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Administering Marine Spaces: International Issues



A publication of FIG Commissions 4 & 7 Working Group 4.3

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Foreword

The coastal zone is a complex and finely balanced ecosystem contained within a relatively narrow band of land and sea. Many coastal marine ecosystems are among the most productive in the world. They provide food and livelihood for millions of people. Coral reefs are home to more than a million species. Coastal zones are economically, politically and socially critical to many nations. Coasts are used by millions of people for recreation. Major transport hubs are situated in or near the coastal zone where ports and harbours are vital to commerce and trade.

This narrow band of land and sea occupies only 20 per cent of the world's land area. Half the world's population, some 3,000 million people, live within 200 km of the coast and it is estimated that by 2025 this figure may double. Our cities use some 75 per cent of the world's resources and discharge similar amounts of waste.

It is hardly surprising then that this marine space is under serious threat from a myriad of overlapping and conflicting interests. The evidence of change is compelling and manifest. It is therefore imperative to manage, administer and govern the coastal zone in a considered, sustainable and structured manner; to protect and nurture the environment we live in. Failure to do so may have disastrous consequences for future generations.

FIG, through the work of this joint workgroup, has been active in the areas of Coastal Zone Management, Marine Cadastre and Marine Governance since 2002. This has included an international workshop, published papers, presentations and attendance at FIG and other International fora. During this time the workgroup has encouraged research and discussion on issues related to administering marine spaces and this publication is the culmination of that work.

The publication comprises a number of chapters that focus on issues related to the administration of marine spaces from regional perspectives. Its purpose is to stimulate further discussion and research in this most important subject area. Whilst it is not possible to deal with all issues, it does underscore the international importance of administering marine spaces.

I would like to thank the authors for their hard work, dedication and passion in contributing to this publication.

Adam Greenland
Chair of FIG Commission 4

Prof. Paul van der Molen
Chair of FIG Commission 7

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Preface

Working Group 4.3 (WG4.3) is a joint working group of the International Federation of Surveyors (FIG) that since 2002 is concerned with issues related to marine cadastre, coastal zone management and ocean governance. It is made up of members from Commission 4 (Hydrography) and Commission 7 (Cadastre and Land Management). Both Commissions share interests in management and administration issues related to tenure and property rights, and together cover land, coastal, and marine environments.

By 2001 it was obvious to those presenting papers at international conferences and participating in international and regional initiatives that administering rights in marine spaces was of global interest. This is not surprising since a significant number of the world's population lives on or close to coasts. This global interest generated many academic papers and international meetings supported by academe, government organizations, and professional organizations. International professional organizations such as FIG and regional bodies such as the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) witnessed significant increases in activities related to the administration of marine spaces. This is the environment in which WG4.3 operated over the past four years and led to the realization of this publication.

Generally, issues related to the administration of marine spaces may be categorized as stakeholder issues, technical issues, and legal issues. Many of these issues are common across international jurisdictions but, obviously, there are issues peculiar to specific jurisdictions. This publication (*Administering Marine Spaces: International issues*) as a product of the FIG, is designed to give a sample of international issues related to administering marine spaces since it is improbable that one document can address all issues for every international jurisdiction.

Authors have contributed papers on topics related to Africa, North America, Europe, Australia, Asia and the Asia-Pacific region, and small island states such as the Caribbean. All papers, regardless of focus, present material that directly or indirectly impact upon the administration of human rights, responsibilities, and restrictions in marine spaces. The first paper provides an overview discussion of issues relevant to administering marine spaces while the other papers focus on national or regional issues sampled from the international realm. It is hoped that this publication will edify readers and stimulate further discussions and research on relevant topics.

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July 2006

Issues in the Governance of Marine Spaces

Michael Sutherland and Sue Nichols

Abstract

Good governance is based on recognition of the interests of all stakeholders and inclusion of their interests where possible. Interests can be expressed in a variety of ways, for example: sovereignty, jurisdiction, administration, ownership (title), lease, license, permit, quota, customary rights, aboriginal rights, collective rights, community rights, littoral rights, public rights, rights of use, and public good. Coastal states are challenged with managing the multidimensional tapestry of these interests (and perhaps others) in the coast and offshore. Over the next few decades those responsible for marine policy and administration have been challenged with trying to understand this tapestry and communicating it to the various decision makers and stakeholders. However, addressing the complexities associated with these interests solely from a boundary delimitation perspective does not necessarily improve the governance of marine spaces. This paper explores a number of legal, technical, and stakeholder issues related to governing marine spaces.

1. INTRODUCTION

The governance of any geographical area, including marine spaces, is actually the management of stakeholder relationships with regard to spatial-temporal resource use in the pursuit of many sanctioned economic, social, political, and environmental objectives. Good governance is based on recognition of the interests of all stakeholders, and inclusion whenever possible. Governance involves setting priorities that may establish hierarchies of interests, but the basis is recognition of what is excluded, as well as what is given priority in certain situations.

These interests can be expressed in a variety of ways, for example: sovereignty, jurisdiction, administration, ownership (title), lease, license, permit, quota, customary rights, aboriginal rights, collective rights, community rights, littoral rights, public rights, rights of use, and public good. One feature of being a coastal state is that there is a multidimensional tapestry of these interests (and perhaps others) in the coast and offshore. Marine administrators are challenged with trying to understand and communicate this to the various decision makers and stakeholders.

A marine cadastre, or other marine information management system, serves to meet the information requirements for governance of marine spaces by facilitating the management of thematic information and their boundaries and limits. In past research we initially assumed that spatial delimitation of interests would help clarify resource management and use regime in marine spaces. What was learned from our research was that this approach was very limited and probably impossible. The main reason is that there are numerous marine boundaries, and four dimensions at least had to be considered. Drawing lines on charts was often not feasible, legally valid nor of value. The legal profession taught us that

there were a myriad of boundaries: at least one if not more for every resource and every resource use. Starting from the boundary perspective was a nonstarter.

Effective governance of marine spaces requires that a number of things need to be considered including:

- the need for inclusion;
- the need to change our concepts of a cadastre to deal with multiple interests for the same space at the same time;
- the difficulties in identifying, yet including, all the stakeholders;
- the importance of information, not necessarily precise boundary delimitation;
- the need to develop tools better than the traditional cadastre to govern marine spaces effectively.

To address the listed considerations, this paper will explore the governance of marine spaces by focusing on a number of stakeholder issues, legal issues, and technical issues. However what is meant by governance will first be discussed.

2. GOVERNANCE

The governance of marine spaces is the management of stakeholder activities in these spaces. To optimize this management and to address stakeholder issues requires that effective governance frameworks be in place. Collaborative, cooperative, and integrative governance are improved frameworks for dealing with stakeholder issues. Traditional governance models have been based on a management science approach where the premise is that leadership of organizations (public, private or civic) is strong, and have good understanding of their environment (future trends, rules of the game, and the organization's goals) [Paquet, 1999]. As such, the leaders provide direction for the groups they represent.

A hierarchical governance model is one such example. This form of governance, usually practiced by the state or some other governing authority, is usually enacted through policies, laws and regulations [Hoogsteden, Robertson and Benwell, 1999; Paquet, 1999; Savoie 1999]. This hierarchical model assumes a top-down approach is always best, whereas subsidiarity (i.e., the principle based on the assumption that individuals are better able to take care of themselves than any third party) might alternatively provide a better solution in some circumstances. Subsidiarity would support, for instance, the devolution of responsibilities to citizens by provincial/state authority (or to states/provinces by federal authority) as much as possible unless they were unable to manage [Rosell, 1999; Chiarelli, Dammeyer and Munter, 1999].

The management science approach also assumes that organizations are operating in “a world of deterministic, well-behaved mechanical processes” [Paquet, 1999]. However, life is full of paradoxes, contradictions, and surprises [Handy, 1996], so the management science approach has been inadequate, continually faced with situations that are ill-defined, uncertain, unstable, or unreliable. As a result of the failure of the management science approach to governance to adequately handle all the complexities of life, other models have been proffered. These models are based on cooperation, coordination, collaboration, integration or other principles of shared responsibilities. The similarities or overlaps in the

definitions of these models again underscore the absence of general principles to help guide in the design of good governance structures [Paquet, 1999]. Among these models are:

- Distributed governance which is embedded in a set of organizations and institutions built on market forces, the state, and civil society, and which deprives the leadership of the exercise of monopoly in the direction of the organization. [Paquet, 1999; Meltzer, 2000];
- Co-governance (e.g. practiced on a state-civic level) that comprises mutual organization by two or more involved groups [Charette and Graham, 1999; Hoogsteden, Robertson and Benwell, 1999];
- Triangle-wide governance that consists of the integration of the three families of institutions (economy, society and polity) into a sort of neural network [Paquet, 1999; Meltzer, 2000];
- Transversal and meso-innovation systems of governance that employ "consensus and inducement-oriented systems to achieve coordination among network players" [Paquet, 1999];
- Renaissance-style independency forms of governance that utilize informal terms, and the devolution and decentralization of decision-making to achieve its objectives [Paquet, 2000].

These models are by nature subversive to those organizational structures based on traditional models of governance. They challenge the view that an "omnipresent person or group has monopoly on useful knowledge and can govern top down" [Paquet, 2000].

There are many definitions of governance. Some of these include:

- "The process whereby a society, polity, economy, or organization (private, public or civic) steers itself as it pursues its objectives" [Centre on Governance, 2000; Paquet, 1994; Paquet, 1997; Rosell, 1999].
- "The process of decision-making with a view to managing change in order to promote people's wellbeing" [Kyriakou and Di Pietro, 2000].
- "The set of processes and traditions which determine how a society steers itself thereby according citizens a voice on issues of public concern, and how decisions are made on these issues" [Meltzer, 2000].
- "The guidance of national systems shared by ensembles of organizations rooted in the three sectors (economy, polity, civil society and community)" [deBlios and Paquet, 1998].
- The means by which local, regional, national and international communities organize themselves and subsequently respond to issues of interest to members of those communities. It involves leadership on the part of government and the use of policy and programs to control and influence activities within communities [Manning, 1998].

A number of points essential to governance are alluded to in the above definitions. Firstly, governance is all encompassing, touching virtually every area of human existence. Secondly, governance can take many forms, and takes place on many levels. This is supported by Masson and Farlinger [2000]. Each form of governance makes use of facilitative processes, mechanisms and systems to pursue goals. Thirdly, governance is about the provision of direction towards the achievement of objectives. The direction taken must take cognizance of the interests, rights, responsibilities, and differences among all stakeholders.

3. STAKEHOLDER ISSUES

Practical problems in governance include:
- how identify who the stakeholders are;
- how to engage them effectively; and
- how to manage their input, including keeping the dialogue going over time.

This can be summarized as defining the governance process in terms of liaising, listening, learning, and leading. Too often agencies responsible for programs and projects focus only on the last step.

3.1 Stakeholder identification

One of the greatest limitations in most marine programs and projects is having a narrow approach to stakeholder participation. This is often driven by issues such as: time constraints, lack of knowledge, single issue focus, or governmental silos. It is particularly true in coastal region were there may be jurisdictional uncertainty, overlaps, and gaps. However, the top down approach, while perhaps being the easiest to manage, is also the least likely to have sustainable results. Spending time at the local level in the initial stages of marine activities (e.g., through workshops and town hall meetings) can help to identify the breadth of stakeholders and their interests.

3.2 Effective Stakeholder Engagement

Effective consultation is not just "this is what we are going to do for you." Frequently, information meetings allow question periods but do not include processes for taking and putting input to use. A variety of means can be used to obtain input including web portals. The information provided for consultation also has to have the right message and medium for the variety of different audiences.

3.3 Managing Stakeholder Input

Once input is obtained, consensus building strategies are required to establish priorities and identify appropriate solutions. Frequently the priorities are different at the local, regional, and national level. Whoever is leading also has to listen and learn if the differences are to be accommodated or resolved. And this is an on-going process that will effect the life of the governance activity.

