

ISSUES IN THE DEVELOPMENT OF A MARINE CADASTRE

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ABSTRACT

A collaborative research project between the Department of Geomatics, University of Melbourne, Natural Resources and Mines (NR&M), Queensland, Land Victoria, Geoscience Australia and GeoFix Pty Ltd is currently investigating the issues to be considered in the development of a national marine cadastre for Australia. The two year project, funded by the Australian Research Council (ARC), is primarily focussed on delivering solutions to the problems hindering marine cadastre development and implementation, and aims to establish a direction for future research.

This paper will outline the incentive, objectives and principle tasks of the marine cadastre project. To outline the justification for marine cadastre research, the results of a national questionnaire are briefly presented. In establishing the criteria for the design of a marine cadastre, some issues impacting on the management of rights, restrictions and responsibilities are discussed. In particular, a discussion is given of the need for the design to unambiguously handle the technical implementation of spatial entities as defined within current legislation. A summary of the work carried out under Federal Government marine cadastre initiatives is also provided.

1 INTRODUCTION

The maritime jurisdiction to which Australia lays claim is one of the largest in the world. The exploration, exploitation, conservation and management of resources within Australia's maritime jurisdiction fall to an extremely diverse range of stakeholders. The regulation and administration of these activities is shared in various ways amongst the Commonwealth of Australia and its States. Fundamentally, the areas over which the Commonwealth and each State has jurisdiction and may exercise its sovereign rights and administrative powers are defined within a complex framework of legal instruments.

The specific purpose of a national marine cadastre will be to handle the definition, administration and maintenance of boundaries in the marine environment in accordance with international, national and state legislation. Accordingly, the design of a marine cadastre must reflect the legal regime for defining areas of rights restrictions and responsibilities – rigorously and unambiguously. In this context, many difficulties arise as a result of the complexities involved in technically implementing the legal descriptions contained within such regimes.

In recognition of the growing importance of the marine cadastre concept, a group of academics and interested individuals from government and the private sector were drawn

together in 2001 to prepare a proposal to fund an investigation into the development of an Australian marine cadastre. That bid was successful and a program of research into the issues surrounding the design and development of a marine cadastre commenced in mid 2002. The project will run for two years, with two core research themes.

This paper summarises progress of research carried out by the Australian marine cadastre project. Various issues identified by pilot project work deemed to be of critical importance to the design of a marine cadastre are briefly discussed. Other marine cadastre initiatives that are currently underway are also presented, including the work of the Intergovernmental Committee on Surveying and Mapping and that of the Australian National Marine Data Group.

2 ARC MARINE CADASTRE PROJECT

In June 2002 work commenced on a project titled Defining and Developing a Marine Cadastre for Australia. The two year grant was awarded under the ARC's Linkage-Projects scheme whereby funding is made available to match the contributions being made by the industry (non-university) partners. The fundamental objective of the marine cadastre project, which has approximately another eight months to run, is to identify the issues and problems that inhibit the development of a marine cadastre for Australia and thereby to establish a direction for future research.

Work on the project has progressed well and a considerable amount of interest has been generated in the topic of an Australian marine cadastre. A full time research assistant has been employed to work on the project and two postgraduate students are undertaking related research. Below is a review of the major components of the work carried out to date and a summary of that which is to be conducted in the forthcoming year.

