A Seamless Land-Sea Cadastre: A South African perspective

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Abstract

Human interaction with the marine environment is increasing at a rate at which their management systems cannot keep pace. The land cadastre is deemed to be well established and understood thanks to hundreds of years of development. Meanwhile, as marine technological innovations advance and population density in coastal areas grows; human interaction with the oceans is evolving, making existing systems in place for their management seem outdated. There are parallel survey and adjudication components between land cadastre and the marine environment. Internationally, marine cadastre initiatives are being researched and implemented to update marine management systems while there is recognition for convergence of land and sea based spatial data infrastructures. This paper explores the need for the development of a seamless cadastre across the land-sea interface for South Africa by assessing the perceptions of stakeholders that deal in land and/or marine environments. The study investigates access to land versus marine spatial data, legal and technical aspects, components and features of a possible marine cadastre.

Keywords: land cadastre, feasibility, marine cadastre, perspectives

1. Background

The ocean covers about two-thirds of the surface of the Earth and is essential in regulating the weather and sustaining a variety of flora and fauna (United Nations, 2003). Internationally, there is an emerging shift of focus from land to the sea and the related marine management systems. Human interaction with the sea is evolving at a faster pace than that of ocean management systems. The lagging behind of marine management is becoming more critical as the supply of terrestrial resources diminish. Such interactions, although regulated by a range of policies, have complex relationships as

they often overlap and compete in the same area offshore (Binns *et al*, 2004). This creates an environment of uncertainty for stakeholders in exercising their rights, restrictions and responsibilities (RRRs). Ocean management systems are put in place to assist in ocean governance by coastal countries and to address their specific marine needs on a local scale while conforming to international conventions like the United Nations Convention on the Law of the Sea (UNCLOS) amongst others. Policies for managing marine activities will be rendered partially ineffective if stakeholders are uncertain of the spatial extent of their RRRs. This uncertainty does not foster good ocean governance seeing that it enables stakeholders to wilfully or ignorantly break the law. This is the case in many countries due to the virtual nature of marine boundaries. The spatial data infrastructure (SDI) of the terrestrial cadastre is well understood and implemented with an array of policies and institutions in South Africa (SA). The term cadastre has not readily been used in connection with the sea (Binns *et al*, 2004) but according to Neely *et al* (1998) and Sutherland (2005) some terrestrial cadastre components like adjudication, RRRs and surveys have equivalents in the sea. In SA, the terrestrial cadastre terminates at the land-sea interface and has an existing SDI in place. If there are equivalent requirements for marine management, can the cadastre be extended seamlessly across the land-sea interface to aid in improving governance of SA's marine jurisdiction?

This paper explores the need for the development of a seamless cadastre in SA by assessing the perceptions of stakeholders in the development, application and use of a South African marine cadastre. As with any SDI which forms the base upon which new or modified management systems develop, the perceptions of stakeholders is vital to the development process. In spite of having an extensive land cadastre in SA, the prospect of a marine cadastre has not been explored. The perceptions of stakeholders about a marine cadastre might provide insight into its usefulness in SA. It is therefore necessary to consider the history of marine management in SA and the factors driving the need for marine cadastre, as well as the legal issues around the land-sea interface.

1.1. International Endeavours in Marine Cadastre Establishment

The concept of a marine cadastre is not without precedent internationally. It is being researched and developed in the USA and New Zealand (NZ) to support decision making concerning sustainable development for preservation of their marine territories. In the USA, ocean management policies of the past were single purpose regimes and did not interact well with other management systems (Fowler and Treml, 1999). To remedy the disparate systems, the National Oceanic and Atmospheric Administration (NOAA) designed and implemented the Ocean Planning and Information System (OPIS) for the South

Eastern States of the USA (Fowler and Treml, 1999). Later the USA government realised that a multilateral approach was needed for the entire marine territory and absorbed the oceanic base maps from OPIS into the NOAA Integrated Coastal and Ocean Observation System (IOOS). This process included in its design local and international policies and conventions, all stakeholder activities and population distribution (NOAA, 2009). The spatial output has the fundamental base maps linked to relevant legislation and policies in an accessible online multipurpose marine cadastre. Stakeholder activities are spatially delimited by type and reflected as interactive layers on the web based NOAA IOOS.

In NZ, the Office of the Surveyor General (OSG) Report for 1999 identified two goals for the Land Information New Zealand project. These are the need to "provide information and advice to enable the government to decide how future rights to the seabed will be defined and held" and "a national spatial referencing system that meets NZ's core land and seabed information needs" (OSG, 1999). Subsequently, the government with collaboration of academics, defined a basic framework for extending the existing measures for land cadastre to the marine environment and this approach was supported by amending existing legislation that was considered restrictive (OSG, 1999). The surveying fraternity of NZ recognized that a single and seamless management system in the form of a marine and land encompassing cadastre would improve governance of their marine jurisdiction while avoiding duplication of data houses that record, update, store and manage spatial data.

The cases of the USA and NZ indicate that extensive research into and mutual understanding of a marine cadastre is required by all private and government stakeholders. The global shift of focus towards increased human activities with the sea is not restricted to a few coastal states and unless ocean management styles are improved, the results can be exponential seeing that the oceans form a linked ecosystem that does not adhere to international boundaries.

1.2. Definition of Marine Cadastre

A standardized definition for marine cadastre is complicated by constantly changing coastlines and overlapping interests in multidimensional space (Binns *et al*, 2004). Definitions for marine cadastre have emerged from several researchers (Collier *et al*, 2001; Nichols *et al*, 2000 and Robertson *et al*, 1999) with the prevailing assumption of it being a spatial information system dealing with boundaries of an ambulatory nature. In most cases the definition is specific to a country's needs based on its past political and sea management regimes and the direction the country is heading in terms of economic

growth. Marine cadastre is a developing concept which can be modified to suit a particular country thereby making no two exactly alike.

