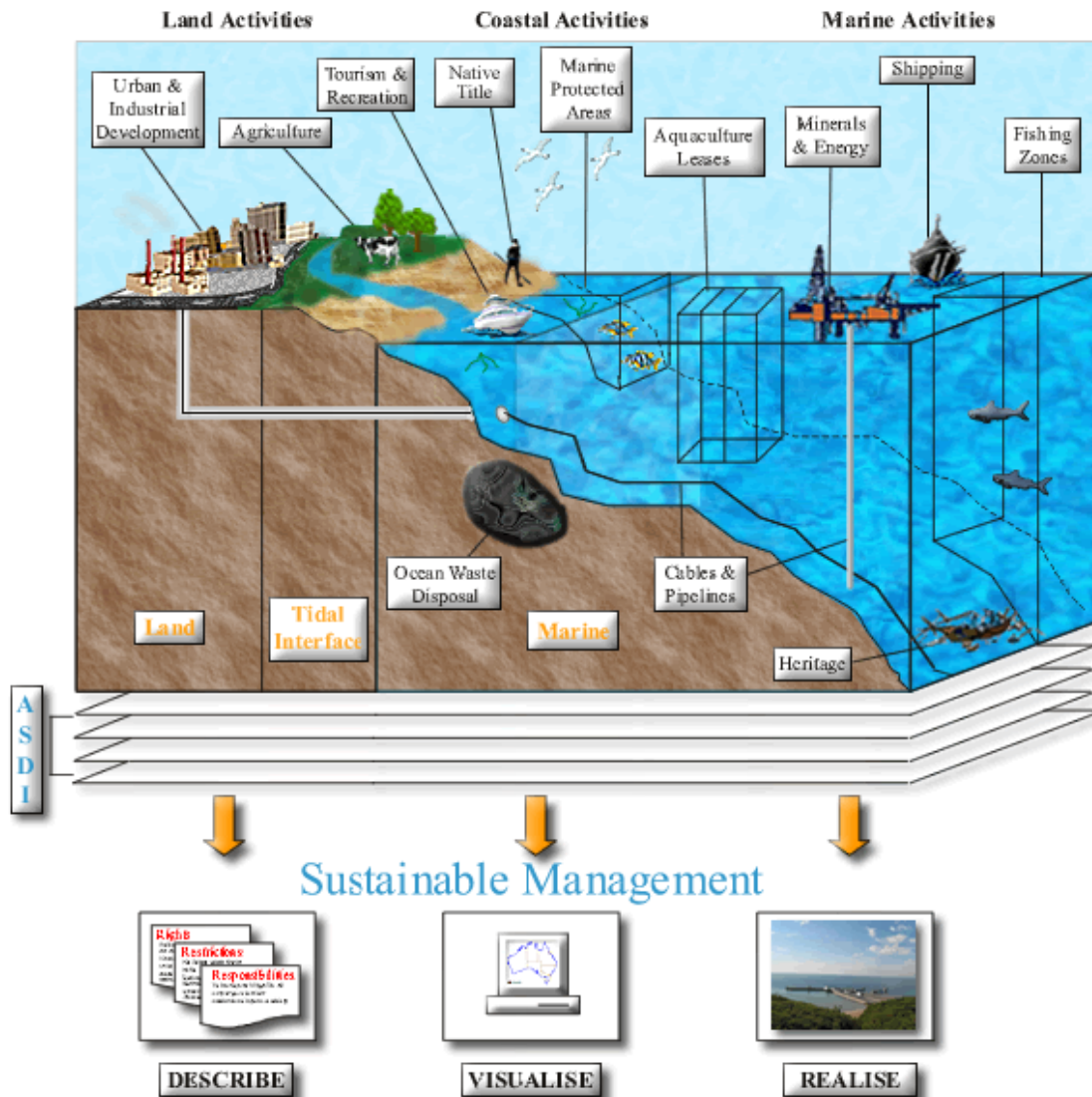


Figure 1
Marine Cadastre Concept Diagram
 (Binns *et al*, 2004)