2.1 National Questionnaire

One of the first tasks undertaken was the development and distribution of a national questionnaire. The objective of the questionnaire was to assess the extent to which spatial data is being used in the marine environment and to learn something of the ways in which such data is applied and any limitations faced by the user community. Since the questionnaire was made available, 110 responses have been received. The returns have subsequently been analysed and the results presented at the Coastal GIS conference held at the University of Wollongong in July 2003 (Forse and Collier, 2003). The questionnaire itself can be accessed at: <http://www.geom.unimelb.edu.au/maritime/questintro.htm>

In brief, the pertinent findings were:

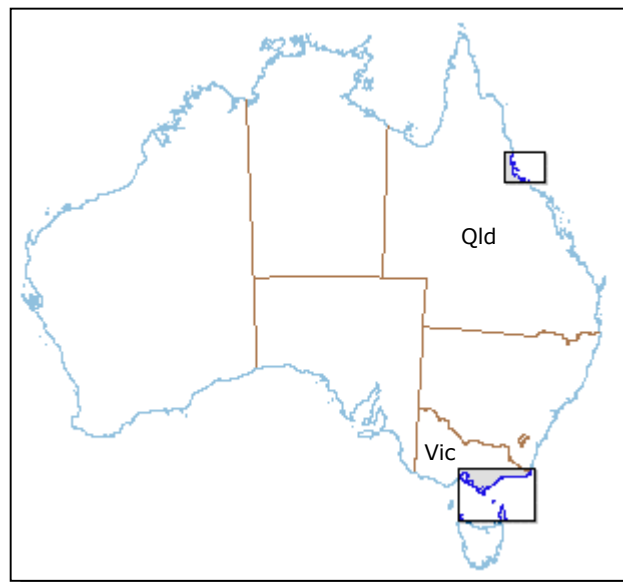
- Federal and State government departments are the dominant suppliers and users of offshore spatial data
- Primary business areas in which marine spatial data is being used include environmental monitoring, administration and management and scientific research
- Tidal plane definition is widely recognised as a complex issue which impacts on many users and creates a great deal of confusion and uncertainty

- 3D data is generally required with the height (depth) component being particularly important for many applications
- Digital maps and charts form the main medium for the dissemination of marine spatial data
- There is considerable uncertainty amongst users about the legislative controls under which activities in the marine environment are controlled
- Most users believe currently available spatial data serves their purposes adequately
- Access to spatial data emerges as a principal difficulty for many users
- There was an overwhelming response in favour of the marine cadastre concept with users believing that it will overcome many of the restrictions in the availability and suitability of currently available marine spatial data

2.2 Pilot Project

One of the key research tools being used to support the research program is a pilot project which provides a real-life environment for the testing of research hypotheses and the demonstration of the concept and complexities of a future marine cadastre. In recognition of the diversity of Australia's marine environment, the pilot project is made up of two areas. As shown in Figure 2.1, the first pilot area is located off Townsville on the Queensland coast, the second area includes Port Phillip Bay and extends eastward along the Victorian coast to the New South Wales border. More details about the pilot project areas can be found at: <http://www.geom.unimelb.edu.au/maritime/index.htm>

Figure 2.1. Location of pilot project areas (Queensland and Victoria)



Queensland Pilot

Developing a pilot project strategy that maximised the research opportunities was a priority for the project. It was recognised early on that a number of national initiatives and Queensland-based projects could also contribute to, and benefit from, synergies associated with broader terms of reference for one of the pilot sites. Hence the Queensland pilot

incorporates formal collaboration with the Tidal Interface Workgroup of the Intergovernmental Committee on Surveying and Mapping; the Sovereign Extent Workgroup of the Great Barrier Reef Interdepartmental Committee; and the Marine Cadastre Technical Working Group formed by the Australian National Marine Data Group. Terms of Reference and deliverables for the Queensland pilot have been developed that jointly satisfy the requirements of all the collaborating parties.

Fundamental to the Queensland pilot is a focus on marine boundaries as spatial infrastructure for the definition of legal boundaries, which are managed collaboratively. Implicit in this scoping statement are the following:

- Spatial infrastructure means compliance with the ANZLIC ASDI vision and the supporting distribution network
- Definitions must meet the business needs of a range of disparate organisations associated with the marine environment
- Legal Boundaries includes all boundaries for which the Courts are the final arbiters
- Managed means demonstrating how business needs can be satisfied while preserving the integrity of the infrastructure

In the context of the Queensland pilot, a spatial analysis for the marine environment has been undertaken which has in particular addressed harmonisation issues associated with land cadastre, topographic, hydrographic and tidal interface spatial infrastructure. In addition, the pilot is looking to preserve the legal integrity of spatial entities within the context of the infrastructure.