1.3. The United Nations Convention on the Law of the Sea

The UNCLOS established the areas of jurisdiction that coastal countries can rightfully claim and manage as their marine territory. As seafaring and other maritime activities evolved and international cooperation became more formal, the common law of the sea became codified in the form of UNCLOS after four preceding marine based Geneva Conventions (O'Connel, 1982). These four Geneva Conventions, established in a staggered fashion since 1958, had specific focus on the high seas, continental shelf, fisheries conservation and territorial seas (O'Connel, 1982). Conflict between coastal states with different economic-political standards prescribing to one, some or all of the Geneva conventions became more commonplace and forced the United Nations (UN) to play a greater role in finding a universally accepted standard (Miles, 1998). The UNCLOS became the largest, most complex and difficult global negotiations hosted by the UN (Miles, 1998). It significantly drew on provisions from the Geneva Conventions while introducing new concepts for ocean management (Miles, 1998). All legal and political regimes and different levels of socio-economic development of signatory nations, international conservation matters and natural migratory movement of fauna were considered and incorporated into UNCLOS (UN, 1999). The convention lays down a comprehensive set of laws governing use of the sea and establishes rules abided by over 150 signatory countries (Miles, 1998). UNCLOS was signed into effect in December 1982 in Jamaica. Significantly it recognized that all marine spaces and associated issues are interrelated so that integrated approaches provided the best remedy to avoid future conflict (UN, 1999). Of interest to this study is that SA is signatory of UNCLOS having signed the convention in December 1984 and ratified it in December 1997 (DIRC, 2006).

1.4. Factors driving the need for improved ocean governance

While UNCLOS provided methods for coastal states to claim marine jurisdictions and conferred obligations to manage therein, human activities have outpaced these general provisions. The ocean can produce a complex mix of socio-economic and environmental impacts and these are just beginning to be exploited through increasingly invasive technological innovations for maximizing marine benefits (Binns *et al*, 2004). The issue of sustainable management in the face of improving technology is highlighted by South Africa having declared marine protected areas (MPAs) while issuing prospecting leases for offshore oil at various ocean depths (McDonald, 2013) and the plans to bury carbon in

suitable geomorphological structures in the seabed (Carnie, 2013) . The most recent prospecting lease issued by the Petroleum Agency of SA is the Durban Basin that abuts the coastline of KwaZulu-Natal (McDonald, 2013). Furthermore, Members of the SA Parliament, signed the Benguela Current Convention with their counterparts in Angola and Namibia in March 2013 to help in conservation and protection of the South-West marine ecosystem of Africa (Attwood, 2013). This ecosystem stretches from Port Elizabeth on South Africa's Southeastern coastline to the Angolan province of Cabinda and is one of the largest marine protected ecosystems between collaborating governments (Attwood, 2013). In addition, SA placed two claims for an extended continental shelf under Article 76 of UNCLOS (DIRC, 2006). The first claim is for extension of the SA mainland's continental shelf and the second is a joint claim with France for the extension around Prince Edward and Crozet Islands (DIRC, 2006). The claims will be heard by the United Nations Commission on the Limits of the Continental Shelf in 2014 and if successful, would add an additional 1.9million square kilometres to SA's maritime jurisdiction (Jordan, 2013). Together with the shift of focus from land to sea and the rising significance of a healthy marine environment, all forms of stakeholder activities require newer, integrated and holistic approaches to marine management for sustainable development (Robertson *et al*, 1999).

From the land-sea interface through to the outer limits of the South African marine jurisdiction, various marine activities are highlighted by the South African National Biodiversity Institute (SANBI) National Biodiversity Assessment (NBA) (SANBI, 2011). The activities the NBA focuses on are fishing (subsistence, recreational, long line and commercial), coastal development and offshore discharge of wastewater, MPAs, shipping channels, tourism, undersea cables, mining (shore, surf zone and offshore) amongst others (SANBI, 2011). These activities are placing increasing pressure on the environment and natural resources (SANBI, 2011). Although existing marine based legislation is a driver for separation of stakeholder RRRs, these activities overlap in a multi-dimensional space that makes adherence to intangible boundaries difficult. This grey area requires clarification and a marine cadastre may be a step in the direction of improving ocean governance in SA.

As mentioned earlier, parallel components exist in land cadastre and marine RRRs. Spatial data discrimination between land and sea might hamper decision making as duplication and different accuracy standards allow errors to creep in. If a marine cadastral system is not to operate in a silo, standardization is needed to mesh spatial data with their related attribute data (like legislation, conventions and other data deemed pertinent).

1.5. South African Marine Management

1.5.1. The coastal zones and land-sea interface

Prior to SA ratifying the UNCLOS in 1997, the Maritime Zones Act No.15 of 1994 (MZA) was introduced as local legislation to define maritime zones prescribed in the UNCLOS. The MZA defines the different maritime zones up to and including the continental shelf. The baseline is defined by the low water line, which is realised by a line between adjacent coordinates listed in Schedule 2 of the MZA, some forming the closing lines that separate internal water bodies (like harbour openings, estuaries and river mouths) from the open sea. Figure 1 shows a simple cross-profile of the coastal zones from UNCLOS which SA has adapted into local legislation in the MZA.

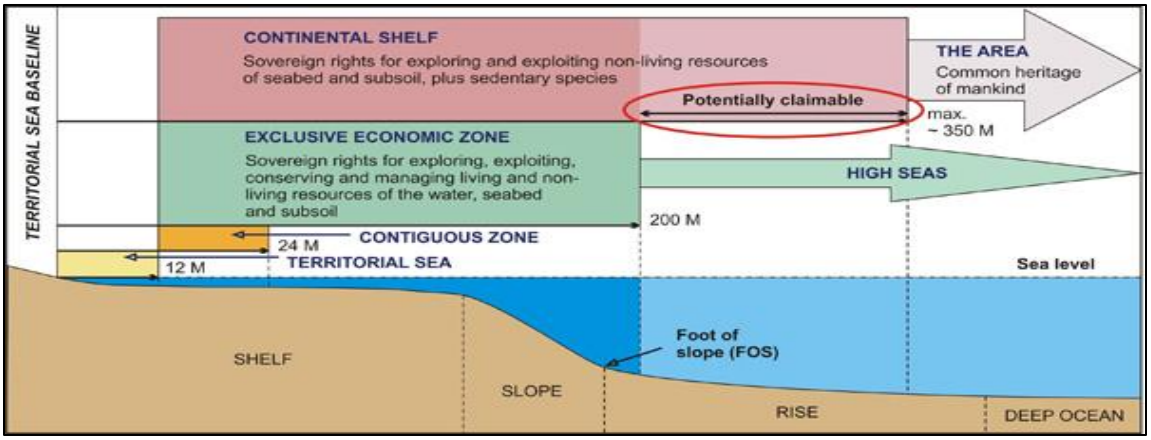

Figure 1. The coastal zones as defined in UNCLOS. "M" denotes nautical mile which is 1 852 metres (Source: United Nations, 2003)

In addition to the UNCLOS and MZA, there are numerous other overlapping, sometimes target specific Acts, policies and Conventions that require consideration when managing marine space. The most significant legislation is the Integrated Coastal Management Act No. 24 of 2008 (ICMA). The ICMA makes provisions for enhancing coastal governance by acknowledging the ocean as a national asset, to aid in sustainable coastal planning and development, natural resource management, pollution control and waste management. The ICMA largely replaces the Sea Shore Act No. 21 of 1935 (SSA). The ICMA was enacted to accommodate the changing uses and environmental importance of intricately related coastal areas as opposed to the earlier and more restricted SSA. The definition of the sea in the ICMA is more detailed than that found in the SSA as the sea, as defined in the ICMA, now excludes estuaries while including the seabed, subsoil and substrata (Whittal and Fisher, 2011). The detailed and specific definition in the ICMA places more power in the hands of the government to manage the sea as a public asset.