The above may seem simplistic, but ignoring these issues can undermine the best intentioned activities. Some examples in Canada include:

- Significant delays in establishing a Marine Protected Area (MPA) because a First Nation (aboriginal) group was excluded in the initial discussions: The MPA program is led by the federal government which has taken nearly ten years to recognize and understand the importance of provincial, municipal, and private interests [Leroy, 2002].
- Ineffectiveness of a provincial policy to limit coastal development because of lack of trust at the local level despite numerous "information" meetings: The result was that

policy implementation was delayed for 10 years and inappropriate construction increased in the meantime to avoid the expected regulations [Nichols, et al., 2006].

- Lack of comprehensive coastal zone management programs due to uncertainty and fragmentation in jurisdiction, administration, ownership, and use of coastal resources: There are not well established arrangements for collaboration among all of the government agencies at the several levels involved and each activity causes a new process of stakeholder identification and consultation. From an information perspective this has led to a lack of consistent data about interests and boundaries along the coast.

4. LEGAL ISSUES

Another way of viewing marine governance is through an analysis of governance functions that link governance to the law and information. These include the following (Nichols, Monahan and Sutherland, 2000):

- allocation of resource ownership, control, stewardship and use within society;
- regulation of resources and resource use (e.g., environmental protection, development and exploitation, rights to economic and social benefits);
- monitoring and enforcement of the various interests;
- adjudication of disputes, including inclusive processes;
- management of spatial (geographically referenced) and other types of information to support all of the above functions.

This approach highlights the role of the legal frameworks within each nation in managing marine space. These frameworks are generally multi-layered ranging from the *United Nations Law of the Sea Convention (UNCLOS)*, international customary law, and international treaties to national, state, and local level laws derived from tradition, legislation, and the courts.

4.1 The Legal Complexity of Interests in Marine Space

The United Nations Law of the Sea Convention [UN, 1982] establishes a framework for national and international governance by, among other provisions, establishing limits of national resource use and control. However, each nation must also have a set of procedures for allocating resources within these zones. In many cases, this depends on tradition and legal frameworks. These frameworks may be defined by the local, regional (provincial/state) and/or national legal systems and constitutions. Even when only government interests are considered, the resulting marine/coastal legal arrangements are usually complex.

To illustrate this complexity, consider the following terms often used interchangeably or inappropriately [Cockburn and Nichols, 2002]:

- ***Sovereignty***: supreme rights of ownership; entities holding sovereign rights reserve the right to impose their will on others and to usurp the ownership rights of others (e.g. by expropriation). In international law, to be sovereign means that a state "must be able to exercise jurisdiction, over a determinate tract of territory, … and have legally independent powers of government, administration and disposition over that territory." [Walker, D, 1980].

- ***Legislative Jurisdiction***: "[t]he sphere of authority of a legislative body to enact laws and to conduct all business incidental to its law-making function." [Black, 1979] or that aspect of power where rules (i.e. rights, responsibilities and restrictions) of social, cultural, economic and political behavior are defined, and wherein it is determined how and when those rules are applied and enforced.
- ***Administrative Authority***: "[t]he power of an agency or its head to carry out the terms of the law creating the agency as well as to make regulations for the conduct of business before the agency; distinguishable from legislative authority to make laws." [Black, 1979]. It is therefore the *means* by which jurisdictionally defined rules are applied and enforced.
- ***Title or Ownership:*** the means whereby the owner of the rights to the object of property has the just possession of that object (although actual possession or occupation may be by another). Where sovereign, jurisdictional, and administrative rights are normally rights vested in governments and their agencies, title may be held by different levels of government, groups, and individuals. Depending on the legal system, 'ownership' may be full or partial and usually consists of derivative interests (e.g., lease, use, license, mortgage).

4.2 The Specific Nature of Marine Interests

In theory, land and marine spaces both have this complex legal regime. However, three characteristics of marine interests make the complexity more apparent:

- ***The legal frameworks are evolving rapidly and therefore can be incomplete and contain more uncertainty than on land:*** Although property and other related law always evolves on land, over the last century, marine legal frameworks have been changing more rapidly. Causes include:
  - expansion of national territories under the Law of the Sea (and consequent boundary and limit delimitation issues);
  - need to clarify intergovernmental title, jurisdiction, and administration within these expanded territories;
  - rapid development of relatively new marine resource uses or increasing intensity of existing uses (e.g., petroleum and mineral exploitation and transportation, coastal development, recreation and tourism, aquaculture and sea ranching, renewable energy production);
  - emergence of new issues such as conservation and environmental risk reduction;
  - increasing recognition of the rights of indigenous groups and other groups in coastal and marine resource.

- ***There are virtually no rights of exclusive use or ownership in marine space***: The three dimensional aspect of 'a parcel' is more apparent (Figure 1) than on land because rights are usually allocated for specific portions (e.g., seabed, water column) or specific activities (e.g., fishing, navigation). The interests usually coexist and even this coexistence may change over time (e.g., seasonal rights). This increases the number of stakeholders that must be considered for any marine/coastal area. It also results in myriad boundaries of jurisdiction, administration, ownership and use – in some instances, a boundary or limit for each specific resource or activity.

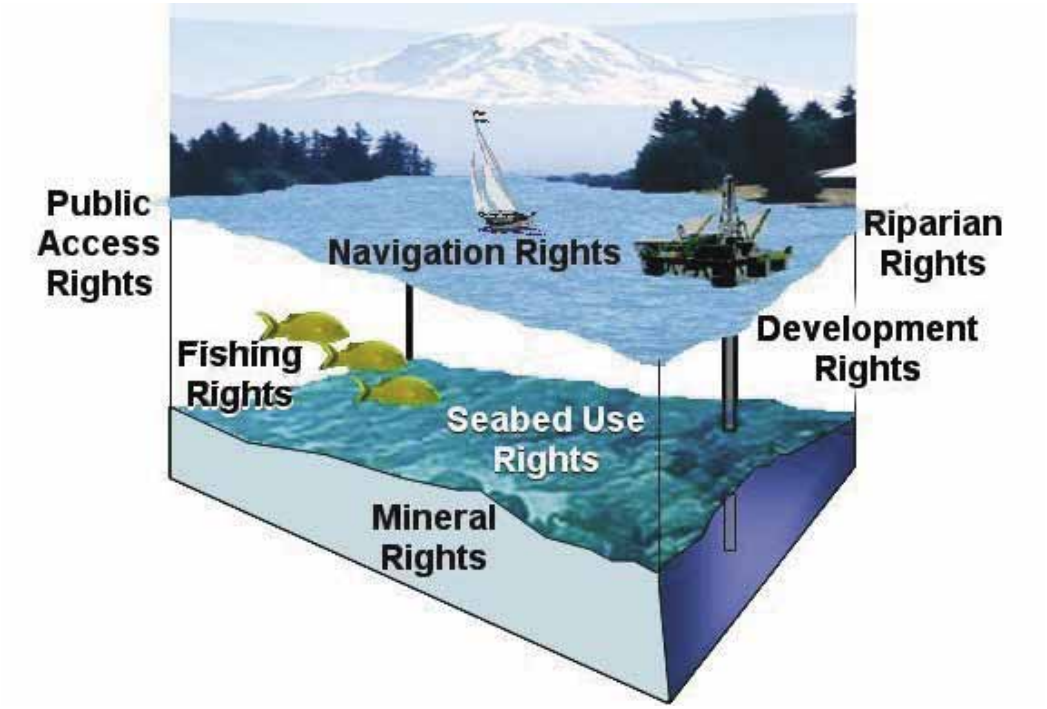

Figure 1: 3-Dimensional Marine Parcel
(From Sutherland [2005])

- ***Interests in marine space tend to come in smaller 'packages':*** Related to the first point is the fact that the management of marine interests tends to focus on specific resources or activities rather than geographic areas. On land, for example, we package spaces as:
  - state land vs. private land;
  - federal land vs municipal land;
  - exclusive rights of surface ownership such as freehold, which include fixtures (e.g., trees, buildings, and at least some subsurface rights).

  This fragmentation of interests is also usually reflected in (or caused by) the institutional structures of government. Thus the Ministry of Fisheries may administer an area of marine space for fishing and related activities and the same space is subject to different regulations for navigation that is regulated by the Ministry of Defense. One result is the fact that information about the stakeholders, their interests, and activities is widely scattered throughout government.

4.3 The Elusive Land-Water Interface

Much of marine activity is focused on the coast. Similarly, the intensity of land use in many countries is greatest at the coast in large part because of traditional transportation and shipping through ports. The result is that the number of stakeholders, the opportunities for

conflict among their interests, and the value they or society places on those interests is at a maximum at the coastline. This results in and is affected by the following issues, among many others:

- ***Overlaps and gaps:*** There are often overlaps of jurisdiction, administration, and ownership between government bodies that are primarily land based and those that are marine based (e.g., in ports where land and marine activities are intertwined). One consequence is that information about those interests may not only be fragmented but also inconsistent and incomplete;

- ***Complex private and public interests:*** Private land interests frequently extend into marine space (e.g., rights for wharf development, littoral rights associated with upland ownership, traditional rights to areas for fishing through weirs). In many cases these rights are undocumented and have been acquired through traditional use. Furthermore, these rights are not usually well understood by planners, managers, and policy makers without a water law background. An additional complexity is that there are emerging or increasing interests such as the public right to access beaches and to have environmental protection of endangered habitats. Such public interests typically clash with private interests, and in many cases neither are well defined or documented.

- ***Lack of appropriate information for traditional governance practices:*** Information about coastal interests is generally not well managed because, for example:
  - there are numerous government agencies involved resulting in fragmented, duplicated, incomplete and inconsistent datasets;
  - historical datasets are often incomplete and out of date because there was little concern until recently;
  - no one agency (and in some cases no specific level of government) has the responsibility to lead data management activities in both coastal land and marine spaces.

- ***Boundaries and limits are not well delimited:*** Boundaries and limits in the coastal zone are typically made with reference to physical features, many of which are difficult to clearly define or relocate (e.g., high water, the shoreline, the normal baseline). The land water interface is ambulatory and traditionally most boundaries and limits followed the motions of that interface. Today greater emphasis is placed on 'fixing' these lines. This may be driven by law (e.g., nations generally declare their national baselines under the Law of the Sea at a point in time for offshore boundary delimitation); by institutional structure and practice (e.g., the municipal coastal boundaries defined on a map); or by technology (e.g., the desire to establish co-ordinates or boundaries for geographical information systems). However, for the most part, the law only delimits boundaries when, and if, an issue arises. Therefore without court decisions or specific legislation the location of many boundaries is a matter of considerable interpretation [Sutherland, 2005].

5. TECHNICAL ISSUES

5.1 The importance of information

Information is an essential technical component of the governance of marine spaces. Information on resources that currently exist, the nature of the environment within which those resources exist, as well as on the users and uses of those resources is always a requirement for effective evaluation and monitoring of marine areas. Information on, for example, living and non-living resources, bathymetry, spatial extents (boundaries), shoreline changes, marine contaminants, seabed characteristics, water quality, and property rights can all contribute to the sustainable development and good governance of coastal and marine resources. All of these types of information have spatial components and therefore spatial information is important to the good governance of marine spaces (Figure 2) [Sutherland, Wilkins and Nichols, 2002].