MARINE CADASTRE CONCEPT

There is still a lot of contention surrounding the definition of a marine cadastre, however it is agreed that a framework for managing the complex and often conflicting rights and interests in the marine environment is needed. The marine cadastre diagram developed within the first Australian Research Council (ARC) marine cadastre project (described below) describes a marine cadastre as providing the ability to ‘describe, visualise and realise’ the various rights, restrictions and responsibilities within the marine and coastal environments (Binns *et al*, 2004).

This means being able to ‘describe’ a particular right or interest – ie an aquaculture lease or shipping channel, then being able to ‘visualise’ the boundaries and associated information, and finally being able to ‘realise’ or locate this information in the real world. Figure 1 further describes this concept.

INTERNATIONAL ACTIVITIES

The Centre for Spatial Data Infrastructures and Land Administration, Department of Geomatics, University of Melbourne is involved in an international collaborative research project on marine SDI and marine cadastre. This project is in the Asia-Pacific region, under the United Nations supported PCGIAP. This project was also supported by the International Science Linkages program established under the Government's innovation statement Backing Australia's Ability.

There is currently a general lack of transparency in the Asia-Pacific region as to the kind of cadastral data and land administration systems that exist and the scope, quality, and information communication technologies they utilise. Importantly all countries in the region are undertaking some form of cadastral or land administration reform with most developing countries receiving international advice or aid.

This provided the justification to establish the PCGIAP-Working Group 3 (Cadastre) which aims to document existing cadastral systems in a standardised way (website: www.cadastraltemplate.org or <http://www.gsi.go.jp/PCGIAP/98wg/98wg3.htm>). In order to achieve this, WG3 needs support to assist its effort to fulfil tasks regarding development of Regional cadastral activities. The Department of Geomatics, University of Melbourne, which currently has an active research group working in the field of SDIs, Land Administration and Marine Cadastre is giving such assistance to PCGIAP.

United Nations-Permanent Committee on GIS Infrastructure for Asia and the Pacific

Development of a Regional SDI initiative in Asia-Pacific region began with the creation of the Regional SDI coordination group formed the Permanent Committee for GIS Infrastructure for Asia and the Pacific (PCGIAP), formed in 1995 under the auspices of the United Nations Regional Cartographic Conference for Asia and the Pacific (UNRCC-AP).

The national mapping agencies in the Asia-Pacific region formed the PCGIAP as a result of Resolution 16 of the UNRCC-AP. The aims of PCGIAP are to maximise the economic, social and environmental benefits of geographic information in accordance with Agenda 21 by providing a forum for nations across the region to cooperate in the development of the Asia-Pacific SDI (APSDI) and contribute to the development of the global infrastructure.

There are three tiers in the PCGIAP organisational structure, consisting of a plenary body comprising all participating member nations, a middle tier including working groups and a secretariat which facilitates and implements all decisions made by the top tier body. In addition to reporting to the UNRCC-AP, this Committee also established links with other relevant United Nations programs and international bodies such as FIG, ISO/TC 211, ISCGM, EUROGI, PCIDEA, ISPRS, IUGG, ICA.

PCGIAP comprises 55 nations which are represented on the Committee by directorates of national survey and mapping organisations and equivalent national agencies. An Executive Board, comprising representatives from twelve member nations (President, Vice President, Secretary, and up to nine other members), coordinates the Committee's work program. The activities of and work programs of the Executive Board is supported by its Working Groups including WG1: Regional Geodesy; WG2: Regional Fundamental Data; WG3: Cadastre; and WG4: Institutional Strengthening.