Whittal and Fisher (2011) identify an inconsistency between current legal definitions of the Low Water Mark (LWM) found between the MZA and ICMA. The MZA refers to coastal baselines as the starting line of maritime zones (shown in Figure 1). These zones are referenced to a combination of normal or straight baselines that straddle internal waters (Whittal and Fisher, 2011). The MZA defines normal baselines as the intersection of the low-water plane over an 18.6-year tidal cycle **inclusive of spring and neap tides**. In the ICMA, the LWM is the lowest line to which coastal waters recede **only during ordinary spring tides** and is therefore, lower than the LWM defined in the MZA (Whittal and Fisher, 2011). Between the MZA, SSA and ICMA ambiguity arises as to the definition of the line that separates land from sea and can compromise good ocean governance. The true position of baselines, which are used to reference SA's maritime zones and define the boundary between land and sea is of importance to this study as it would indicate the starting line for a marine cadastre.

Additional to the inconsistencies caused by legal definitions addressed above, complications for a marine cadastre arise because the sea is three-dimensional with activities occurring from the seabed, through the water column to the surface. A fourth dimension (time) can also be added with the daily tidal fluctuations and seasonal changes in marine activities (e.g. migration of species during the Sardine Run, recreational and commercial fishing).

1.5.2. The South African legal regime for marine spatial planning

In addition to the ICMA, other policies overlap in ocean governance ranging through sustainable development policies, mining rights laws, development legislation, biological and environmental legislation and UNCLOS. Taljaard and Niekerk (2012) suggest that multipurpose marine spatial planning (MMSP) can support the ocean governance process. Further, Taljaard and Niekerk (2012) provide a table of applicable legislation matched with "key paradigms" to support MMSP (Table 1, adapted). The ICMA is seen as the most appropriate Act that is geared towards sustainable spatial management of the coastal areas although the Biodiversity and Municipal Systems Acts also meet the majority of key paradigms. Table 1 shows the building blocks already in place for a multipurpose marine management system.

Table 1. Key paradigms versus relevant legislation (adapted from Taljaard and Niekerk, 2012)

Legislation	**Key paradigms**					
	Spatial planning	Objectives based management	Ecosystem based management	Adaptive management	Participatory rational-decision making	Cooperative environmental governance
Constitution			*x*		*x*	*x*
NEMA*			*x*	*x*	*x*	*x*
Biodiversity Act	*x*	*x*	*x*	*x*	*x*	*x*
ICMA	*x*	*x*	*x*	*x*	*x*	*x*
Municipal Systems Act	*x*	*x*		*x*	*x*	*x*

*****National Environmental Management Act

Marine legislation typically defines limits using words. For example, Section 4 of the MZA provides for the Contiguous Zone of SA as a 12 nautical mile band of sea adjacent to the territorial sea but does not exceed 24 nautical miles from the land baseline. Clarification and consistency in some legal definitions as highlighted in the example by Whittal and Fisher (2011) in the previous sub-section would aid in improving ocean governance. Even if inconsistent legal definitions are resolved, the spatial dimension described in legislation that governs marine activities will remain on paper. The geographical expression of those legal provisions may be accomplished by a marine cadastre.

2. Materials and methods

Prior to implementation of any new concept, the perceptions of stakeholders in the field of interest are essential. This study applied two approaches to ascertain the perspective of South African stakeholders. In the first approach, a questionnaire was designed using Adobe Forms Central™. This application provided templates for all question types possible in a questionnaire. These varied from single-option restricted, multiple-response and open ended questions with optional "other" fields. The questionnaire was administered online and accumulated responses instantaneously as stakeholders depressed an embedded "Submit" button. The main criteria in selecting organizations and individuals were that they dealt with matters on land and/or sea. This enabled the researcher to understand the linkages between land and marine based spatial data. Responses to the questionnaire from individuals outside the sphere of land or sea spatial data were deemed invalid. The main areas of information sought by the questionnaire were organization and business focus areas of respondent, access to spatial data (land versus marine), awareness and application of legislation relating to management of activities

both on land and offshore, components that could be considered for a marine cadastral system and opinions of its possible benefits to their organizations.

The questionnaire yielded 102 valid responses. There was no specific number of questionnaires circulated as a brief description and link to an online version were placed on websites or emailed to organizations. In respect of the total valid responses, 71% of respondents reported their organization category as the private industry, 18% represented all three spheres of government while the remaining 11% comprised parastatals, non-profit organizations and academics. Further analysis of the private industry respondents showed that they comprised land surveyors, marine scientists, maritime lawyers, hydrographers, and engineers. The respondents were not restricted to one line of work, had wide-ranging job descriptions, and were at varying ranks in their respective organizational structures. Although organization categorization resulted in a bias towards private industry, wide ranging diversity in business focus was evident. Five prominent business focus areas emerged (Figure 2).