Victorian Pilot

To date, work on the Victorian pilot has focussed on data compilation and a parallel review of relevant Federal and State legislation. Figure 2 shows a snapshot of the available data within the Victorian pilot project area, much of which could be legitimately incorporated into a future marine cadastre. The complexity and diversity of the data is immediately apparent. Researchers have been working on adding links to relevant pieces of legislation and regulation, giving users the ability to determine what legislative controls exist and how they impact on activities in the study area. Currently, work is proceeding on the creation of an on-line web service that will not only give users access to data but will also facilitate spatial querying and other manipulations. For example, typical questions such as "I am here (e.g. based on a GPS position of a vessel); what restrictions are there on what I can do?" can be posed and answered. The web-service will compare the user's stated position against all relevant spatial data and legislative controls and return the definitive answer to such a question and any other question likely to be asked of a marine cadastre. The principle objective behind the Victorian pilot is to provide a "laboratory" for researchers to implement, test and refine their ideas and theories. Specific areas of research are discussed later.

2.3 Workshops

To date, two workshops have been conducted and a third is planned for early in 2004 (possibly April). The first workshop was held in Townsville on 5-6 August 2002. The

objective was to bring together stakeholders with an interest in the marine environment and thereby to gain cooperation and support for the Queensland component of the pilot project. To this end, the workshop was very successful, with more than a dozen organisations agreeing to be partners in the pilot project including fundamental players such as the Australian Hydrographic Office, the National Oceans Office, the Australian Institute of Marine Sciences and the Great Barrier Reef Marine Park Authority. Presentations from the workshop are available on CD from NR&M.

The Townsville workshop organising committee recognised the importance of viewing a Marine Cadastre as fundamental spatial infrastructure. At the time of the workshop, ASDI recognised Institutional Arrangements; Technical Standards; Fundamental Data and Clearinghouse as fundamental elements of any SDI. As such the workshop was structured around business requirements analysis of a mature marine cadastre, based on these four fundamental elements.

The second workshop was held in Melbourne on 14-15 November 2002. The objective of this workshop was to explore and identify key issues in relation to the development and application of a marine cadastre from a diverse range of perspectives. An idea of the broad level of interest in the marine cadastre concept and the issues that must be considered as implementation of the marine cadastre progresses can be seen from the workshop presentations available at: <http://www.geom.unimelb.edu.au/maritime/workshop.htm>

One of the most beneficial outcomes of the Melbourne workshop was the emergence of a general consensus of opinion in regard to a definition for the marine cadastre. In this regard, a distinction was made between a marine GIS and a marine cadastre. Whilst delegates recognised the need for both, it was generally agreed that the marine cadastre should be confined to the management and administration of offshore boundaries that have a legal basis for their definition. For example, the migratory movements of the Southern Right Whale could form a legitimate layer in a marine GIS but could not and should not be considered as part of a marine cadastre. In fact, the marine cadastre itself would be a fundamental layer of a marine GIS, providing a spatial framework upon which all other spatial data could be built.

2.4 Industry Consultation

One of the final stages of the research project is to undertake an extensive program of industry consultation. Some preliminary discussions with industry players have already been carried out, but the full program of industry consultation is yet to be implemented. The objective of conducting industry consultation is to get to a higher level of detail in regard to the requirements and applications of an Australian marine cadastre from a user perspective. In the coming months, a number of organisations will be approached to participate in the industry consultation process.