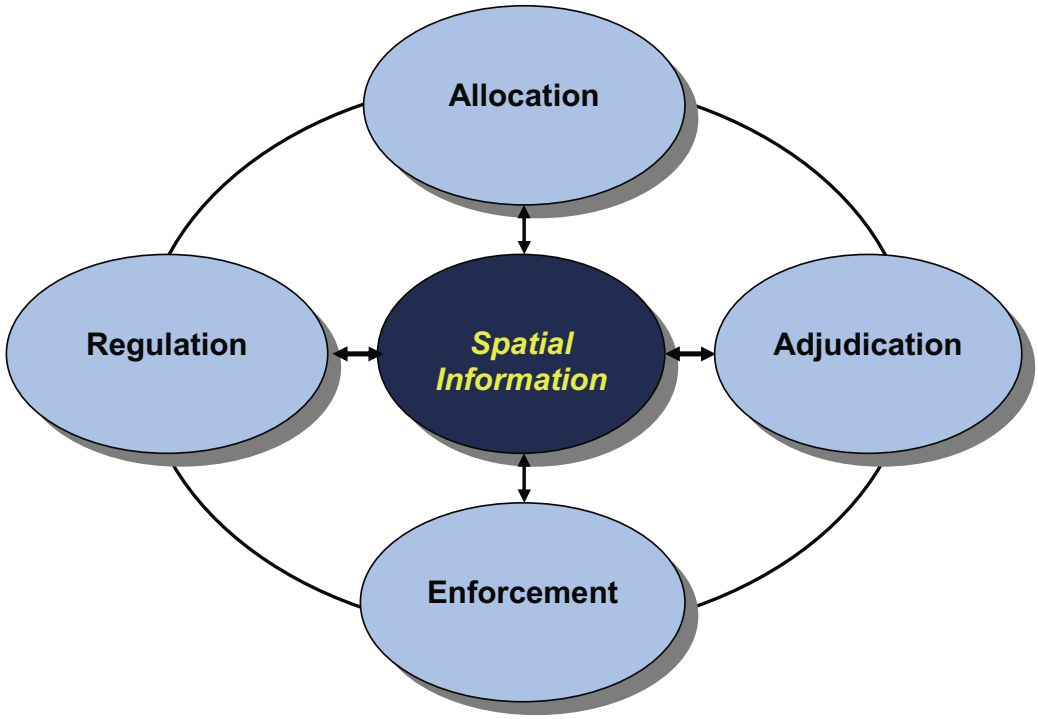

Figure 2: The role of spatial information in governance
(From Nichols, Monahan and Sutherland, 2000)

Boundary information is one type of spatial information that is essential in the management and administration of marine spaces. However in some cases it may be better not to focus on boundaries, as boundary uncertainties (e.g., as with federal and provincial boundary uncertainties in some coastal regions in Canada) are sometimes the cause of social and administrative conflicts in coastal and marine spaces. Recent governance research supports the relevance of imprecise or ill-defined boundaries insofar as the

existence of these boundaries is not a catalyst for dispute [Nichols, Monahan and Sutherland, 2000]. The precise delimitation of boundaries usually become important in relation to the need to allocate equitable resources perceived to be dissected by the potential boundary [Hildreth and Johnson, 1983]. For example, such is the case with the boundary dispute between Nova Scotia and Newfoundland [Arbitration Tribunal, Nova Scotia-Newfoundland Dispute, 2002].

5.2 The issue of four-dimensional rights in marine spaces

When considering marine environments from a right-based perspectives, one ought to consider that in one column of the marine environment there are rights to the surface of the water column (e.g. navigation), to the water column it self (e.g. fishing), to the seabed (e.g. fishing and mineral resources), and to the subsoil (e.g. mineral resources). The very nature of the marine environment requires that rights be considered in terms of at least three dimensions, in snapshot, and more practically in four dimensions considering that rights to marine spaces change over time. Technically, therefore, tools developed to manage and administer rights to marine spaces should consider the inherent multidimensional nature of those rights [Ng'ang'a et al, 2004].

5.3 Dealing with multiple interests for the same space at the same time

Concepts such as the marine cadastre or marine administration systems have been discussed in many academic papers as technical means for aiding in the management and administration of rights in marine spaces. Any technical tool such as a marine cadastre or marine administration system is faced with the challenges of not only dealing with the multidimensionality of rights to marine spaces but also with the fact that in many international jurisdictions there is the added complexity of overlapping interests (e.g., jurisdictional rights, administrative rights, title, leases, customary rights, aboriginal rights, public rights, etc.). The design of marine information systems dealing with the management of rights information ought to take the possibility of overlapping and co-existing rights into consideration [Ng'ang'a et al, 2004].

5.4 Fitting into larger 'information' initiatives

The management of marine spatial information is an asset to the efficient management of marine resources, and can in many instances help to avoid minimize conflict among the many stakeholders. Recognizing this, and the fact that no one stakeholder possesses all necessary information, many jurisdictions have begun initiatives to better manage coastal and marine spatial information and to apply information technology and concepts to the management of marine spatial information [Ng'ang'a et al, 2004; Nichols, Monahan and Sutherland, 2000].

In order to coordinate the dissemination of marine spatial data that can support good governance of coastal and marine spaces, marine geospatial data infrastructure initiatives are underway in many parts of the world. Initiatives such as Canada's Marine Geospatial Data Infrastructure (MGDI) and the U.S. Federal Geographic Data Committee (FGDC) are considering the information and other infrastructure components necessary to provide geographically dispersed stakeholders with spatial data to support governance decision-

making. Regional bodies such as the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) are also taking steps to implement marine geospatial infrastructures.

The components of any marine geospatial data infrastructure are expected to include key spatial data, computer network infrastructures, spatial data management software and other software, data- and other standards, metadata, stakeholders, and possibly a spatial data clearinghouse. Table 1 shows spatial data infrastructures as part of a marine information system from a property rights perspective.

Table 1: Components of a Marine Information System from a Property Rights Perspective
(After Sutherland, 2005)

COMPONENTS	CHARACTERISTICS
Objects of property	▪ Marine / coastal resources
Property rights	▪ Title ▪ Jurisdiction powers ▪ Administrative powers ▪ Other rights and interests
Subjects of property	▪ Jurisdictional and administrative powers ▪ Individuals ▪ Groups
Spatial extent of property	▪ 4D marine spaces ▪ Geographic extents ▪ Limits / boundaries
Spatial Data Infrastructure	▪ Spatial information / data; ▪ Metadata ▪ Standards ▪ Laws, legislation and regulations; ▪ Land/property administration infrastructure (recording, registration dissemination, management, institutions, processes, organization etc.); ▪ Information management infrastructure (institutions, computer networks, standards, etc.)

5.5 Issues in defining coastline boundaries

Tidal boundaries along coasts in North America are defined in law either by the "intersection of a specific tidal datum with the shore" or by "tide marks left on the shore by the receding waters of a particular stage of tide" [Nichols, 1983]. Internationally this is more or less true. Because tidal datums are related to specific sea levels and therefore subject to temporal and spatial variations, and because the marks left by tidal actions on shores also vary with the changes in sea level and tides, boundaries defined by these methods are sometimes subject to ambiguous positioning in 3-dimensional space.

Constant tidal action against the shore can cause the deposit of material on the shore or the erosion of shore material and therefore the physical configurations of shorelines are subject to constant change [Flushman, 2002; Lamden and de Rijcke, 1985; Nichols, 1983]. This means that resurveys are sometimes necessary in order to keep coastal boundary information up to date. These and other factors are issues in defining coastline boundaries and therefore indirectly affect the governance of marine spaces since, for example, the implementation of jurisdictional and administrative rules and regulations often depend upon defined boundaries.

5.6 Science and Local Knowledge

As on land, traditional or local knowledge can play an important role in marine governance. Unfortunately the value of local knowledge is not always appreciated or is ignored because: it is not standardized; it is not considered 'objective'; or it is difficult to obtain. However science has only begun to give a picture of the vast ocean territory, even near the coast. We have snapshots and sporadic data, which like lead line depth measurements, leave much to be discovered and understood. Local knowledge is an asset not to be underestimated in filling in those gaps, validating the scientific sample and theories, or in understanding the interconnection within ecosystems. Fishers along the East and West Atlantic coasts, for example, could have advised the scientists who helped governments who established fishing quotas in the 1970s-1990s that many north Atlantic the fish stocks were declining, long before the science driven government policies endangered the fishing resources.

6. DISCUSSION

Marine cadastres and other marine administration information systems have been proposed as technical solutions to the management of information about interests in marine resources in support of coastal and ocean governance. It is easier to design such systems to be useful for managing information on single activities or resource use (e.g., petroleum leases) occurring in marine spaces. However, in order to be of maximum benefit to the governance of marine spaces these information systems will have to be able to manage and visualize information on multiple marine resource interests that overlap in 3-dimensional space, and time. These systems should also function in an environment of efficient and effective governance and legal frameworks, and optimal institutional arrangements that meet the often diverse needs of identified and engaged stakeholders. Therefore, we would like to propose that activities affecting the rights and responsibilities, including information management, need to consider the following:

1. A multidisciplinary approach is needed in the governance of marine spaces. Surveyors, lawyers, planners, and resource managers all understand part of the picture. To be complete or even useful, any information system to support marine governance needs to reflect the variety of interests, their complexity, and the unique aspects of marine interests.
2. The emphasis should not necessarily on precise boundary delimitation. Many of the boundaries and limits are undefined or un-delimited until an issue arises. Others are fuzzy or moveable by nature and best serve the interest of stakeholders that way.

3. The sheer number of overlapping and coexisting interests in four dimensional space means that new approaches to presenting appropriate information are needed. Rather than imposing a land-based system (i.e., grids, straight lines and co-ordinates), the focus should be on helping stakeholders and decision makers visualize the complexity and multiplicity of interests.
4. Co-management arrangements may be a better option than management of zones and geographical areas defined by boundaries if governance is to be inclusive and recognize all interests. Co-management (e.g., networking of information sources) will also be necessary in developing truly useful information systems, rather than a single agency approach.

The oceans provide an opportunity to not make the same mistakes we have made in land resource management and land information systems. Perhaps what we can create for marine space can help to improve our governance and information systems on land.

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Marine Administration Research Activities within Asia and the Pacific Region – Towards a Seamless Land-Sea Interface

Abbas Rajabifard, Ian Williamson and Andrew Binns

Abstract

Administering the marine environment is an important topic for discussion and management internationally, especially within the Asia and Pacific Region. This region relies heavily on the ocean as a source of food, for transportation and for income through activities such as tourism and hence it is important to manage such marine spaces effectively. With this in mind, the Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP) is involved in several international collaborative research projects within the marine environment. The main objectives of these activities are looking at defining the issues to be considered in the context of developing effective and appropriate administrative infrastructure systems as part of national Spatial Data Infrastructure initiatives to manage marine resources in the context of the United National Convention on the Law of the Sea. This includes the facilitation and development of a set of guidelines appropriate to the Asia and Pacific region for the design of such systems.

This paper aims to describe current SDI based research activities within the sphere of marine administration throughout the Asia and Pacific region. The paper provides an overview of the incentive, objectives and principle tasks as well as the results of current research activities being undertaken through Working Group 3 (Cadastre) of the PCGIAP. These activities aim to aid in meeting the sustainable development (economic, environmental and social) objectives of the region through the development of a seamless enabling platform to provide more efficient and effective decision making capabilities across both the marine environment and the land-sea interface.

1. INTRODUCTION

Countries throughout the world have spent considerable time and effort in attempting to effectively manage the economic, social and environmental aspects of land, with management of the marine environment placing second to that of land. For some countries however, the marine environment provides the main avenue for resources ranging from basic everyday needs such as food to economically powerful fossil fuels, and provides avenue for transportation and social cohesion. This is especially relevant within the Asia and Pacific region.

The Asia and Pacific region accounts for some 60% of the world's population and includes 56 nations covering the largest geographic land region in the world. Most of these nations, especially those within the Pacific, have marine jurisdictions that are greater than that of their land mass. Australia for example, has maritime responsibility for twice that of the Australian continental landmass (Kaye 1995) with the ability for the size of area under Australia's jurisdiction to increase under the 3rd United Nations Convention on the Law of

the Sea (UNCLOS). The nations within the region are also at different stages of development and range from the largest archipelago nation (Indonesia) to the largest landlocked nation (Mongolia) in the world.

These large national marine environments also contain a wealth of actual and potential resources, with the demand for exploiting these resources increasing rapidly. Each nation must explore, exploit and manage its ocean territory in a way that will maximize benefit to the nation, while at the same time protecting the delicate ocean environment (Collier et al. 2001). This has not been achieved effectively, with marine pollution as well as over fishing occurring across the region. In 1995 for example, the FAO classified nine of the world's 17 fisheries as being in serious decline, with four depleted commercially (PANOS 1995). Even in wealthier OECD countries such as Australia, poor management and an increase in competition for control over major sources of revenue such as natural gas and oil is causing an exhaustion of natural resources in the marine environment.