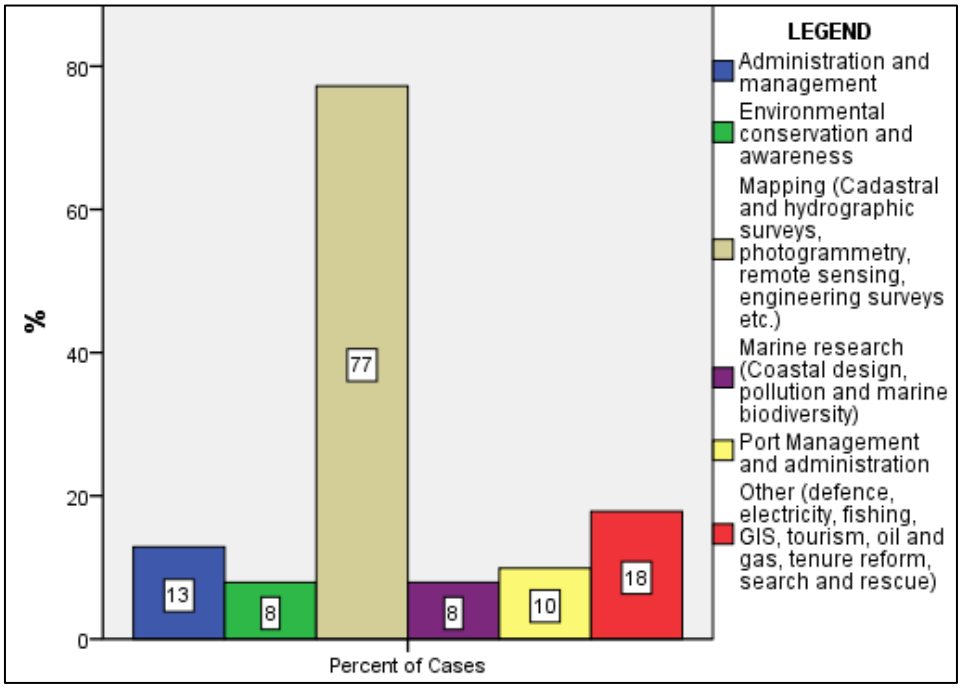

Figure 2. Main areas of business focus

Statistical analyses of the questionnaire used SPSS statistical software. Textural analyses were done on open-ended questions to obtain themes using IBM Text Analytics. The analysis entailed grouping respondents into different categories, performing descriptive statistics and the Kruskal-Wallis Test which is non-parametric test to determine if responses between groups are significantly different or not, and if different what these differences are using Pairwise Comparisons (Kvam and Vidakovic, 2007).

The Kruskal-Wallis Test does not require responses to be weighted if the number of responses differs between group categories.

Following from the questionnaire, the second approach involved a presentation on marine cadastre in October 2013 in Cape Town to the South African Cadastral Managers. These senior officials were from national Surveyor-General offices and Deeds Registries of the Department of Rural Development and Land Reform (DRDLR) of SA. Over 100 persons attended. The officials present were well versed on the legal and technical aspects of the land cadastre of SA. Their perceptions in extending the system into the sea were considered particularly important seeing that these managers report to advisors of the Minister of the DRDLR for any amendments to legislation and prescribed procedures regarding the national cadastre.

3. Results

3.1. Access to spatial data – land versus marine environments

The KW test was performed at a significance level of 5% (p=0.05) to determine access to land and marine cadastre between respondents categorized by organization and job title. The job title group was reduced to four general groups [geospatial fraternity (A), engineering (B), marine sciences, law and research (C), port and corporate management (D)].

Table 2. Kruskal-Wallis Test to show difficulties in accessing land versus marine cadastre between respondents categorized into groups.

GROUP CATEGORY	DIFFICULTIES ACCESSING LAND BASED SPATIAL DATA	DIFFICULTIES ACCESSING MARINE BASED SPATIAL DATA
By Organization	***p = 0.072*** Median across all groups = 2*	***p = 0.007*** Medians: Academia, NGO, parastatals = 1* National Government = 2* Private industry, Provincial and local government = 3*
By Job Title	***p = 0.276*** Median across all groups = 2*	***p = 0*** Medians : Groups A and B = 3* Groups C and D = 1*

**** The numbers 1, 2 and 3 correspond with Yes, No and Not Sure respectively.***

Even though respondents were categorized into different groups and subjected to the KW test, there are generally no difficulties in accessing land based spatial data as opposed to marine data (Table 2). Of note is the wide variation of responses in the difficulties in accessing marine based spatial data. Details on any difficulties accessing land and marine spatial data were requested in follow up questions

(Tables 3 and 4). The varying difficulties experienced in access to land and marine spatial data are highlighted below.

3.1.2. Access to land based spatial data

The most significant disparity in responses in the grouping by organization was between private industry and all three spheres of government (76% against 18.7% respectively, Table 3). Finding the data, format and cost implications were prominent difficulties experienced across both groups. In the organization group this trend suggests that access and collaboration in data sharing are disparate between the Government and private sector. The job title group indicates that the geospatial fraternity experiences most difficulties. Although this is the case, the KW Test shows that access to land spatial data of all respondents is without serious difficulty (Median = 2, Table 2).

Table 3. Issues affecting access to land based spatial data

	GROUPING BY ORGANIZATION							GROUPING BY JOB TITLE			
Difficulties	**National Government**	**Provincial Government**	**Local Government**	**Private Industry**	**Non-Profit Organization**	**Parastatal**	**Total %**	**Geospatial**	**Marine science, law and research**	**Engineering**	**Total %**
Copyright issues	0.00	1.33	0.00	5.33	0.00	0.00	**6.67**	6.67	0.00	0.00	**6.67**
Finding the data	1.33	2.67	2.67	22.67	1.33	1.33	**32.00**	28.00	1.33	2.67	**32.00**
Format	1.33	2.67	0.00	14.67	0.00	1.33	**20.00**	17.33	1.33	1.33	**20.00**
Licence issues	0.00	1.33	0.00	5.33	0.00	0.00	**6.67**	6.67	0.00	0.00	**6.67**
Cost implications	0.00	2.67	1.33	16.00	1.33	0.00	**21.33**	20.00	1.33	0.00	**21.33**
Websites offline or broken links	1.33	0.00	0.00	12.00	0.00	0.00	**13.33**	13.33	0.00	0.00	**13.33**
TOTAL %	**4.00**	**10.67**	**4.00**	**76.00**	**2.67**	**2.67**	**100.00**	**92.00**	**4.00**	**4.00**	**100.00**

3.1.3. Access to marine based spatial data

National Government respondents did not report significant difficulties (Median = 2) while other groups within the Organization category fall into the Yes (Median =1) and Not sure (Median = 3) options (KW Test, Table 2). Table 4 shows that amongst those who reported having difficulties in accessing marine data, the biggest hindrances were finding marine based spatial data (46.15%). National government experiences the least difficulty in accessing marine spatial data. Of interest is that **responses to the questionnaire** from the geospatial fraternity greatly differed compared to the Marine science, law and research group and Port and corporate management group (78 versus 11 and 7

responses respectively). A significant cause for this disparity between these groups was the geospatial fraternity's core business area being with spatial data while with other groups, this spatial data is required as supporting evidence. Nevertheless, finding marine based spatial data still poised the biggest difficulty for all "Job Titles".