PCGIAP-Working Group 3 (Cadastre)

The Cadastral Working Group was established in 2000 based on the Resolution from the 15th UNRCC-AP in Malaysia. Currently the Chair of WG3 is held by Australia and

the Vice-Chair by Malaysia. Through that Resolution, it was recommended that the following work plan be undertaken for the period 2000-2003:

- (a) Facilitate discussion on marine spatial data management and cadastres, focusing on the issues involved in the establishment of appropriate administrative infrastructures to manage marine resources in the context of the United Nations Convention on Law of the Sea;
- (c) Facilitate a workshop to develop an appropriate generic template for country profile analyses describing the status of cadastre and land administration, and the need for improvements, which will facilitate benchmarking and the development of performance indicators.

With this in mind, the PCGIAP, through its WG3, believes that facilitating discussion on marine spatial data management and marine cadastres is essential to the development of the Asia-Pacific SDI; development of regional marine SDI and marine cadastre; realisation of economic, social and environmental benefits for the region; and the implementation of the United Nations Conference on Environment and Development (UNCED) Agenda 21. The Committee also believes that data sharing avoids wasteful duplication of resources and facilitates data integration providing better data for decision making and thus expanding market potential.

WG3 had two major tasks during the period 2000-2004. First to undertake a review of cadastral activities in Asia-Pacific through questionnaires and the organization of a regional workshop (conducted in July, 2003 in Japan) to discuss the development of cadastral templates to compare systems and their role in National SDIs. Secondly, to better understand the spatial dimensions of the marine environment in the Asia-Pacific region and undertake a regional workshop (conducted May 2004 in Malaysia – see below). WG3 is currently tasked with a project (2005-7) to better understand and investigate the integration of built (cadastre) and natural (topographic) environment datasets within the context of National SDI initiatives across Asia and the Pacific.

International Workshop on Administering the Marine Environment – The Spatial Dimensions

Based on the second objective of WG3, and with support from the Department of Surveying and Mapping, Malaysia, an international workshop to discuss the spatial dimensions required for the administration of the marine environment was held from 4-7 May, 2004 in Kuala Lumpur, Malaysia. The main objectives of the workshop were to facilitate: an understanding of the needs of SDI in the marine context; an understanding of the administration of marine rights, restrictions and responsibilities; and to document issues in establishing a marine dimension as a key component of National SDIs.

The Workshop reviewed national administration of marine environments of countries in Asia and the Pacific region based on a common template to identify problems, issues, similarities and differences in spatial data infrastructures; institutional arrangements; the administration of rights, restrictions and responsibilities; and technology, human resource and capacity building in the marine environment. 102 people from 11 countries (Malaysia, Australia, Fiji, India, Cambodia, Indonesia, Kiribati, Thailand, Brunei Darussalam, Canada, Ireland) attended the workshop.

The first day of the workshop included the official opening and presentation of invited reports, papers and country reports. The second day was allocated to the discussion of

the three main objectives of the workshop and the development of possible resolutions and recommendations to the PCGIAP on administering the marine environment.

A background paper discussing the “Issues in Developing Marine SDI” was presented by the Workshop Chair, Professor Ian Williamson. As part of this presentation, the key environmental, social and economic factors and issues driving the development of Marine SDI were highlighted. It was also noted that whilst access to spatial data aids in effective decision-making to achieve sustainable development, the majority of SDI initiatives stop at the land-sea interface. This encourages marine data to be held in various formats, at various accuracies within ‘data silos’. Therefore, there is a need to identify technical, legal and institutional arrangements hindering coordination and management of the marine environment.

Delegates attending the workshop then broke into groups with each discussing different aims and objectives. Some of the major points highlighted during the discussion sessions include:

- Importance of including a marine component within the SDI policies as part of countries obligations to UNCLOS.
- SDI and cadastre are different and cadastral data can be subsets of SDI as well as a process based on SDI.
- SDI should facilitate access, management and sharing of spatial data in both the marine and land environments at any jurisdictional/political level.
- The marine cadastre can include components of the land-based cadastre and in addition it must take into consideration the fuzzy nature of boundaries as well as a 3D (volume) and sometimes 4D (temporal) nature of the interests in the marine environment.
- Importance of collaboration between FIG, Commission 4 and PCGIAP, WG3 (Cadastre) on issues relating to marine SDI and marine cadastre.
- Lack of a single organisation capable of coordinating issues in the marine environment.
- Importance of institutional reform and capacity building in administering marine rights, restrictions and responsibilities.
- The marine SDI should relate to natural boundaries as well as administrative boundaries.