There is a need to create a framework for marine administration in order to provide a foundation from which management issues, including the global focus on sustainable development, can be addressed. In order to address this, various research initiatives are being undertaken through the Permanent Committee for GIS Infrastructure for Asia and the Pacific (PCGIAP). This paper aims to describe the research that has been undertaken and is currently being undertaken within Asia and the Pacific under Working Group 3 (Cadastre) of the PCGIAP on facilitating the development of a marine administration framework.

2. PCGIAP COMMITTEE

The PCGIAP was established in 1995 through the efforts of the United Nations Regional Cartographic Conference for the Asia and Pacific Region (UNRCC-AP) following its 13th Conference in Beijing. The aims of PCGIAP are to maximize 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 Spatial Data Infrastructure (APSDI) and contribute to the development of the global infrastructure (Rajabifard et al. 2003).

PCGIAP operates under the UNRCC-AP, submitting its reports and recommendations to this conference. It comprises of 56 nations which are represented on the Committee by directors of national survey and mapping organizations or equivalent national agencies. Each member nation participating in the Committee has one vote and decisions of the Committee are taken by a majority of the Representatives present and voting. An Executive Board comprising representatives from twelve member nations, including a President, Vice President and Secretary, coordinates the Committee's work program. The term of the Executive Board is the period between UNRCC-AP Conferences, currently three years.

Projects are undertaken within the PCGIAP by Working Groups, which are described in Table 1. These working groups help to fulfill the aims and objectives of the Permanent Committee with meetings held both in conjunction with the meetings of the UNRCC-AP and also between these meetings.

Table 1: Working groups of the PCGIAP in the period 2003-2006

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

Working Group 3 (Cadastre) was established in 2000 based on the Resolution from the 15th UNRCC-AP in Malaysia. Through that Resolution and as part of the WG3 work plan, it was recommended that the United Nations within available resources, and in cooperation with the Working Group on the Cadastre under the PCGIAP, and with the expert assistance of relevant organizations such as the International Federation of Surveyors (FIG) and the International Hydrographic Office facilitate:

- discussion on marine 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 the Law of the Sea.

This work in relation to marine administration is seen to be within the context of the development of a seamless land-sea SDI for the region, and is essential to the implementation of the United Nations Agenda 21 and the realization of economic, social and environmental benefits for the region.

3. MARINE ADMINISTARTION RESEARCH IN THE ASIA AND PACIFIC REGION

Work on the marine administration component of the Working Group 3 work plan began in 2002 with research being undertaken in conjunction with the Centre for Spatial Data Infrastructures (SDI) and Land Administration, Department of Geomatics at the University of Melbourne, Australia, into improving the understanding of Marine Cadastres in Asia and the Pacific Region. Research was undertaken in two main areas, however the principle aim of research was 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.

3.1 Development of a Marine Cadastre

The first major research area was the consideration of the similarities and differences between the existing land cadastre and a future marine cadastre and suitability and extension of the Australian SDI to the marine environment, as well as an attempt to sufficiently define the concept of a marine cadastre.

Some of the major issues identified within this research include:

- the ambulatory nature of the coastline;
- the size of the marine areas to be managed
- the complex spatial and temporal interactions in the marine environment;
- the need for mechanisms to facilitate quick and effective updates of marine spatial data;
- the need for a virtual register of interests in the marine environment to support decision making; and
- the wide range and nature of marine activities and stakeholders which need to be taken into account

In an attempt to overcome these issues, the concept of a marine cadastre, as described in Figure 1 (Binns et al. 2003), is being considered by a number of countries including Australia, Canada and New Zealand. In all of these countries, as well as within the Asia and Pacific region, there are a large range of stakeholders and activities that occur within the marine environment, ranging from tourism and recreational activities such as boating and swimming, to the disposal of waste and drilling for oil and natural gas deposits. In order to effectively manage these activities, the administrative and legal boundaries that govern where and when such activities can occur need to be known. The rights and restrictions that go along with such boundaries also must be recorded. For example, marine protected areas have defined boundaries for the purpose of excluding or restricting the rights of other stakeholders within such an area. Knowledge of these rights and restrictions need to be attached to the boundaries, and the boundaries easily displayed and mapped within a GIS in order for them to be effective. This would enable users and stakeholders to "describe, visualize and realize" spatial information in the marine environment (Todd 2001).

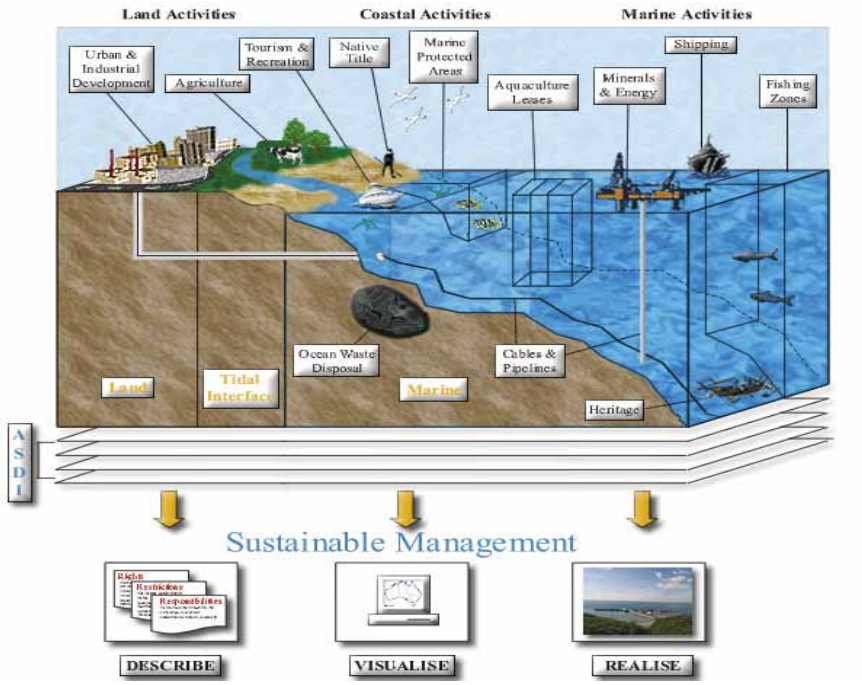

Figure 1: Marine Cadastre Concept (Binns et al. 2003)

The creation of a marine cadastre would also need to include mechanisms to enable spatial information within the marine environment to be continually updated and maintained, in a similar fashion to the terrestrial cadastre. In order to assess the applicability of land based principles, a set of fundamental cadastral and land administration principles and their applicability to the recording of rights, restrictions and responsibilities to aid in marine administration were identified. These include: policy principles; tenure principles; legal principles; and institutional principles.

The policy and institutional aspects were most applicable to the marine environment, as the physical difference between the two environments is not a major concern when applying these principles. This included:

- the need for the creation of a national oceans policy in order to provide direction for the administration of the marine environment. According to Williamson (2001), the development of a policy will drive legislative reform, which in turn results in institutional reform and finally implementation with all its technical requirements, important steps in developing any marine cadastre.
- The need for an overarching governing body to address marine cadastral issues, including the implementation of a marine cadastre at a national level similar to the implementation of SDI initiatives.
- The realization that the marine environment is dynamic. The key to managing it is to start simple, develop a strong marine cadastre framework foundation, and allow the system to evolve and grow as future uses arise.

The ability to apply tenure and legal principles to the marine environment is not as straight forward. Within the marine environment, the need for private transactions is limited, due to the lack of freehold rights. This differs from land, where the ability to transact is the primary aim of the cadastre. There is also a major difference in the description of spatial boundaries. On land, legislation is used to describe how boundaries are demarcated, with monuments used as the primary point of truth for boundaries. In the ocean, the precise location of boundaries is generally embedded in legislation, making statutory regulations the point of truth for boundaries. The physical difference in the two environments also causes issues. Boundaries are delimited rather than demarcated, can be three or four dimensional as opposed to two dimensional, overlap regularly as opposed to rarely and need to be systematically defined, rather than sporadically defined as on land.

The existence of immature institutional arrangements and the lack of an overarching government department to coordinate the collection and maintenance of spatial data in the marine environment creates the need for the utilization of an SDI. This would aid in partnership creation and providing standards from which issues of data interoperability can be addressed. It would also ensure the development of a seamless administration model that covers both land and marine environments, enabling more efficient and effective decision making. The ability to apply the SDI policies and technologies within the marine environment however needed further investigation. This was undertaken as part of a new research initiative, described later in this paper, to examine the ability of using a seamless SDI model to cover both the land and sea environments.

3.2 Technical Implementation of Legally Defined Marine Boundaries

The second major area of research 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. As a result of the dynamic nature of the marine environment and the human activities that occur therein, the implementation of legally defined marine boundaries is subject to a variety of political, legal and technical challenges. This research has addresses the technical issues which cannot normally be dealt with using conventional land cadastre principles. The key issues identified and addressed under this research are centered upon marine boundary delimitation and positioning, and include spatial uncertainty, maintenance of four dimensional parcels, and the modeling and management of quality metadata.

Accordingly, the outcomes of the research are threefold. Firstly, the research presents the development, implementation and analysis of algorithms and procedures for quantifying uncertainty in the delimitation and positioning of marine boundaries. Conclusions are drawn from tests conducted with real–world and simulated datasets. Secondly, the research has developed algorithms and procedures for constructing and maintaining four–dimensional marine parcels. Thirdly, this research identifies the fundamental quality metadata elements necessary for handling information about uncertainty in the technical implementation of marine boundaries (Fraser et al. 2006).

This early research also aimed to gain a broader understanding of the requirements of those individuals and organizations who use, manage and administer maritime spaces and marine

spatial data. This was achieved through the running of several workshops and a broad based questionnaire.

3.3 Industry Consultation

The questionnaire and workshops enabled researchers to identify the major users, suppliers and producers of marine spatial data, which included mainly government agencies and departments. The major role for spatial data was in environmental issues offshore, whilst also serving an administration and management function. 94% of respondents revealed that spatial information was either essential or important for the management of their offshore functions. The majority of offshore data was supplied to users in digital form, though paper charts were still used by some organizations. It was also interesting to note that most users of spatial data required information in 3D, with many also requiring variations in time. Users of offshore spatial information indicated that they are generally dependent on information being kept up to date, especially boundary information. This can be seen in the dependence on the boundary which is defined by the intersection of a tidal plane with the land, with almost 70% of respondents in some way dependent on tidal plane definitions. (Forse and Collier 2003)

The workshops and questionnaire provide an overview of issues and information on how spatial data is being used offshore. However, to gain a more detailed and higher level picture in order to understand the issues surrounding the implementation of a marine cadastre from a user perspective, industry consultation was undertaken. The major industries consulted included:

- the Queensland Resource Registry within Department of Natural Resources and Mines, State of Queensland, Australia;
- Parks Victoria within the Department of Sustainability and Environment, State of Victoria, Australia;
- National Mapping Division within the Australian Federal Government;
- the Australian Hydrographic Office;
- Spatial Information Infrastructure – Department of Sustainability and Environment, State of Victoria, Australia;
- Environmental Protection Agency Australia;
- Native Title and Indigenous Land Services, Government of Australia; and
- Maritime Safety Queensland - Department of Transport, State of Queensland, Australia.

The outcomes of these consultations enabled current problems and issues effecting major marine stakeholders to be identified. These included:

- The ambiguous nature of terminology within legislation
  - e.g. tidal datum not clearly visualized and realized
  - e.g. marine park boundaries and areas described within legislation as ‘mud maps’
  - Lack of lineage and traceability standards for legislation reference implementation
- Determination of high water
- Lack of political will and poor commitment from government in regards to developing a system such as a marine cadastre
  - Focus is on small scale technical issues, not on realistic whole scale institutional and cultural problems
- Fragmentation of data, varying scales and quality

    - Spatial accuracy/precision of sourced data is unknown
    - Currency of boundary data unknown
- No lead agency to coordinate marine data access, mapping and exchange
- Terms Marine Cadastre, Marine SDI, Marine Spatial Information System etc need to be clarified
- Current focus of SDI is on "data" and "data quality" which limits the potential business and response to market needs
- Need for infrastructure which can manage temporal issues
- Lack of overall strategic policy for infrastructure development in the marine environment

The ability to solve these problems within the initial research focus was limited, however they were considered in the development of further research within the sphere of marine administration. The work achieved through both these research areas and identification of issues through industry consultation enabled four new key research areas to be defined and undertaken. These areas include:

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

3.4 Resolving Issues in the Definition of the Tidal Interface

The coastline is defined by the line of intersection between the land-mass and a nominated tidal place. However, the coastline does not have a concise or unambiguous spatial or legal definition, creating uncertainty and potential conflict in the case of competing interests in the tidal zone. This also makes the delimitation of maritime boundaries dependent on the definition of the coastline somewhat problematic. A new approach for defining the coastline that will remove this current ambiguity in the tidal zone will make it feasible to create a single national cadastre covering the both onshore and offshore environments.