Table 4. Responses to issues affecting access to marine based spatial data

	GROUPING BY ORGANIZATION							GROUPING BY JOB TITLE			
Difficulties	**National Government**	**Provincial Government**	**Academia**	**Private Industry**	**Non-Profit Organization**	**Parastatal**	**Total %**	**Geospatial**	**Marine science, law and research**	**Port and corporate management**	**Total %**
The cost implications	0.00	2.56	2.56	5.13	5.13	2.56	**17.95**	5.13	10.26	2.56	**17.95**
Finding the data	2.56	2.56	10.26	17.95	5.13	7.69	**46.15**	15.38	17.95	12.82	**46.15**
Licence issues	0.00	2.56	0.00	5.13	0.00	2.56	**10.26**	2.56	2.56	5.13	**10.26**
Copyright issues	0.00	0.00	2.56	7.69	0.00	2.56	**12.82**	2.56	5.13	5.13	**12.82**
Format	0.00	2.56	2.56	7.69	0.00	0.00	**12.82**	7.69	5.13	0.00	**12.82**
TOTAL %	**2.56**	**10.26**	**17.95**	**43.59**	**10.26**	**15.38**	**100.00**	**33.33**	**41.03**	**25.64**	**100.00**

3.2. Legal perspective

In determining the legal perspective, the questionnaire was designed to ascertain the awareness of legislation and whether particular legislation were being applied in day to day business of respondents (Table 5). The Land Survey Act 8 of 1997 (LSA) was the most understood law amongst respondents. The LSA is central to land cadastre in SA as it is is applied in demarcating rights on the ground by erection of monuments to mark the boundaries between properties. In comparison, the ICMA was applied less than the awareness levels of respondents. The SSA, being an older Act was very well known but is hardly in use due to the ICMA replacing most of its provisions. Table 5 highlights that respondents grouped by their areas of business focus were aware of the main pieces of legislation that governed their day to day activities. The application of legislation lagged behind its awareness. While it is not implied that every law a respondent is aware of should be used in their activities, Table 5 indicates that land based management systems were better understood than marine based systems.

Table 5. Cross tabulation –Response numbers regarding awareness and use of South African Laws

Business focus	Integrated Coastal Management Act 24 of 2008		Maritime Zones Act 15 of 1994		Sea Shore Act 21 of 1935		Land Survey Act 8 of 1997		TOTAL	
	AWARE	USE	**AWARE**	USE	**AWARE**	USE	**AWARE**	USE	**AWARE**	USE
Administration and management	**7**	5	**5**	1	**9**	4	**12**	10	**33**	20
Defence	**2**	1	**2**	2	**2**	1	**2**	2	**8**	12
Electricity Utility	**0**	0	**0**	0	**1**	1	**1**	1	**2**	4
Environmental conservation and awareness	**7**	3	**7**	4	**6**	3	**5**	4	**25**	32
Fishing	**1**	1	**1**	1	**1**	0	**1**	0	**4**	5
GIS	**1**	1	**0**	0	**1**	1	**1**	1	**3**	5
Import and export	**4**	2	**4**	3	**4**	3	**3**	4	**15**	23
Infrastructure Development	**1**	1	**1**	0	**0**	0	**1**	1	**3**	4
Mapping	**43**	26	**17**	5	**58**	34	**73**	72	**191**	285
Marine research	**8**	6	**7**	4	**7**	1	**7**	2	**29**	34
Mining	**0**	0	**0**	0	**0**	0	**1**	0	**1**	1
Oil and gas	**1**	0	**1**	1	**1**	1	**1**	1	**4**	6
Port Management and administration	**10**	8	**9**	6	**10**	5	**9**	6	**38**	53
Search and rescue	**2**	0	**2**	1	**2**	2	**1**	2	**7**	10
Tourism	**1**	1	**1**	1	**0**	0	**0**	0	**2**	3
Total	**89**	56	**58**	29	**103**	56	**119**	109	**369**	528

3.3. Marine Activities and their restrictions

Very few of the respondents (16.03%) reported that they could practice their activity at will anywhere in the sea with most responses in the No (42.75%) to Not Sure (41.22%) options (Table 6). Uncertainty in application of the law and ambiguous legal terminology demonstrated previously may partly explain this. Business areas that relate to management and are within the ambit of government (like defence, environmental awareness and conservation, and mapping) show that government agencies do exercise their functions as custodians of the marine territory. Similarly, awareness of restrictions to activities tended towards “No” and “Not sure” options. This suggests that although there are restrictions defined in law, stakeholders did not fully comply due to lack of awareness.

Table 6. Percentages of responses to business activities and restrictions

Business Focus	Business activity performance anywhere at sea			Total %	Awareness of restrictions			Total %
	Yes	No	Not Sure		Yes	No	Not Sure	
Administration and management	1.53	3.82	4.58	**9.92**	3.85	1.54	3.85	**9.23**
Defence	1.53	0.00	0.00	**1.53**	1.54	0.00	0.00	**1.54**
Electricity Utility	0.00	0.76	0.00	**0.76**	0.77	0.00	0.00	**0.77**
Environmental conservation and awareness	1.53	2.29	2.29	**6.11**	3.08	1.54	0.77	**5.38**
Fishing	0.00	0.76	0.00	**0.76**	0.00	0.77	0.00	**0.77**
GIS	0.76	0.76	0.00	**1.53**	0.77	0.77	0.00	**1.54**
Import and export	0.76	2.29	0.00	**3.05**	3.08	0.00	0.00	**3.08**
Infrastructure Development	0.00	1.53	0.00	**1.53**	0.00	0.00	1.54	**1.54**
Mapping	5.34	20.61	31.30	**57.25**	11.54	16.15	30.00	**57.69**
Marine research	0.00	3.05	2.29	**5.34**	0.77	1.54	3.85	**6.15**
Mining	0.00	0.76	0.00	**0.76**	0.00	0.00	0.77	**0.77**
Oil and gas	0.76	0.00	0.00	**0.76**	0.77	0.00	0.00	**0.77**
Port Management and administration	3.05	3.82	0.76	**7.63**	6.15	0.77	0.77	**7.69**
Search and rescue	0.76	0.76	0.00	**1.53**	1.54	0.00	0.00	**1.54**
Tenure reform	0.00	0.76	0.00	**0.76**	0.77	0.00	0.00	**0.77**
Tourism	0.00	0.76	0.00	**0.76**	0.77	0.00	0.00	**0.77**
TOTAL %	16.03	42.75	41.22	**100.00**	35.38	23.08	41.54	**100.00**

Of those who reported restrictions on their activities the following themes prevailed:

- Legal restrictions and law being uncertain.
- Man-made structures (coastal engineering, buoys)
- Marine conservation areas
- Unresolved maritime boundaries with Mozambique and Namibia.
- Shipping channels, cables and pipelines.
- Fishing restrictions imposed by authorities and from coastal property owners who feel their rights are being depleted by fishermen on their doorstep.
- Harbours, ports and navigation hazards and uncertainty of High and Low Water marks.