2.5 Specific Research Areas

As mentioned above, the ARC grant has provided funds for the appointment of two post graduate students to undertake research related to the marine cadastre project. These two students are working on different research problems. One research area focuses on the relationship between the land cadastre and a future marine cadastre with a view to identifying similarities and differences. The second research area focuses on the issue of uncertainty in the definition and positioning of maritime boundaries and will investigate the integration of accuracy metadata within a multi-dimensional cadastral object model for

the management of boundaries in the marine environment. The two research areas are summarised below.

Comparative Analysis of the Land Cadastre and the Future Marine Cadastre

Research within this area is focussed on assessing the applicability of the legal, institutional and administrative arrangements used in the management of land-based spatial information to the marine environment. This will include an assessment of the pertinence of Australian cadastral systems as well as the adequacy of the Australian Spatial Data Infrastructure.

In order to achieve this aim and fully understand the challenges faced in developing a marine cadastre however, a review of Australia's historical involvement in the management of its marine environment has been undertaken. This includes not only the dynamic nature of both national and international tools of ocean governance, but also problems that need to be addressed through the development of a marine cadastre. The influential environmental, economic and social (sustainable development) factors driving the development of a marine cadastre, are also investigated.

It is also important to investigate and critically analyse current international research into methods employed in the creation of similar marine cadastral systems around the world, such as those being developed in the USA, Canada and New Zealand. This investigation has been completed, along with a discussion of the current institutional, administrative and jurisdictional frameworks currently employed within each of the major maritime industries within Australia, such as fisheries and oil and gas exploration.

The background research discussed above will lead to the identification of issues and problems which need to be addressed in order to develop a functional marine cadastre for Australia.

Managing Maritime Boundary Uncertainty

This research aims to establish the importance of considering and dealing with the accuracy of marine boundary data in a future marine cadastre. It is argued that accuracy issues are critical not only to users, who need to know where boundaries are and the rights, restrictions and responsibilities associated with those boundaries, but also to data custodians and managers. Given the virtual nature of maritime boundaries, the maintenance of a marine cadastre should rigorously take into account data accuracy and hence, quality metadata, upon the technical implementation of legal regimes.

The initial stages of research will focus on establishing the theoretical background for the geodetic delimitation of maritime boundaries, tidal planes and the coastline, and for the modelling of spatial uncertainty in the context of marine boundary data. This theoretical study will provide the background for the subsequent development and implementation of algorithms that will enable a rigorous treatment of uncertainty in a future marine cadastre. It is recognised that a multi-dimensional cadastral object model is fundamental for the full treatment of uncertainty within the marine cadastre. Such a model will need to be investigated for its ability to handle the complex spatial and temporal nature of marine boundary information, the requirements of data custodians and users, and for the full implementation of the uncertainty principles studied and developed in earlier research.

A tangible outcome of this research will be the development of procedures and systems to deal with the spatial behaviour of uncertainty in the management of marine boundary data. In practical terms this will allow the influence of uncertainty to be demonstrated and accounted for in the real-time positioning and visualisation of marine objects and interests. For stakeholders involved in political, social, environmental and commercial activities, access to knowledge about the quality of maritime features will lead to a greater level of confidence and certainty in the mutual use of marine spaces.

3 ISSUES TO BE CONSIDERED IN MARINE CADASTRE DESIGN

Following the work carried out in the Queensland Pilot, the following sections look at some of the issues recognised as needing careful consideration in the design and development of a national marine cadastre.

3.1 Realising the Spatial Extent of Rights Restrictions and Responsibilities

Whilst it is recognised that the Commonwealth of Australia and the State of Queensland each have tenure, and share various administrative powers, jurisdictional rights and sovereignty over Australia's marine environment, a number of interesting questions often arises: exactly where do these rights, restrictions and responsibilities start and stop? How would we visualise these areas? Can we realise the boundaries with any certainty?