In addressing the spatial issues, the research aims to identify and resolve technical issues that impact on the consistent delineation of the coastline. This research uses a technique where by the various tidal datums can be mapped using a mathematical approach. Recent technology which enables coastal terrain data to be captured more accurately at a higher resolution will be supplemented with a harmonic tidal model to derive the required tidal datums (Daw Quadros 2005).

The research has recently developed a system that produces the height of tidal datums (Highest Astronomical Tide, Mean High Water Springs and Lowest Astronomical Tide) at any given position on the Australian east coast. This information is to supplemented with foreshore terrain data from NSW to delineate the relevant coastline. The next stage of the project is going to involve a comparison of the coastline with tide gauge data and current coastline models.

3.5 The Use of Natural Rather than Artificial Boundaries in a Marine Cadastre

The use of traditional and often arbitrarily defined boundaries can be disadvantageous in the marine environment. Naturally occurring boundaries, such as sea floor characteristics, migratory movements of a particular species or the extent of a particular kind of sea grass can be more suitable to the definition of jurisdictional zones, as seen in the delimitation of marine protected areas. This research aims to create a concept for the delimitation and management of jurisdictional boundaries based on natural features and conditions.

This is based on recognition that spatially based management of a resource is not appropriate unless the spatial dynamics (including distribution, density and mobility) of the resource are clearly understood. Where mobile natural boundaries define the spatial limits of a resource, administrative boundaries should only be set at the extremes of the natural variation. This research will look at addressing data format issues, asses seasonal variations in natural boundaries and investigate connections to sea floor topography (Leach 2005).

3.6 Marine Policy, Legal and Security Issues and the Marine Cadastre

All countries face a myriad of both national and international laws, treaties and conventions relating to and assessing their relationship and rights to the sea and sea bed. Not only is this web of legislation complex, but as described by Nichols et al (2000) there is also an increasingly diverse range of actors and authorities active in the marine environment, multiple and unclear jurisdictional limits, various co-management arrangements, and no single agency managing offshore rights and boundaries creating overlapping and competing interests. All of these facets of management need to be related to marine policy. Such a policy must also deal with increasing responsibilities of ensuring safety within claimed maritime zones, issues of illegal fishing and ensuring that a county is kept secure from the risk of terrorism. Hence this component of research aims to analyse the ability of utilising a marine cadastre in resolving maritime security and policy issues.

3.7 Extension and Application of the SDI to Support a Marine Cadastre

The ability for data custodians and data users to have ready access to data which is reliable, complete and current is already becoming available within the terrestrial environment through the development of Spatial Data Infrastructures (SDI). Within the marine environment however, this is far from reality. Recently, ANZLIC – Australia's spatial information council, recommended that the Australian SDI concept be extended to cover the marine environment. This has also occurred in several other nations including Ireland (Bartlett 2004) and the USA (NOAA 2003). The intention of this area of research is to analyse the components of current SDI models and attempt to extend, modify and test these principles in an offshore environment. The ultimate aim is to design an SDI model that seamlessly covers both land and sea, creating an enabling platform for the use and spatial information and services.

One of the major issues in managing and administering activities, be it on land or at sea is having access to relevant spatial data and information concerning the area, as described by Doody (2003):

- Data + Context = Information

- Information + Analysis = Understanding
- Understanding + Management = Possibility of sustainable action.

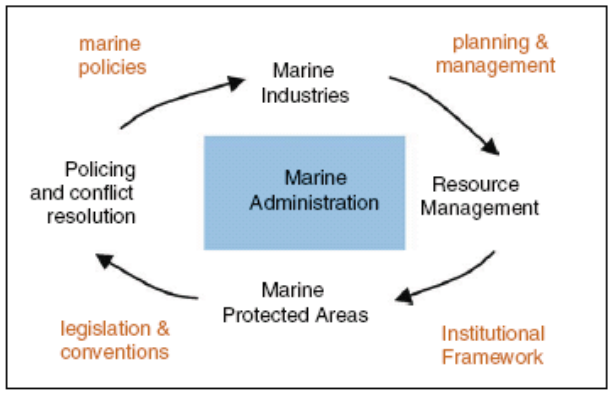

Figure 2: Marine administration (Strain et al. 2006)

Figure 2 shows some of the activities involved in marine and coastal zone administration. Each of these requires spatial data and information such as tide charts, bathymetry, climate, sea surface temperatures and currents, living and non-living resources, property rights in the area, legislation and international conventions in order to be managed successfully. However problems with accessing, sharing and using spatial data related to these areas is often reported. This can be seen in a proposed marine data policy by the CSIRO (1998) which stated that 'present users of ocean and data are faced with a confusing array of datasets and data formats'. This has resulted in the increasing need for the development of an enabling platform to underpin decision making, through the development of an SDI to better manage and share spatial data assets (Strain et al. 2006).

An SDI framework facilitates the exchange and sharing of spatial data between people. It is an underlying infrastructure in the form of policies, standards and access networks that allow data to be shared within and between organisations, states and countries. It has been likened to road or rail infrastructure over land, and comprises roads as well as the rules, maintenance policies and jurisdictional rights to them (Strain et al. 2006). Research has been undertaken to attempt to apply the SDI concept to the marine environment in order to aid in the development of a decision making platform across the land-sae interface. The development of such as enabling platform will aid in the use of decision making tools such as GIS and break down the silos of information held by various agencies in the marine environment.

The use of decision making tools such as GIS within the marine environment is increasing, but there is a need to improve the underlying framework for access to up-to-date data and spatial information. Currently, the ability to provide consistent and accurate spatial information on the wide range of rights and spatial boundaries in the marine environment is hampered by the fact that interests overlap and information is held in silos by various agencies.

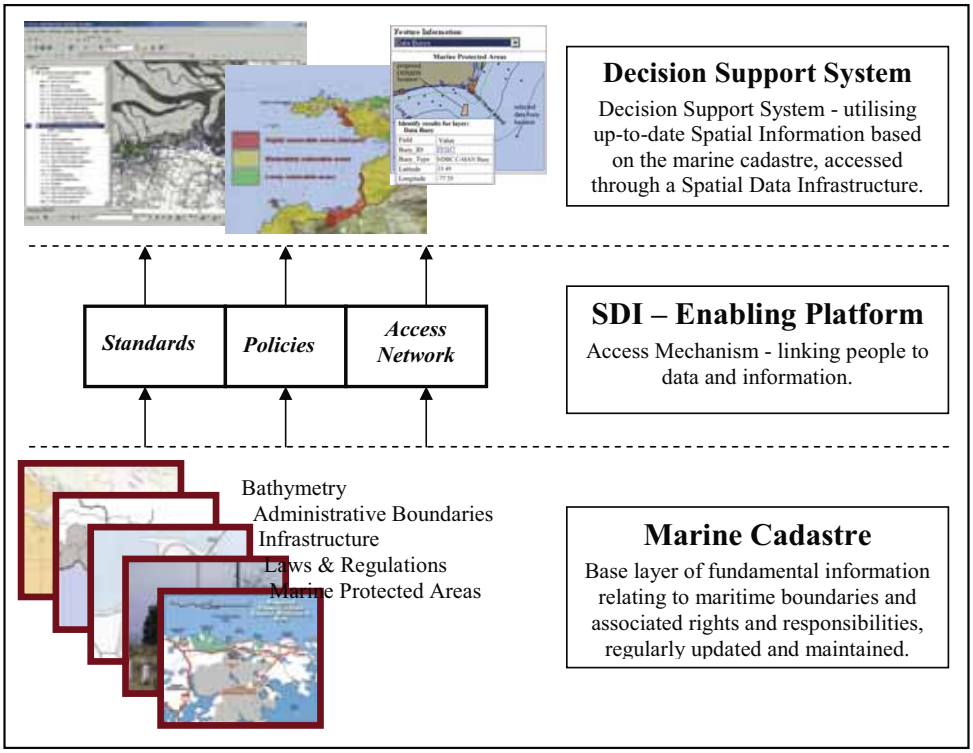

Figure 3: Underlying infrastructure for more effective marine administration

As seen in Figure 3, research into marine SDI and the development of a marine cadastre is aiming to increase this underlying infrastructure by providing an access mechanism to more up-to-date and accurate information regarding maritime boundaries (Binns et al. 2005). As a result of research, a seamless SDI model has been proposed which has used the major SDI principles of people, data, access network, standards and policy. This model now needs to be refined and tested, with barriers effecting possible implementation needing to be identified, from both an individual jurisdictional perspective (e.g. individual country) as well as internationally. This will help in achieving the PCGIAP's goal of establishing a regional SDI for Asia and the Pacific.

4. INTERNATIONAL WORKSHOP ON ADMINISTERING THE MARINE ENVIRONMENT – THE SPATIAL DIMENSION

As part of the PCGIAP WG3 work plan a four day international workshop on Administering the Marine Environment was conducted in Malaysia, 2004. The objective of the workshop was to better understand the spatial dimensions of administering the marine environment in the Asia and Pacific region and in particular, to facilitate:

- an understanding of the needs of an SDI in the marine context;
- better understanding and appreciation of the administration of marine rights, restrictions and responsibilities and to agree on terminology; and

- documentation of issues in establishing a marine dimension as a key component of National SDIs.

Over 100 people from 11 countries attended the workshop, with a representative of each country presenting a report on the marine administration activities in their jurisdiction, based on a common marine administration template. This workshop was facilitated by identifying common problems, issues, similarities and differences in SDI; institutional arrangements; the administration of rights, restrictions and responsibilities; technology; and human resource and capacity building. The PCGIAP-WG3 is continuing to promote countries to complete the Marine Administration Country Template in order to have a wider view of the management of the seas of Asia and the Pacific region. Completed templates can be found online with the information collected helping in the research being undertaken (www.marineadministration.org).

The main discussion areas of the workshop focused on:
- issues in administering the marine environment
- definition of marine SDI and marine cadastre; and
- administration of marine rights, restrictions and responsibilities.

Key outcomes of these discussions took the form of resolutions, concentrating on issues in the region and particularly the role of marine SDI and marine cadastre in aiding more effective marine administration (Rajabifard et al. 2005).

Two of the key resolutions stemming from the Workshop include:

- ***Resolution 1*** *– Spatial Dimension of Administering the Marine Environment*
  The workshop recommended that all countries in the Asia and Pacific region with an extensive marine jurisdiction and administrative responsibility be encouraged to include a marine dimension in their NSDI as part of their obligation to meeting their responsibilities under the United Nations Convention on the Law of the Sea (UNCLOS). It was further recommended that countries cooperate with other countries to ensure technical, operational and policy consistency in the marine elements of NSDIs developed in the Asia and Pacific region (PCGIAP-WG3 2004).

- ***Resolution 3*** *– Defining the Spatial Dimension of the Marine Environment*
  The workshop recommended 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, visualizes and realizes 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 (PCGIAP-WG3 2004). This is described in Figure 4.