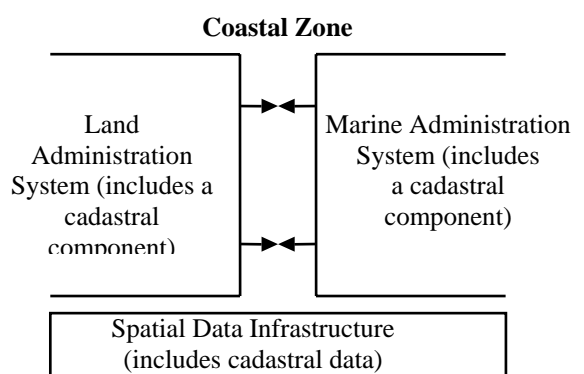
The last day of the workshop was used to discuss and finalise the workshop outcomes, resolutions and the report to the PCGIAP. The participants discussed and agreed on five Resolutions as listed below:

Resolution 1 – Spatial Dimension of Administering the Marine Environment

Recommends that all countries in the Asia-Pacific region with an extensive marine jurisdiction and administrative responsibilities be encouraged to include a marine dimension in their National SDI as part of their obligation to meeting their responsibilities under UNCLOS. *And further recommends* that they cooperate with other countries to ensure technical, operational and policy consistency in the marine elements of National SDIs developed in the Asia-Pacific region.

Resolution 2 – PCGIAP-FIG Collaboration

Recommends that PCGIAP and FIG collaborate through their respective work plans on marine cadastre, marine SDI, marine administration systems and ocean governance and encourages the FIG to participate in the Marine Cadastre Template Project.



Resolution 3 – Defining the Spatial Dimension of the Marine Environment

Recommends that the term “marine administration system” is adopted for the administration of rights, restrictions and responsibilities in the marine environment, with the spatial dimension facilitated by the Marine SDI. *And further recommends* that a marine cadastre is defined as a management tool which spatially describes, visualises and realises formally and informally defined boundaries and associated rights, restrictions and responsibilities in the marine environment as a data layer in a marine SDI, allowing them to be more effectively identified, administered and accessed.

Resolution 4 – Requirement for Further Development of Guidelines and Tools to Administer the Spatial Dimension of the Marine Environment.

Recommends that PCGIAP further investigates and develops guidelines and tools for administering the spatial dimension of the marine environment.

Resolution 5 – Expression of Gratitude to the Malaysian Government.

The University of Melbourne research team is now analysing the results of the workshop as well as publishing online, all country reports presented at the workshop. The template for country reports is also available online and other countries are invited to complete the template and forward it to the team to further strengthen the project outcomes. The web address for both the template and results is: <http://www.geom.unimelb.edu.au/maritime/PCGIAPWorkshop.htm>. The team also recently designed and created a dedicated website (www.marineadministration.org) for marine administration in which all completed country templates are available with other related materials. This website will be the main portal for these activities through PCGIAP in the future. Discussions are under way to collaborate with Commission 4 (Hydrographic Surveying) of the International Federation of Surveyors in extending the number of countries participating in this initiative.