Fundamentally, the answer to these questions hinges upon the exactness with which a technical solution can embody a legal description. In this context, a spatial analysis of all the legal instruments relevant in defining the areas over which Queensland has sovereignty, sovereign rights, jurisdiction and administrative powers has been conducted. To accurately visualise the extent of these areas (all levels of rights, restrictions and responsibilities) as a level of fundamental infrastructure, it has been shown that the various spatial entities must each be identified, correctly interpreted and an unambiguous technical implementation provided for. For instance, to simply view the boundary between the sovereign extent of the State of Queensland and the Commonwealth of Australia, one or more of the following legal instruments (to mention a few) must be sourced (NR&M, 2003):

- Letters Patent (1859, 1862, 1872, 1878), with reference to Imperial Law (Statute and Case);
- Harbours Board Act (1892);
- Seas & Submerged Lands Act (1973);
- Commonwealth of Australia Constitution Act
- Petroleum (Submerged Lands) Act 1967;
- Coastal Waters (State Powers) Act 1980;
- Coastal Waters (State Title) Act 1980;
- Crimes at Sea Act 2002;
- Great Barrier Reef Marine Park act 1973;
- UNCLOS 1997;

- Case Law concerning internal waters (i.e. *inter fauces terrae*).

Each document contains implicit and/or explicit descriptions relating to the spatial extent of the legally binding area of sovereignty, whereby other legal documents may be cross-referenced for the purpose of legal definition or clarification. If the areas pertaining to the State's jurisdiction or administrative rights are to be visualised for example, additional legal documents would need to be sourced and analysed in a similar context. Hence, answers to the questions raised earlier can be found clearly amongst the instruments – finding them and implementing them unambiguously is where research and analysis is required.

To avoid ambiguity and/or uncertainty, the technical solutions offered by a marine cadastre for visualising and realising the spatial extent of a legal definition must correctly reference the spatial entities according to their original legal description. Similarly, decisions regarding the extent of an area entrenched in Case Law need to be implemented according to their original meaning. It is not difficult to see therefore, that providing a technical implementation for *all* the spatial definitions contained within the current framework of Australian legislation concerning the marine environment is not a simple task.

3.2 Technical Implementation of Legal Regimes

An emerging issue which has also gained significant recognition is boundary uncertainty resulting from the use of administrative practices which are inconsistent with legal definitions. In particular, the administrative practices of interest are those used to define the spatial extent of areas having a littoral and/or ambulatory boundary.

Whilst most administrative practices are employed to reduce the often overwhelming cost of field survey, the point of contention that arises is the creation of a number of different boundary determinations for the one legal entity. For instance, various government agencies involved in the management of land abutting tidal waters have employed alternative – and often conflicting – practices to approximate the legal definition of Mean High Water Springs (MHWS), as defined within Queensland Statute Law (NR&M, 2003). It has been identified that such approximations may include interpretations based on one or more of the following:

- Geomorphology
- Ecosystems
- Geography (i.e. from contour maps)
- Land and use
- Edge of vegetation

Clearly, none of these approximations are likely to accurately represent the legal definition for MHWS. As a result, ambiguity in the true spatial extent of an area becomes apparent, leaving a variety of questions to be answered: What legal definition does the approximation(s) attempt to implement? Which approximation, if there is more than one, is the most accurate? Could the approximation be used as evidence in a court of Law?

To address the issue of uncertainty in the location of tidal water boundaries, standards and guidelines (consistent with the national legal framework) for implementing technical solutions to visualise and/or realise a legal description must be developed. In recognition of this need, the ICSM Tidal Interface workgroup (discussed in §4.1) has committed to the development of National Guidelines in collaboration with ANZLIC and the national Parliamentary Counsellors Committee (PCC) for the definition of boundaries in the tidal interface.

To further support the consistent implementation of legal definitions for spatial entities, Natural Resources and Mines (in connection with the Queensland Pilot) is currently working on an Information Paper titled “Doctrine of Accretion and Erosion: Decision Tree and References”, which has been distributed in draft form. This paper attempts to provide a clear set of guidelines (framed through a series of questions) to assist in realising natural boundaries that have been subject to the process of erosion and/or accretion.