3.4. Land versus marine cadastre

One of the goals of the questionnaire was to determine if the land cadastre of SA is efficient and to gauge whether stakeholders felt that similar RRRs out at sea require similar adjudication. Figure 3 below suggests that land cadastre is indeed well understood and rigorous enough for the purpose for which it was built.

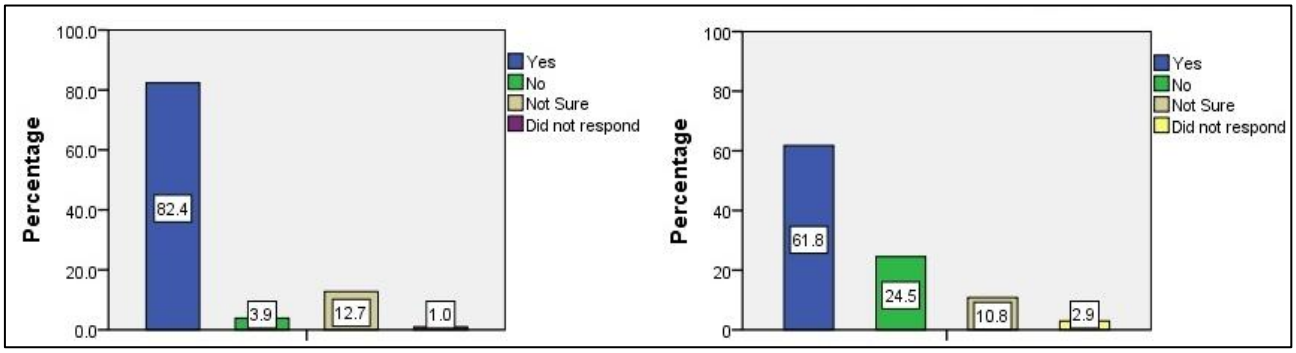

Figure 3. Access to an efficient SA land cadastre (left) and rigorousness of SA land cadastre (right)

A follow up question requested a motivation as to why mapping of the sea should be similar to that of land and the following were the most prominent emerging themes:

- Insufficient data available for the ocean.
- Laws are target specific and not properly applied while state agencies overlap resulting in users uncertain of who to go to.
- Zoning and planning should be done in a similar fashion to terrestrial property.
- Nonexistent recording of existing RRRs.
- Information that exists is hoarded and duplicate datasets of different accuracies are created.
- Near shore, where most human activities occur, requires the most clarification of RRRs.
- Lacks data from spatial professionals in key decision areas.
- Cost and governance.

When asked if there were any physical boundaries which they were aware of, the prevailing response was the High Water Mark and manmade structures like walls and buoys within harbours.

3.5. Priority components, features and access to a marine cadastre

Table 7 indicates whether respondents thought that access to a marine cadastre would benefit their organizations, on a scale from “Strongly agree” to “Strongly disagree”. The results are stratified by the business focus of participants. Responses show that differences between groups occur mainly in the

"Strongly agree" to "Neutral" options. Overall, respondents tended to agree that a marine cadastre would benefit their organizations.

Table 7. Percentage of responses to the benefits of having access to a marine cadastre

Business Focus	**Benefits of a marine cadastre to your organization**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
Administration and management	33.33	33.33	33.33	0.00	0.00
Defence	50.00	0.00	50.00	0.00	0.00
Electricity Utility	0.00	100.00	0.00	0.00	0.00
Environmental conservation and awareness	71.40	14.30	14.30	0.00	0.00
Fishing	100.00	0.00	0.00	0.00	0.00
GIS	100.00	0.00	0.00	0.00	0.00
Import and export	50.00	25.00	25.00	0.00	0.00
Infrastructure Development	0.00	0.00	100.00	0.00	0.00
Mapping	20.80	26.00	48.10	3.90	1.30
Marine research	62.50	12.50	25.00	0.00	0.00
Mining	0.00	0.00	100.00	0.00	0.00
Oil and gas	0.00	0.00	100.00	0.00	0.00
Port Management and administration	50.00	30.00	20.00	0.00	0.00
Search and rescue	0.00	50.00	50.00	0.00	0.00
Tourism	100.00	0.00	0.00	0.00	0.00
Total of 100%	**32.80**	**24.40**	**39.70**	**2.30**	**0.80**

The data above demonstrates that marine cadastre would be beneficial to a variety of organizations across many business focus areas. As a result of this agreement between different stakeholders, Table 8 shows pooled results from all categories of respondents, giving the most favoured components for a marine cadastre. Mining, pipelines, cables, MPAs, navigation hazards, shipping and fishing areas were viewed as necessary components. The last 5 components were volunteered by individual respondents as other components to consider. This data shows that sustainable development of marine space is of significant to stakeholders.

Table 8. Favoured components for a marine cadastre

Components	Number of responses	Percentage of Cases
Ecological information	58	59.80
Mining rights and mineral deposits	83	85.60
Bathymetry	45	46.40
Undersea cables	81	83.50
Pipelines	79	81.40
Shipping channels	71	73.20
Fishing areas	72	74.20
Marine conservation/park areas	84	86.60
Tourism information	45	46.40
Navigation hazards	69	71.10
Navy and defence	1	1.00
Submarine DEM	1	1.00
Fish farming	1	1.00
Exploration	1	1.00
Production rights	2	2.10

Figure 4 indicates a scale of importance for marine cadastre features. The features suggested to stakeholders in the questionnaire were well responded to with a non-response rate averaging 2.6%. All of the features for a marine cadastre suggested in the question were favourably rated in the "Medium" to "High" range.