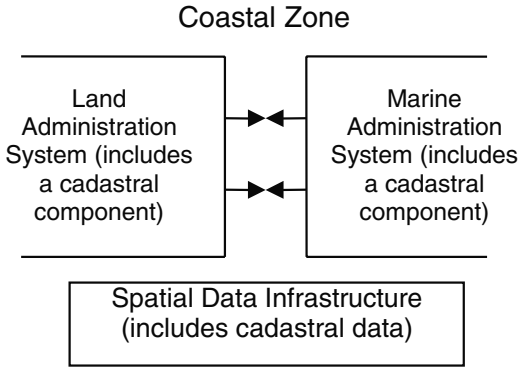

Figure 4: The spatial dimension of the marine environment

Other important issues and points of discussion raised within the workshop included:

- that an SDI should facilitate access, management and sharing of spatial data in both the marine and land environments at any jurisdictional/political level;
- that a marine cadastre component of marine administration 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 interests in the marine environment;
- the need for collaboration between FIG Commission 4 and PCGIAP-WG3 on issues relating to marine SDI and marine cadastre;
- the lack of a single organisation capable of coordinating issues on marine management;
- importance of institutional reform and capacity building in administering marine rights, restrictions and responsibilities;
- the legal and security issues affecting both the creation of effective marine policies and hindering the creation of a culture of data sharing within the marine environment;
- that any marine SDI should relate to natural boundaries as well as administrative boundaries;
- the importance of the link between land and marine environments – they cannot be treated in isolation; and
- the need for international cooperation as maritime actions transcend national boundaries.

(Rajabifard et al. 2005)

Although the discussions and points raised were in relation to the Asia and Pacific region, these points are also relevant to the wider international community. It is important that the issues discussed within the workshop are addressed through collaborative measures, with research and development across nations needing to be shared. This will enable the development of mechanisms and structures for governance of marine territories that are sufficiently flexible to allow integration of global and international objectives with those of local communities and interests. It must be remembered that there is a need to effectively manage the land-sea interface as well as the terrestrial and marine environments themselves. Research within the Asia and Pacific region under the PCGIAP WG3 is attempting to do this.

5. CONCLUSION

There is now a call to move toward a virtual world and create an enabling platform to support such as initiative. This is not limited to the terrestrial environment, with the marine environment, as demonstrated in this article, playing a vital role in day-to-day tasks of countries, especially within Asia and the Pacific. Research is being undertaken to create more effective mechanisms for decision making to help administer the marine environment more effectively and efficiently. This includes the development of a marine cadastre, in order to provide the ability to define, visualize and realize boundaries within the marine environment as well as resolving issues in the definition of the tidal interface in order to more accurately define boundaries.

The need to effectively manage the coastal zone as well as the need for integration of data between the land, coast and marine environment requires a management system that incorporates them all. Currently, many countries have a land administration system and some kind of marine management system, but these generally operate as separate entities. This can cause conflict within the coastal zone or land-sea interface.

Interoperability between technologies and spatial data, as well as incompatibility of data formats, coordinate systems, geodetic parameters and other aspects of data pose problems in the ability to share and exchange data in the marine environment. Research into the development of a seamless SDI model across the land-sea interface aims to address these issues both at a national level and through the development of the Asia-Pacific Regional SDI through PCGIAP. The development of such an overarching infrastructure also aims to more effectively manage the fragile land-sea interface.

The key to success in the marine environment is to start simple, develop a strong marine cadastre framework as a foundation, and allow the system to evolve and grow as future demands arise. Using common SDI standards, policies and access networks can ensure that spatial data is interoperable not only within the marine environment but across the coastal zone, facilitating the design of a seamless SDI to improve decision-making and administration.

ACKNOWLEDGEMENTS

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Resolving Spatial Uncertainty in the Tidal Interface

Philip Collier and Nathan Daw Quadros

Abstract

The tidal interface or inter-tidal zone is that part of the coastal zone that falls between the extremes of Highest Astronomical Tide (HAT) and Lowest Astronomical Tide (LAT). It is an area of considerable interest and diverse human activity. The tidal interface possesses significant economic and commercial value while at the same time being a sensitive and delicately balanced environment. A number of competing and sometimes complementary rights, restrictions and responsibilities from private, public and commercial interests interact in the inter-tidal zone. The administration and governance of these interests in an equitable and sustainable manner is a complex and challenging task.

Virtually all activities in the tidal interface are spatially governed. More often than not, the defining boundaries relate to the line of intersection between a particular tidal datum and the land mass. For example, in Australia, freehold titles to coastal land parcels are limited in their seaward extent by the line of Mean High Water. On the other hand, government jurisdiction in the marine environment extends seaward from the line of Lowest Astronomical Tide. The difficulty with boundaries defined on the basis of tidal datums is that rigorous and consistent realisation of the line of intersection between a nominated tidal datum and the land mass is notoriously difficult, creating spatial uncertainty and the potential for conflict and dispute.

This paper describes and discusses the fundamental issue of dealing with spatial uncertainty in defining and realising boundaries which are linked to tidal datums. Some practical examples are presented to highlight the complexity of the problem. Having presented the background, a technical solution for realising the line of intersection between any given tidal datum and the land mass will be presented. Issues involved in implementing this solution will be described and its relevance and application to the development of a national marine cadastre will be discussed.

1. THE MARINE CADASTRE CONCEPT

The idea for a national marine cadastre stems from the broadly recognised need to improve administration and management of the marine environment from a spatial perspective. The marine cadastre aims to create a sustainable and equitable management system for spatially governed offshore rights, restrictions and responsibilities. In Australia, administration of offshore and coastal boundaries is shared by a complex mixture of federal, state and local government agencies, leading to overlapping jurisdictional responsibilities and considerable confusion for stakeholders. In response, a marine cadastre will provide a single, reliable and authoritative means for the delineation, management and administration of legally defined offshore boundaries at any scale.

The abundance and diversity of activity in the coastal zone and the complex nature of boundaries in the marine environment are illustrated in Figure 1. This figure demonstrates both the need for and the potential applications of a future marine cadastre.

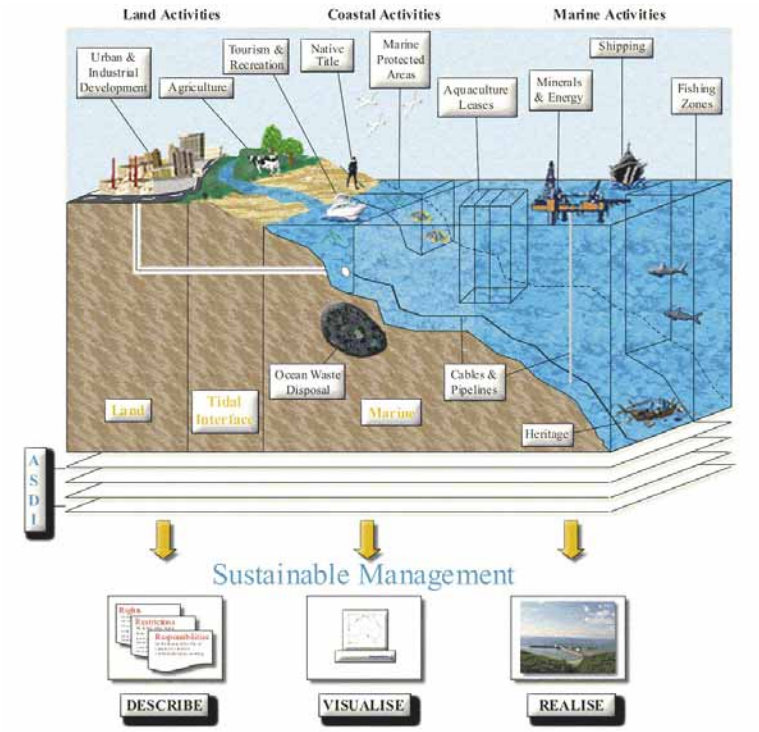

Figure 1: The Australian marine cadastre concept (Binns, 2003)

It is argued that a marine cadastre is vital to the long term sustainable management of Australia's marine environment. The nation's maritime jurisdiction is one of the largest in the world (16.1 million km^2). 85% of Australians live within 50 km of the coastline (ABS, 2004). In addition to supporting a wide range of recreational and public-good uses, Australia's marine environment generates a significant proportion of the nation's wealth, through shipping, fishing, aquaculture and natural resource extraction. It is vital to the national economy and the long-term sustainability of the ocean environment that this diverse mix of offshore activities is managed equitably.

The first marine cadastre research in Australia began in mid 2002 with the awarding of an Australian Research Council grant to a group of researchers from the University of Melbourne and committed industry and government partners. This project aimed to identify and define the main issues that will impact on the development of a future national marine cadastre. As a first step, the similarities and differences between the land cadastre and the marine cadastre were identified and considered (Binns, 2003). The features that distinguish the marine cadastre from the land cadastre were found to be (Collier, Leahy, Williamson 2001):

- The lack of *tenure* or ownership
- The inability to physically delineate boundaries
- The existence of three dimensional and sometimes four dimensional marine parcels
- The existence of overlapping rather than exclusive rights, restrictions and responsibilities
- The temporal nature of marine boundaries

At the same time as this research was being undertaken, a parallel research theme considered the *virtual* nature of offshore boundaries and addressed technical issues relating to spatial uncertainty in the realisation and visualisation of marine boundaries (Fraser et al., 2003).

A subsequent ARC grant took effect in mid 2004 and has allowed the research effort in marine cadastre issues to continue. The now expanded research team is pursuing objectives in four key areas covering a broad range of issues concerned with the implementation of Australia's marine cadastre. The four research areas are:

- The use of natural rather than artificial boundaries to define offshore jurisdictional limits
- The extension and application of the Australian Spatial Data Infrastructure to the marine environment
- Marine policy and security issues in relation to a marine cadastre
- Resolving issues in the definition of the tidal interface

The fourth of these research areas is the particular interest of the present authors and is the primary subject of this paper.

2. AMBIGUITY IN THE TIDAL INTERFACE

As shown in Figure 2, the tidal interface (otherwise known as the inter-tidal zone or foreshore) is that portion of the land mass that falls between the extremes of Highest Astronomical Tide (HAT) and Lowest Astronomical Tide (LAT). The horizontal width of this zone can vary dramatically, depending upon the steepness of the foreshore terrain and the magnitude of the tidal range. Where the foreshore slope is gradual and the tidal range is large, the inter-tidal zone can extend over a kilometre or more. If however the foreshore terrain is very steep, the lines of HAT and LAT can be practically coincident. In addition to showing the extremities of the tidal interface, Figure 2 also shows a number of other tidal datums that may be relevant in a marine cadastre, depending on the context and application at hand.

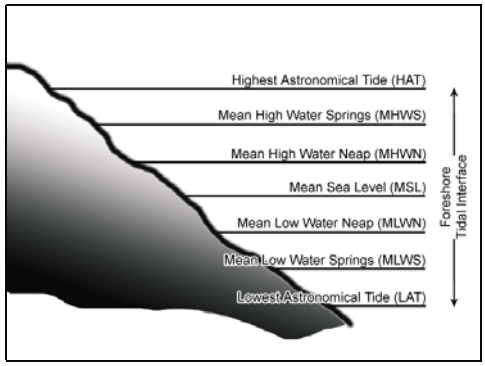

Figure 2: The Tidal Datums and the Tidal Interface

Coastal land parcels throughout Australia typically extend to the line of Mean High Water (Geoscience Australia, 2006), however international maritime boundaries defined under the United Nations Convention on the Law of the Sea (UNCLOS) are related to the line of LAT. The fact that, in Australia, different tidal datums are used to define different offshore (and onshore) boundaries has resulted in a number of different state and federal legislative definitions for the words such as *coastline* and *foreshore*. Typically, these terms are used to describe the line of intersection between a tidal datum and the terrain, but often no specific statement is made as to which tidal datum is being referred to. The words *coastline* and *foreshore* are therefore often shrouded in ambiguity from a spatial perspective.

The capacity to consistently and unambiguously realise the line of intersection between any nominated tidal plane and the land mass is a fundamental requirement of any marine cadastre. Wide ranging discussions at the national and international[1] level have clearly identified this as a research priority. It is widely agreed that only when a solution to this problem is found and implemented will it be possible to realise a functioning marine cadastre.