4 OTHER AUSTRALIAN MARINE CADASTRE ACTIVITIES

Figure 4.1 presents an overview of the interaction between the various marine cadastre initiatives currently underway in Australia. The activities of the ICSM Tidal Interface Working Group and the ANMDG Marine Cadastre Working Group are discussed below.

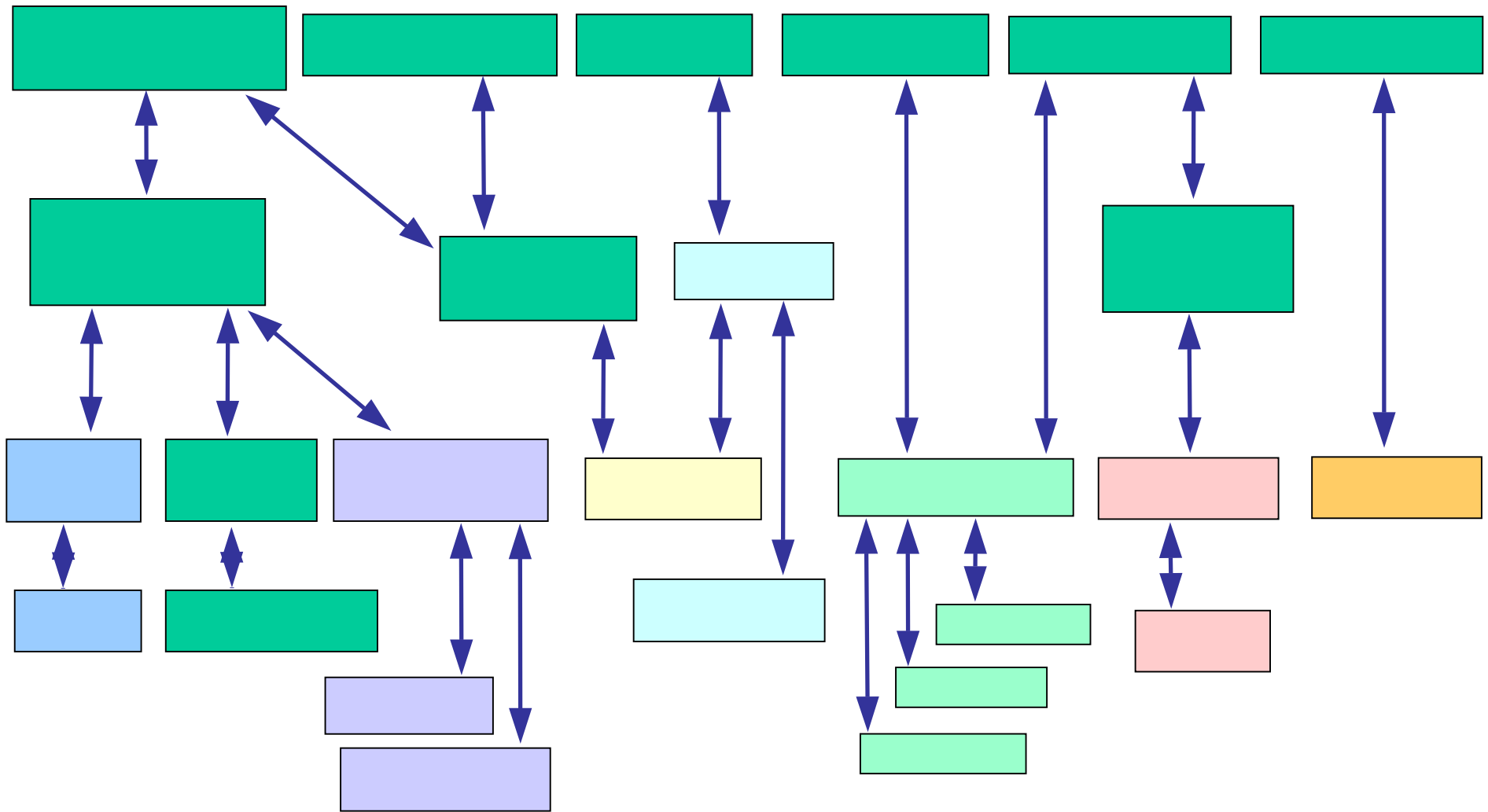
4.1 ICSM Tidal Interface Working Group

Land and maritime boundaries are frequently partially composed of boundaries defined within the tidal interface. Many of the terms used to describe tidal interface boundaries within legislation, semi-legal documents and technical specifications do not have clear and unambiguous definitions. Definitions that are provided often describe the same tidal boundary differently.

Recognising the need to improve this situation the Intergovernmental Committee on Surveying and Mapping (ICSM) instigated a working group to investigate current practice and make recommendations on how improvements could be made. To date this group has established a lengthy compendium of terms commonly used in Commonwealth, State, Territory and New Zealand legislation. The group has also considered a rationalisation of this vast array of terminology into a reduced number of ‘key terms’. The idea being that it may be possible to develop a reduced number of well defined key terms and gradually introduce these into common usage.

Amending legislation to match key terms however is clearly not practical in the short term. Most legislation is not amended for decades, and changes in terminology would not be sufficient reason for amendment on its own. Even if legislation is due for amendment, there are often practical reasons why terminology cannot be altered. However, accepting these very real limitations, the development of key terminology may still prove to be of value. Some legislation can be amended, new legislation can be aligned with clearly defined terms and technical specifications can use recognised and clearly defined tidal interface boundaries.

Figure 4.1. Current Australian marine cadastre initiatives and interested stakeholders



Related issues considered by this working group include how tidal interface boundaries can be ‘visualised’ and ‘realised’. Visualising relates to the problem of showing coastal limits on maps and digital databases. The problem of defining and mapping the various tidal boundaries frequently results in boundaries conflicting in position. For example, it is not uncommon to find a line of Lowest Astronomical Tide lying landward of a line of Mean High Water. Such conflicts may be a result of different sources of data, different scales of source data and changes in the coastline itself.