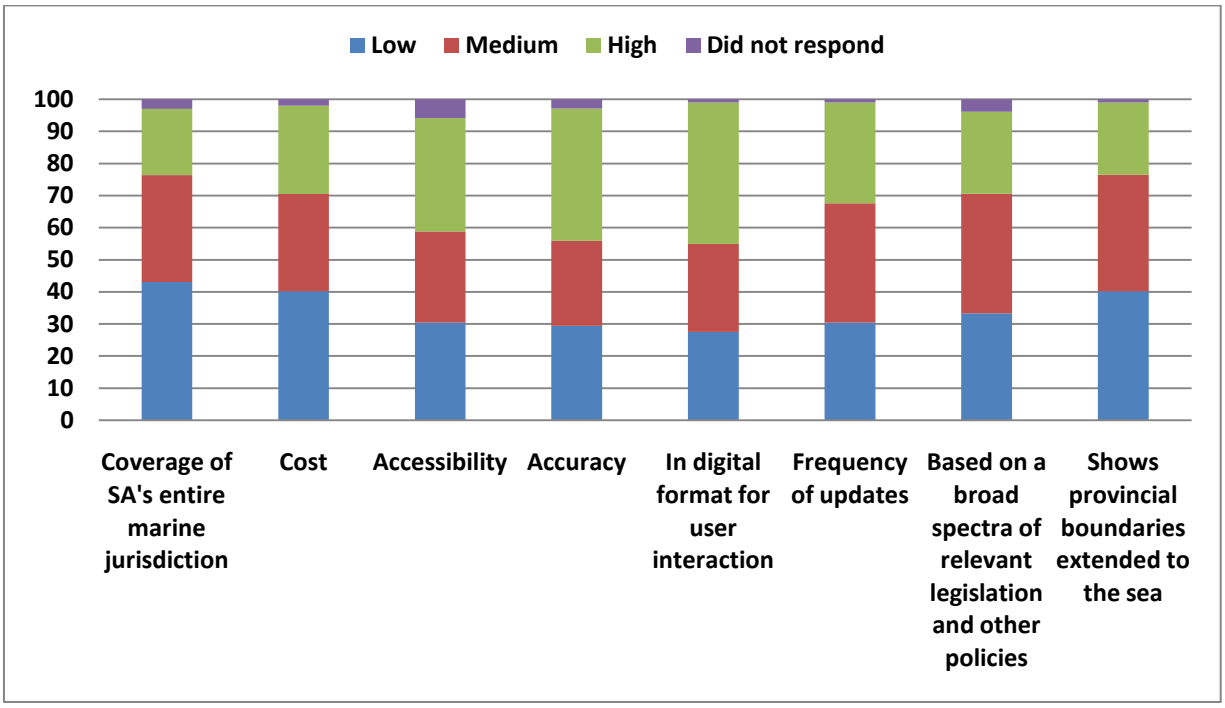

Figure 4. Rating the features of a marine cadastre

3.6. Findings from the focus group meeting

This section reports the main findings of the presentation to South African Cadastral Managers:

- The Deeds Registrars suggested that as they record ownership rights and are not involved in the spatial depiction of property enclosing rights, marine cadastre fell within the ambit of the survey and planning professions. Their role might be to create a register for marine rights.
- The meeting point between marine data custodians and the SDI of SA was uncertain. This indicated uncertainty of the whereabouts of marine spatial data.
- Clarification of international maritime boundaries with Namibia and Mozambique was needed to be recorded for SA's marine jurisdiction. Additionally, it was raised SA has applied for an extended continental shelf under Article 76 of UNCLOS which may greatly increase SA's marine territory. The new territory will pose challenges which may need solutions for possible extraction of benefits.
- The positions of the High and Low Water Marks were noted to be ambiguous. Legal definitions will need clarification although case law exists which have set precedents as to their positions. Resolution of these ambiguities will determine where coastal properties end, define the sea shore and the land-sea interface from which a possible marine cadastre could be referenced.
- It was uncertain whether a possible marine cadastre should be managed by a new state agency or by coastal Surveyor-General provincial offices.
- Legislation was noted to be required for a marine cadastre to be created and/or updated under one jurisdiction that includes both land and sea. This suggests an extension of the land cadastre to include the marine territory.
- Advancing survey techniques may be able to represent overlapping rights at sea. It was stated that overlapping rights do exist on land as well and similar methodology in their separation can be adapted to depict those found in the sea.
- Classic survey monuments used to define land based property extents is not practical at sea, but Global Positioning Systems that operate at high accuracy in real time could be used for referencing kinematic positions of vessels at sea in relation to pre-defined boundaries of RRRs of stakeholders. This would enable infringements to be shown as warnings and for ocean monitoring agencies (like the Navy) to be warned, also in real time.

4. Discussion

The increase in activities offshore of SA suggests an alignment with international trends of marine activities increasing in number and being more invasive. Population growth and increasing activities in coastal towns and cities is highlighted by the NBA (SANBI, 2011). The NBA (SANBI, 2011) also demonstrates how these activities increase the pressures on resources and space in coastal areas (fishing, tourism, aquaculture, pipelines, cables etc.). Additionally, newer technology in mining prospecting and communication is leading to more lease blocks being allocated. Although MPAs are being gazetted, conflict is occurring unintentionally or knowingly in areas where a multitude of overlapping rights exists from the seabed to the surface. The difficulty in accessing marine data reported by respondents (Tables 2 and 4) shows that although activities are becoming more commonplace, the spatial framework for their management is lacking.

Respondents to the questionnaire supported the existence of a well-established land cadastre in SA (Section 3.4). On land, "tenure" refers to private and public lawful possession and occupation of a property indefinitely or over a period of time. The sea is entirely non-alienated by the controlling State, which allocates leases and other rights to the sea to stakeholders with conditions attached through its relevant agencies. A fundamental component of land cadastre is that its base layer of legally defined tangible boundaries, which are delimited by monuments, have graphical layout in the form of diagrams attached to title deeds. Delineation of rights in the ocean will not be as simple as there are overlapping rights and blurred understanding of the limits of RRRs. Boundary descriptions exist, but are virtual in nature, cannot be seen and have ambiguous meaning in legal definitions. The land cadastre attempts where possible to delineate RRRs in a two-dimensional representation. By contrast activities in the sea occur in a three or four dimensional "parcel" of water that extends from the substrata to surface, via the seabed and water column. Survey technology improvements gradually seem more adept at differentiating multiple rights by providing more powerful computing power while converging multiple databases into streamlined, interconnected software packages. Clarified legal definitions for the sea, High and Low Water Mark can be built into these packages for better decisions to be made in management matters. The idea of a marine cadastre for SA garnered strong support from the cadastral managers of SA. With delegates at the meeting being government representatives, the emphasis placed on technical issues, clarification of legal definitions and amendment of laws to meet contemporary and future targets supports the possibility of a marine cadastre seeing that the sea is within the Governments control.