3. DEFINITION AND REALISATION ISSUES IN THE TIDAL INTERFACE

In Australia there is considerable inconsistency in terminology, particularly within legislative descriptions, when referring to the line of intersection of a tidal datum with the land mass. Definitions differ from one piece of legislation to the next and from jurisdiction to jurisdiction. By way of illustration, using four different Acts of Parliament from the state of Queensland, it can be seen from Table 1 that the definition of the word *foreshore* is by no means consistent. The first act refers to the *foreshore* as a single line on the tidal interface, whereas the others refer to it as being a region. Out of the three acts that refer to

[1] "Administering the Marine Environment – The Spatial Dimension" organised by the UN Permanent Committee on GIS Infrastructure for Asia and the Pacific (UN-PCGIAP), held in Kuala Lumpur in May 2004.
"International Workshop on Marine Cadastre Issues" jointly organised by the Fédération Internationale des Géomètres (International Federation of Surveyors) and the University of New Brunswick, held at the University of New Brunswick in September 2003.

the foreshore as a region, two use the term *spring tide*, whereas the other is less prescriptive. Though these differences may appear minor, the ambiguity and uncertainty that is introduced when attempting to realise them in a spatial context is a real barrier to the successful implementation of a marine cadastre.

Table 1: Definitions of the Foreshore in Queensland (Todd, 2003)

Legal Entity	Definition of Foreshore
Administrative Boundaries Terminology Act 1985 - Sect 5	The high-water mark along the foreshore, shore, coastline or similar feature;
Coastal Protection And Management Act 1995 - Schedule 2	The land lying between high water mark and low water mark as is ordinarily covered and uncovered by the flow and ebb of the tide at spring tides.
Fisheries Act 1994 - Sect 4	Parts of the banks, bed, reefs, shoals, shore and other land between high water and low water.
Queensland Consolidated Acts - Volume 1 - Sect 3	The land lying between high-water mark and low-water mark at ordinary spring tides.

In addition to uncertainties in definitions and terminology, there are also significant inaccuracies associated with historical techniques used to spatially realise tidal plane intersections. Using LAT as an example, in the southern areas of Australia, positional accuracy of the line of LAT is said to be in the order of ±100 m. In the northern parts of the country, where the tidal ranges are larger and the foreshore terrain is often very flat, accuracy of LAT determination is closer to ±500 m (Hirst et al., 1999). Such levels of inaccuracy obviously disqualify the use of such data for the delimitation of accurate maritime boundaries. Thus it is needful to develop more efficient and more accurate ways of determining tidal plane intersections to support the marine cadastre concept.

Historically, two techniques have been employed for mapping tidal extremities, conventional surveying and aerial photogrammetry. For example, in the past, surveyors would use conventional techniques to locate points marking the most recent high water peak. These points would then be connected to delineate the line of high tide. This procedure was slow and inefficient. More recently, and for reasons of improved efficiency, aerial photogrammetry has superseded conventional surveying techniques as the preferred method for identifying tidal limits (Graham, 2003). The photogrammetric technique utilises visual features such as vegetation lines, berm crests, beach scarps, high water line and the wet sand line to approximate tidal extremities (Pajak, 2000). These two methods, along with other techniques that rely on directly capturing the coastline from visual evidence, are susceptible to short term fluctuations in wave and tide conditions and the problem that the tidal peak may not coincide directly with the time of data capture.

4. A NEW APPROACH TO REALISATION

The implementation of a marine cadastre in a practical sense will ultimately need to include a consistent and rigorous methodology for the realisation of the line of intersection between any nominated tidal datum and the land mass. The research being conducted at the University of Melbourne is focused on achieving this objective. The fundamental premise behind the research is that the methodology to be developed should be completely rigorous and repeatable, but fundamentally transparent to the user. To this end, the proposed technique will be principally mathematical and computational rather than relying on the more traditional techniques of interpreting imagery (from whatever source) and survey data. Of course this is a rather ambitious objective, especially given the inconsistency that currently prevails in relation to legislative definitions and the practical limitations on data acquisition, however the implementation of a consistent approach is a fundamental pre-requisite if the marine cadastre is to progress from concept to reality.

This new approach – hereafter referred to as the *automated foreshore and tide intersection model* (AFTIM) – relies on two sources of information. The first is the existence of an accurate and comprehensive digital terrain model of the foreshore and near-shore bathymetry. The second is a digital tide model that will allow the height of any nominated tidal datum to be determined for a given location. By combining these two sources of information, it is then possible to compute the 3D line of intersection between the land and the tidal datum for a given coastal region. The concept described here is illustrated in Figure 3 which displays the line of Highest Astronomical Tide in the Sydney region computed using AFTIM.

Note: The highlighted region from the image above is shown to the right in 3D. The vertical scale is exaggerated to highlight the 3D nature of the image.

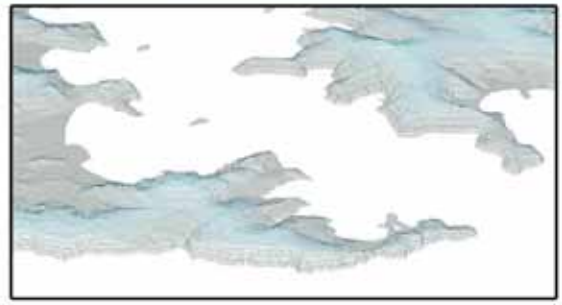

Figure 3: The line of HAT for the Sydney Harbour region, illustrating the concept of a computationally determined line of intersection between a tidal datum and the land mass

4.1 Requirement 1 – Foreshore terrain model

A number of options exist for acquiring terrain data from which a foreshore digital elevation model (that also includes near-shore bathymetry) could be generated. These include:

- Existing topographic maps and bathymetric charts
- Dedicated terrestrial and hydrographic surveys
- Aerial photogrammetry
- Synthetic aperture radar (SAR)
- High resolution satellite imagery
- Airborne laser scanning (ALS) or Laser induced detection and ranging (LIDAR) systems

The first three of these techniques are largely unsuitable in the context of the requirements for AFTIM either because they are either not suited to data collection on a national scale, they are of inadequate accuracy or they do not allow simultaneous acquisition of foreshore

terrain and bathymetry. The last three show some promise and will be discussed briefly below. Their potential as tools for acquiring terrain data in the inter-tidal zone arises particularly from their ability to *simultaneously* acquire both the shallow water bathymetry and the foreshore terrain.

The US National Geodetic Survey used SAR to complete shoreline mapping projects in Castle Bay and Resurrection Bay, Alaska using the satellite based RADARSAT system (Tuell, 1999). The direct acquisition of bathymetric data from SAR images is difficult, being complicated by the need to simultaneously collect data on wind speed, wind direction and surface water velocity (Robinson, 2004). This additional data can be used to correlate sea-surface roughness captured on the SAR image with bathymetric variations, but even still, it is difficult to obtain high accuracy bathymetric information. For this reason, alternative techniques have been sought.

High resolution satellite imagery provides another method for gathering foreshore terrain data. This method is based on the principle that the total reflected energy of electromagnetic waves from a water column varies with water depth (Leu and Chang, 2005). The drawback of this technique is that it also depends on the clarity of the water and the nature of the sea floor. Thus, regions with highly turbid water are not suitable for collecting bathymetric data using this method (Tripathi and Rao, 2002). For regions with low turbidity, supplementary data will need to be gathered on the sea floor, adding to the impracticality of using this method for gathering foreshore data for the AFTIM.

LIDAR is the most promising alternative for gathering foreshore terrain data as it directly measures the bathymetry. It has the advantage that it can penetrate clear water up to depths of 60 m (Wozencroft, 2003), which is more than adequate to map the land mass beyond the depth of LAT. Because of its high data acquisition rate and vertical accuracy, airborne LIDAR systems provide a very efficient tool for localised coastline mapping. However, for large scale (regional or national) applications a space borne LIDAR platform would be required in order to achieve adequate coastal coverage. Until such a platform exists airborne LIDAR will be required to collect data along sections of the coastline. The US Army Corps of Engineers investigated the use of airborne LIDAR to measure the impact of coastline sediment deposition in southern California, Florida and along the Lake Michigan shoreline (Wozencraft, 2003). The study confirmed the validity of LIDAR as a suitable tool for rapidly and accurately measuring coastal elevations on a local scale. Preliminary studies conducted by the authors using LIDAR data collected along a short section of the Queensland coast have further demonstrated the applicability of LIDAR for collecting foreshore terrain data.

4.2 Requirement 2 – Digital tide model

The second requirement for the AFTIM is the ability to accurately realise the height of any nominated tidal datum at any coastal location. Again, this is a complex and demanding requirement if an appropriate level of accuracy, consistency and coverage is to be achieved on a national scale. Below is a discussion of options and issues to be considered in the context of tidal datum generation for a marine cadastre.

One option for tidal datum modelling is to use an array of tide gauges to acquire the necessary tide height data. However, as shown in Figure 4, for a country as vast as Australia, the existing *permanent* tide gauge network is simply not sufficiently dense for this purpose. Thus the development of a comprehensive tidal model will generally require the installation of temporary tide gauges, which is a costly, time consuming and labour intensive exercise. The time consuming nature of the task is exacerbated by the fact that a full tidal cycle occurs only once every 18.6 years.

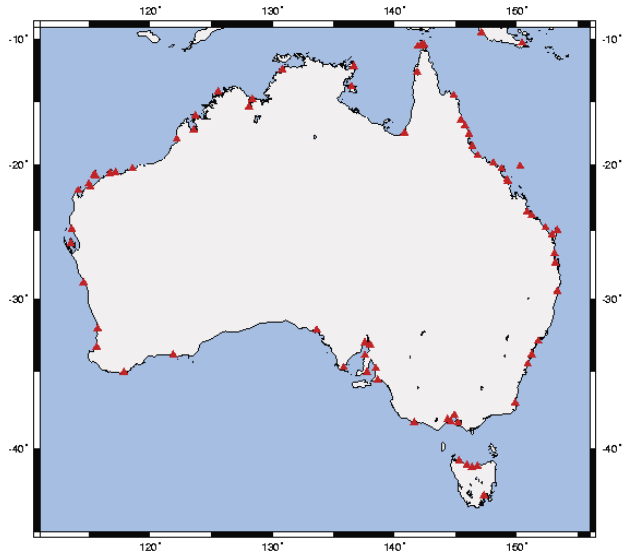

Figure 4 : Australian Tide Gauge Locations (National Tide Centre, 2006)

Notwithstanding the difficulties in acquiring appropriately dense tide gauge data, simple tidal models can be developed by linearly interpolating tide heights between tide gauges. However this technique is only adequate for straight sections of coastline. Where the coastal topography is non-linear, the tidal regime becomes more complex and simple interpolation between tide gauges is inadequate for accurately predicting tidal behaviour.

A more sophisticated approach to tidal modelling involves the computation and refinement of the harmonic constituents of a pre-defined global tide model. This process effectively "tunes" the harmonic constituents to local tide conditions by reference to data acquired from tide gauges specifically installed for the purpose. Of necessity, such an approach can only be applied on a local or perhaps regional scale, simply because of the requirement to install and maintain a network of temporary tide gauges for a considerable period of time.

Harmonic analysis is the process of decomposing a complex wave form into a series of sinusoidal components at particular frequencies. In the case of tidal modelling, harmonic analysis is used to isolate the separate astronomical effects that contribute to the overall tidal signature. Typically, least-squares estimation is used to calculate the amplitude and phase contribution of each constituent.

As shown in equation (1), the magnitude (height) of a particular tidal constituent at a given time and location is a function of the amplitude, frequency and phase of the contributing force (e.g. the declination of the moon). The phase is able to account for location by shifting the tidal frequency in time.

$$h(t) = A\cos(2\pi ft - \vartheta) \qquad \ldots(1)$$

where ;

h is the height (magnitude) of a tidal constituent
t is the time
A is the amplitude of the contributing force
f is the frequency of the force
ϑ is the phase

To find the total tide height (H) at a specified time (t) requires that the contribution of each constituent be combined, as expressed in equation (2).

$$H(t) = h_0 + \sum_{i=1}^{n} A_i \cos(2\pi f_i t - \vartheta_i) \qquad \ldots(2)$$

where;

h_0 is the height of mean sea level relative to the local geodetic height datum
i is the relevant tidal constituent (see Table 2 for definitions)

Expressing equation (2) in an explicit form as the sum of the major tidal constituents gives :

$$H(t) = h_0 + M_2 + S_2 + N_2 + K_1 + O_1 + M_4 + M_6 + S_4 + MS_4 \qquad \ldots(3)$$

A definition for each tidal constituent is given in Table 2.