To some extent the visualisation problems can be overcome by understanding data limitations. However other options, such as a national coastline database, and/or a detailed coastal Digital Elevation Model (DEM) are being considered. The DEM option recognises that the various tidal boundaries are the intersection of the land with the sea. An accurate DEM combined with a reliable tidal model would allow various tide lines to be determined.

Realisation relates to the difficulties in locating the various tidal interface boundaries on the ground. The variety of technical, and to some extent, legal issues involved in locating the boundaries suggests that accurate depiction requires professional expertise. For more details on this issue see Hirst and Todd (2003).

4.2 ANMDG Marine Cadastre Working Group

The Australian National Marine Data Group (ANMDG) established a Marine Cadastre Technical Working Group in consultation with those involved with both the ICSM Tidal Interface Working Group and the ARC project. Recognising that the ANMDG is primarily interested in marine data, the Working Group was tasked with the development of a marine cadastre data model and data dictionary.

Clearly, the development of a data model requires considerable groundwork to be done to define what is to be described. The ARC project is making good progress with this groundwork and this will be refined via the pilot project. The ANMDG Marine Cadastre Technical Working Group is contributing to the pilot project as a pragmatic way of developing an initial workable data model for marine cadastre data.

5 CONCLUSION

This paper describes the activities of the Australian marine cadastre research project, including some of the work carried out by national marine cadastre initiatives. Research into the institutional, legal and technical aspects of marine cadastre implementation has progressed reasonably well and has involved additional input from industry and government agencies. To date, the pilot projects have highlighted a variety of issues needing careful consideration upon the design and development of a marine cadastre.

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