5. Conclusion

The literature presented in this paper highlights : (i) the global shift to marine management systems in light of increasing marine activities, (ii) parallel components of land cadastre found in the marine environment, (iii) the flexible definition of marine cadastre that might differ from one country to another, though the notion of a marine cadastre has international precedent , with particular legal and technical issues, and (iv) perceptions of stakeholders in the area of interest are essential.

This study has determined that although international attempts in developing marine cadastre exist, local investigation is required rather than attempting to transplant a foreign idea into SA. By investigating the perceptions of stakeholders it was deduced that the evolution of human interaction with the sea creates the need for updating ocean management systems. Spatial data does not discriminate between land masses and ocean space and a seamless system incorporating both would better serve as a tool for key decision makers. In the perception of stakeholders canvassed, since the land cadastre is a SDI with well-established links between spatial data, technical and legal areas and has parallel components in the marine space, a marine cadastre is feasible for SA. Although it is feasible, further insight is needed into legal and technical issues involved in creating one seamless cadastre across the land-sea interface.

List of References

Attwood, C. (2013). "World's First Large Marine Ecosystem Legal Framework signed by Angola, Namibia and South Africa." Retrieved 26 November, 2013, from http://www.thegef.org/gef/news/benguela-current-convention

Binns, A., et al. (2004). "Developing the concept of a marine cadastre: an Australian case study." Trans Tasman Surveyor 6: 19-27

Carnie, T. (2013). KZN earmarked for CO2 dump, The Mercury, Independent Newspapers (Pty) Limited, Durban, South Africa. The Mercury. Durban, South Africa, Independent Newspapers (Pty) Limited

Collier, P. A., Leahy, F.J., & Williamson, I.P. (2001). "Defining a marine cadastre for Australia. Proceedings of the 42nd Australian Surveyors Congress, Brisbane, Australia 25 - 28 September." Retrieved 12 May, 2012, from http://dtl.unimelb.edu.au/R/1Y96MS9SG5UV877QAGIB8592AY9A2MPR145TDITTDFJC1BBIYI-00707?func=dbin-jump-full&object_id=66251&local_base=GEN01&pds_handle=GUEST

DIRC (Department of International Relations and Cooperation) (2006). "*United Nations Convention on the Law of the Sea (UNCLOS)*." Retrieved 23 March, 2012, from http://www.dfa.gov.za/foreign/Multilateral/inter/unclos.htm

Fowler, C. and E. Treml (2001). "Building a marine cadastral information system for the United States- a case study." Computers, Environment and Urban Systems 25(4–5): 493-507

Jordan, B. (2013). "SA claims vast new territory." Sunday Times, 01 December 2013

Kvam, P. H. and B. Vidakovic (2007). Nonparametric statistics with applications to science and engineering. New Jersey, Wiley

McDonald, D. (2013). "Sasol to explore SA coast for oil amid objection." Retrieved 17 November, 2013, from http://www.news24.com/Green/News/Sasol-to-explore-SA-coast-for-oil-amid-objection-20131114

Miles, E. L. (1998). Global Ocean Politics: The Decision Process at the Third United Nations Conference on the Law of the Sea 1973 - 1982. Kluwer Law International

Neely, R. M., et al. (1998). "Facilitating integrated regional ocean management using a web-based geographic information system, Coastal Services Centre, National Oceanic and Atmospheric Administration." Retrieved 17 May, 2012, from ftp://www.csc.noaa.gov/pub/metadata/metadata_archive_20080731/OPIS/old/occ_98.htm

Nichols, S., Monahan, D. and M. Sutherland (2000). "*Good Governance of Canada's Offshore and Coastal Zone: Towards an Understanding of the Marine Boundary Issues*." Geomatica (54): pp. 415-424

NOAA (2009). "*NOAA Integrated Ocean Observing System Program. Revised Strategic Plan 2008 - 2014*. U.S. Department of Commerce." Retrieved 12 May, 2012, from http://www.ioos.gov/library/ioos_stratplan_revised_080309.pdf

O'Connel, D. P. (1982). The International Law of the Sea. New York, Oxford University Press

OSG (1999). "Principles for a Seabed Cadastre. OSG Technical Report 9: Office of the Surveyor General - New Zealand." Retrieved 17 May, 2012, from http://www.linz.govt.nz/sites/default/files/docs/surveysystem/geodetic/tr09-principles-for-seabed-cadastre-1999.pdf

Robertson, B., Brenwell, C and C. Hoogsteden (1999). The Marine Resource: Administration Infrastructure Requirements. UN-FIG Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development, 24-24 October 1999. Melbourne, Australia

Republic of South Africa. Integrated Coastal Management Act, No. 24 of 2008. Pretoria, Government Printer

Republic of South Africa. Constitution of the Republic of South Africa, Act No. 108 of 1996. Pretoria, Government Printer

Republic of South Africa. Land Survey Act, No. 8 of 1997. Pretoria, Government Printer

Republic of South Africa. Local Governments: Municipal Systems Act, No. 32 of 2000. Pretoria, Government Printer

Republic of South Africa. National Environmental Management Act, No. 107 of 1998. Pretoria, Government Printer

Republic of South Africa. National Environmental Management: Biodiversity Act, No. 10 of 2004. Pretoria,

Government Printer

Republic of South Africa. Sea Shore Act, No.21 of 1935. Pretoria, Government Printer

Republic of South Africa. Maritime Zones Act, No. 15 of 1994. Pretoria, Government Printer

South African National Biodiversity Institute (2011). "National Biodiversity Assessment 2011: Technical Report." Retrieved 26 July, 2012, from http://bgis.sanbi.org/nba/project.asp

Sutherland, M. D. (2005). Marine Boundaries and the Governance of Marine Spaces. , University of New Brunswick Ph.D. Dissertation

Taljaard, S. and L. van Niekerk (2013). "How supportive are existing national legal regimes for multi-use marine spatial planning? The South African case." Marine Policy 38(0): 72-79

United Nations (2003). "Oceans and the law of the sea." Retrieved 12 March, 2012, from http://www.un.org/Depts/los/index.htm

United Nations (2009). "*Oceans and Law of the Sea.*" Retrieved 12 March 2012, from http://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm

Whittal, J. and F. Fisher (2011). Implications of the Integrated Coastal Management Act No 24 of 2008 on the South African coastal cadastre and its survey and management. AfricaGeo 2011. Cape Town, South Africa. 31 May - 02 June