MARINE SDI AND CADASTRE RESEARCH IN AUSTRALIA

Initial support for marine cadastre research in Australia came in late 2001 with the awarding of an ARC Linkage-Projects grant to a team comprising the University of Melbourne, GeoFix Pty Ltd, Land Victoria (LV), Geoscience Australia (GA) and the Queensland Department of Natural Resources and Mines (NR&M). In addition to the work and contribution being made directly by the ARC project, a number of other initiatives (mainly Government) have commenced for example the National Oceans Office has started regional marine planning for Australia's marine jurisdiction, and also the development of an Oceans Portal. Thus marine cadastre research in Australia has gained strong government support. Healthy coordination of the research effort is being maintained through the nurturing of close collaborative links between the government and academic sectors, while keeping the private sector fully informed of developments.

Progress on the ARC Marine Cadastre Project

The above ARC project formally commenced in June 2002, with the appointment of two postgraduate students and a full-time research assistant. The project ran for two years finishing with a seminar in June 2004 and had as its principle objective the definition of issues currently hindering the development of an Australian marine cadastre and, in that context, the establishment of a direction for future research.

Research within the ARC project focussed on two areas. The first was a consideration of the similarities and differences between the existing land cadastre and a future marine cadastre and the suitability and extension of the Australian Spatial Data Infrastructure (ASDI) to the marine environment. The second research area focused on

issues of 3D and 4D parcel definition, the application of uncertainty in maritime boundary delimitation and coastline definition, and the integration of uncertainty within a multi-dimensional cadastral object model.

In parallel with these detailed areas of research, work was also conducted to gain a broader understanding of the requirements of those individuals and organisations who use, manage and administer maritime spaces and marine spatial data. This was achieved through the running of workshops, the conducting of a broadly based national questionnaire and the execution of detailed industry consultation.

The questionnaire, feedback from the three workshops and findings from the industry consultation process have been combined to identify fundamental design criteria for a future marine cadastre for Australia. A pilot project, with demonstration areas in Queensland and Victoria provided a "laboratory" for testing research hypotheses and refining proposed solutions. Ultimately, the pilot project will become the means whereby the features and capabilities of an Australian marine cadastre can be illustrated and demonstrated to a wider audience. More details on the outcomes of this initial ARC project can be found at: <http://www.geom.unimelb.edu.au/maritime/index.htm>.

New ARC Grant

From the outcomes of the first ARC project, another application for funding to the ARC has been granted under the ARC Linkage-Projects scheme. This second ARC project commenced in late 2004 and will run for three years. The objective of this application is to allow independent collaborative research in this area to continue, by building on the findings of current research and by supporting strategic industry-academic research partnerships.

Progress was made in the first ARC project in identifying and defining fundamental problems hindering the development of an Australian marine cadastre. Though still at an early stage, the new ARC project draws on the body of knowledge and expertise flowing from the first ARC project and aims at providing solutions to four fundamental research problems that have emerged. This is not to say that these four research problems are the only ones that demand attention, but taken together they represent a major impediment to the development of a future marine cadastre for Australia. These are the four key areas for new research:

- Resolving issues in the definition of the tidal interface
- The use of natural rather than artificial boundaries in a marine cadastre
- Extension and application of the ASDI to support a marine dimension
- Marine policy, legal and security issues and the marine cadastre

In line with these four basic research problems, the new research has identified four fundamental aims:

- To resolve scientific and technical issues in the definition and realisation of offshore boundaries that depend on a knowledge of tidal plane intersections with the land mass of the Australian continent (the tidal interface).
- To investigate and report on the use of natural rather than arbitrary boundaries to define jurisdictional limits in the marine environment.
- To extend, modify and test the principles that underlie the current Australian Spatial Data Infrastructure (ASDI) in order to support the implementation of an Australian marine cadastre.

- To analyse Australia's maritime boundaries and zones of maritime jurisdiction with a view to assessing claimed rights and responsibilities in the context of the evolving international law of the sea, current developments in Australian marine policy and enhanced concerns over maritime security.

The new ARC brings together researchers from The University of Melbourne, The University of Wollongong and GeoFix Pty Ltd and includes four industry partners (the Australian states of Victoria, NSW and Western Australia and New Zealand).

THE LAND SURVEYORS ROLE

As discussed above, a maritime nation's rights and interests do not stop at the coastline - they extend out to the limit of the marine jurisdiction. In particular the appropriate management of the coastal zone (several kilometres inland and several kilometres out to sea) is essential for the achievement of sustainable development objectives. Figure 1 attempts to show the breadth and complexity of the relationship and impact of people to the coastal zone.

On land, the surveyor has the role of spatially defining the boundaries of the many different rights and interests that occur as part of the people to land relationship. This is part of the land management and land administration processes in support of sustainable development on land, however land surveyors have traditionally played a limited role in this regard in the marine environment.

An issue that has been discussed throughout this paper is the need for clearly defined boundaries in up to four dimensions (3D and time) to enable a better understanding and management of the competing rights and interests in the marine environment and especially the coastal zone as shown in Figure 1. Currently spatial technologies such as aerial photography, remote sensing, hydrographic surveying and GPS are being used by stakeholders in the marine environment to assess and administer rights, restrictions and responsibilities, and to try and describe the boundaries of a particular resource or location. Often these technologies are underutilised as the people from the marine sectors such as lawyers, fisheries administrators and marine biologists, have a limited spatial understanding or skills. Issues such as data formats, reference frames, spatial data infrastructures and even assessing the completeness and reliability of the spatial information obtained, is not fully comprehended by people from the maritime industries. There is a clear role for land surveyors to work with the marine industries to provide better solutions to defining and managing boundaries and related spatial data in the marine environment. We are not talking about hydrographic surveying but using the skills of the cadastral surveyor in the marine environment.

In many places the current land cadastre, or land law has extended out to include the coastline. For example in the new Vietnamese Land Law 2004, coastal and inter-tidal areas are included as land, so that the law can be applied to these areas as they are intensely used for housing, aquaculture and salt-making. In local government areas in the State of Victoria, Australia the cadastre can extend out to 600m offshore to include jetties, marinas and other maritime infrastructure. In these cases land surveyors have a role in defining the extent of these boundaries in terrestrial/coastal and marine areas. Much of the technology that is used in land surveying is applicable to the marine environment. For example the accuracy and range of GPS can provide a useful solution for defining boundaries in the marine environment.

The challenge for both land surveyors and for marine industries is to embrace the role of surveyors as not just 'land' related, but having the ability and skills to help spatially define and administer the marine environment. The land surveyor now has the opportunity to contribute to the development of the marine cadastre, through providing an accurate description of the boundaries of all the rights and interests in the marine and coastal environments in the context of a spatial data infrastructure that includes both the land and marine environments. The land surveyor is now using their skills to support a wide range of initiatives to support sustainable development objectives on land – the challenge is to now apply these skills to the marine environment and particularly the coastal zone at a time when the improved management is becoming critically important.

CONCLUSIONS

Through both international and national research activities within the Department of Geomatics, the need for better management, access and sharing spatial data in the marine and coastal environment has been highlighted. The ARC and PCGIAP projects have generated a considerable amount of discussion on the concept, definition and benefits of marine SDI and marine cadastre, leading to the introduction of the term 'marine administration system' which facilitates the management of rights, restrictions and responsibilities in the marine environment. Within this context, a marine SDI can improve the ability to describe, visualize and realize spatial information in the marine environment and the marine cadastre can provide a means for defining, managing and administering legally definable offshore boundaries. This will form a fundamental component of marine spatial data and a layer in a future SDI initiative that covers both the terrestrial and marine environments.

The objective of this paper was to discuss the marine administration concepts, to briefly discuss current research initiatives in this area and to use this background to identify greater opportunities for land surveyors in marine related activities. Hopefully the paper has achieved these objectives, particularly to encourage land surveyors to use their measurement, spatial, GIS, land management and land administration skills in the administration of the marine environment and particularly the coastal zone in order to achieve sustainable development.

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