Table 2 : Major Tidal Constituents (Boon, 2004)

Tidal Constituent		Definition	Frequency (degrees/mean solar hour)
h_1	M_2	Principal lunar semidiurnal	28.984
h_2	S_2	Principal solar semidiurnal	30.000
h_3	N_2	Larger lunar elliptic semidiurnal	28.44
h_4	K_1	Luni-solar declinational diurnal	15.041
h_5	O_1	Lunar declinational diurnal	13.943
h_6	M_4	First overtide of M_2	2 x M_2
h_7	M_6	Second overtide of M_2	3 x M_2
h_8	S_4	First overtide of S_2	2 x S_2
h_9	MS_4	A compound tide of M_2 and S_2	$M_2 + S_2$

The first five constituents listed in Table 2 combine to give a significant proportion of the total tidal signature in most locations. The next three are *shallow-water tides*, which, as can be seen, have frequencies which are an exact multiple of the frequency of the parent tides. The MS_4 constituent is an example of a *compound tide* which results from the interaction of two parent waves (M_2 and S_2). While there are other tidal constituents (particularly other shallow-water and compound tides) that could be included in Table 2, those listed account for major part of the tidal regime in most locations (Boon, 2004).

5. ISSUES IN IMPLEMENTING AFTIM

There is a compelling need to rationalise and unify legislative definitions for the *coastline*. While the term typically (though not uniformly) refers to the intersection of a tidal datum with the foreshore terrain, there is often ambiguity or uncertainty about which tidal datum is in view. Solution to this problem can only come through re-drafting and amendment of the relevant legislation. Obviously such a process will take considerable time and requires a will for consistency between state and federal jurisdictions. This may take place in due course and with appropriate lobbying of government, but in the meantime the proposed AFTIM can provide users of the marine cadastre with the flexibility to realise the line of intersection of any nominated tidal datum with the foreshore terrain.

Acquisition of data for the formation of a foreshore terrain model and the computation of a suitably accurate and comprehensive digital tide model represent significant challenges to the practical implementation of the AFTIM proposed above. However, it is argued that both of these difficulties will be overcome with time and planning and with improvements in relevant data acquisition technologies. In the meantime, existing foreshore terrain data and new terrain data acquired on a project by project basis can be used to develop localised foreshore terrain models wherever such data exists. While being less than ideal in terms of

coverage, consistency, accuracy and extent, such an approach will allow early implementation and testing of the AFTIM. Likewise, existing tidal models and localised tide gauge information can be used in the early stages of AFTIM development while pending the computation of more sophisticated and extensive tidal models. Because a substantial period of time is required to collect sufficient tide data to model the full range of tidal behaviour, it will be necessary to institute programs for the collection of tidal data as a matter of priority. In the meantime, using existing terrain and tidal data will permit the approach to be implemented for testing purposes at a local scale and will allow implications for the marine cadastre to be identified and further investigated.

Perhaps the biggest challenge to fully realising the potential of AFTIM lies in the need to develop a solution that works nationally and at any scale. While it is possible within the confines of a research project to prove the concept in a local or even a regional context, the ultimate compilation of suitable national data sets for foreshore and tidal modelling will fall to government authorities. Of course priority can and should be given in this process to coastal areas of high property value and high levels of marine activity, such as Sydney Harbour and Port Phillip Bay.

A further issue in implementing AFTIM for marine cadastre purposes is the need to account for dynamic changes in the marine environment that necessitate re-computation of the line of intersection between a specified tidal datum and the foreshore terrain. Examples of such change include erosion and accretion of the foreshore which may occur naturally or as a result of human activity. In either case, changes in foreshore terrain imply the need to re-determine the location of the intersection of the tidal datum. Again, viewing the situation from a practical perspective, the only viable way to account for dynamic foreshore terrain variations in the short or long term is by regular re-acquisition of the relevant terrain data. In reality, routine, low-cost data collection will only be possible using space borne data collection systems of the future and a routine procedure for upgrading and maintaining the foreshore terrain model.

A similar situation, though less dynamic, is the requirement to account for changes in tidal extremities. An obvious cause will be sea level rise resulting from global warming. A recent article published in the Sydney Sun-Herald showed an inundation map for the Sydney basin resulting from projected future sea level rises. While such changes are expected to occur over very long time frames, they nonetheless need to be considered if a marine cadastre that shows tidal extremities is to be up to date and reflective of the true nature of the coastal environment.

In discussing the dynamic nature of the marine environment and in particular temporal variations in terrain and tidal extremes, a legal question arises that needs further consideration. Suppose an offshore boundary has been defined as a line parallel to the line of intersection of LAT with the foreshore. The question is: will that boundary move if the line of LAT moves as a result of foreshore erosion or accretion? This question of fixed and temporal maritime boundaries needs to be addressed by those experts in the interpretation of legislation and other legal instruments under which offshore boundaries are proclaimed.

6. IMPLEMENTATION OF AFTIM INTO THE MARINE CADASTRE

A marine cadastre will provide users with access to a single, definitive source of accurate and up to date spatial information relating to the location of legally defined offshore boundaries and the rights, restrictions and responsibilities associated with those boundaries. For example, the captain of a commercial fishing vessel may need to know where the geographical limits of a particular fishing zone are, at what times of the year fishing is permitted, what limitations apply to fishing procedures within that zone and to whom licence fees are payable. A marine cadastre could provide all this information instantaneously and in an on-line manner while the vessel is approaching the fishing area. At the same time, a recreational diver may search the marine cadastre for the location of a restricted area within the previously mentioned fishing zone, associated with a submerged shipwreck. Again rules governing access to the wreck and other relevant spatial information could be provided as part of such a query of the marine cadastre. Many other examples of applications of the marine cadastre could be outlined. However, most individuals, organisations and authorities with an interest in the marine environment readily recognise the potential benefits of such a system.

Of particular interest in the context of the proposal outlined in this paper is how the AFTIM concept can be implemented within a marine cadastre to further enhance its function and operation. Tidal datum intersections with foreshore terrain form the basis for the delineation of many offshore (and some onshore) boundaries. The AFTIM offers the ability to consistently and routinely delineate this most fundamental boundary. Its value will be particularly seen in the case of dealing with the ambulatory nature of the *coastline* in the event that boundaries are likewise regarded as ambulatory.

7. CONCLUSIONS

Historical techniques for delineating the line of intersection between a tidal datum and the foreshore terrain are labour intensive and largely unsatisfactory in the context of developing a marine cadastre. Recent technological developments provide the means to generate an appropriately accurate and high resolution foreshore terrain model and digital tidal model. A mathematical solution (called AFTIM) makes it possible to generate the line of intersection using two surface models and will provide a more rigorous and comprehensive solution for removing spatial uncertainty in the tidal interface.

ACKNOWLEDGEMENTS

The work summarised in this paper has been conducted with support from the Australian Research Council, under the Linkage-Projects Scheme (Grant number LP 0453866). The support of the following industry partners is also acknowledged : Land Information New Zealand; Department of Sustainability and Environment, Victoria; Department of Lands, NSW; Department of Land Information, WA.

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A National Geocentric Datum and the Administration of Marine Spaces in Malaysia[2]

CheeHai TEO[3] and Ahmad FAUZI[4]

Abstract

Malaysia is a country with two primary land masses, Peninsular Malaysia and East Malaysia (on the northern part of the island of Borneo). The country has a total land mass of approximately 330,000 square kilometers and 4320 kilometres of coastlines. The marine spaces within its jurisdiction are approximately 574,000 square kilometers. Approximately 30 percent of these spaces are under State jurisdiction. Administering and managing Malaysia's marine spaces across the extent of the country represents a challenge for both surveyors and administrators. A national geocentric datum was adopted in 2002 which, among others, united Peninsular Malaysia and East Malaysia under a single national mapping datum. Prior to the adoption, the country embraces two separate mapping datum. This paper will , to a certain extent, discuss the derivation and features of the national geocentric datum and attempt to outline additional challenges towards the development of an appropriate marine administration (cadastre) system for Malaysia.

1. INTRODUCTION

Malaysia is a country with two primary land masses, Peninsular Malaysia and East Malaysia (on the northern part of the island of Borneo). The country has a total land mass of approximately 330,000 square kilometers and 4320 kilometres of coastlines. These land masses support a population of 25 million. The country also enjoys the distinction of having the southern most tip of the Asian continent at Tanjung Piai, the southern most tip of Peninsular Malaysia. Malaysians refer to their homeland as "tanah-air", literally translated to mean "land and water (*or sea*)". This concept of land/water continuity exists since the country's recorded history. The need to administer and manage both land and marine spaces are thus not an alien concept. Malaysia is part of the South East Asian Region and a founding member of the Association of South East Asian Nations (ASEAN). The country has terrestrial borders with Thailand, Brunei Darussalam and Indonesia and has maritime borders with Thailand, Brunei Darussalam, Singapore, Indonesia, Vietnam and the Philippines.

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2 *This paper does not necessary represent the position of the Ministry of Natural Resources and Environment Malaysia, the Department of Survey and Mapping Malaysia, the Land Surveyors Board Peninsular Malaysia, the Institution of Surveyors Malaysian or the Association of Authorized Land Surveyors Malaysia*

3 *Licensed Surveyor, Malaysia*

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1.1 System of Government

Malaysia's system of government is similar to that of the British, but modified because Malaysia is a Federation of 13 states and 3 Federal Territories. The government is based on a bicameral parliamentary system, headed by a Prime Minister.

The Federal Government has jurisdiction, among others, over external (foreign) affairs, defence, internal security, shipping, navigation, fisheries, ports and harbours whilst the State Government has jurisdiction, among others, *land and its administration*, agriculture, forestry and mining.

1.2 National Marine Spaces

The National Marine Spaces comprise of the following

- Territorial Seas
  the belt of seas measured 12 nautical miles seaward of the territorial sea baseline
- Contiguous Zone
  the belt of seas, contiguous to the territorial sea, measured 24 nautical miles seaward from the territorial sea baseline
- Exclusive Economic Zone
  the area beyond and adjacent to the territorial sea, measured 200 nautical miles seaward of the territorial sea baseline
- Continental Shelf
  the area beyond and adjacent to the EEZ, measured to a limit (usually 350 nautical miles from territorial sea baseline) where a physical continental shelf exists beyond the 200nm limit.

Figure 1: Peninsular and East Malaysia

Figure 2: Malaysia and its South East Asian Neighbours

1.3 Administrative Constraints

Jurisdiction over marine spaces and management responsibilities are split between the State and Federal Governments. The marine spaces within Malaysia's jurisdiction are approximately 574,000 square kilometers. Within this space are more than 600 islands, few have yet to be named.

The State effectively control up to 3 nautical miles from the low water mark whilst the Federal Government has jurisdiction and management from that point to the outer edge of the EEZ and the Continental Shelf.

As a result, the eventual areas of jurisdiction that would fall under the State and Federal Governments are respectively as follows:

State Jurisdiction (Coastal Waters - 3nm offshore)
- Peninsular Malaysia 17950 sq km
- East Malaysia 20250 sq km

Federal Jurisdiction (Territorial Waters - *12nm offshore*)
- Peninsular Malaysia 38800 sq km
- East Malaysia 20300 sq km

These areas (only territorial seas) already represent approximately 30% of Malaysia's land mass.

1.4 Value of Marine Spaces

Within this Marine Spaces are many and at times, competing, uses and these uses include:

- Sources of food from animals, plants and fishes
- Means of transportation and communication
- Areas for development
- Areas for recreation
- Areas for dumping of waste
- Areas for scientific research
- Areas for mineral and hydrocarbon extraction

Figure 3: Aquaculture

Figure 4: Coastal Communities

Figure 5: Typical Coastal Marine Ecosystem

Figure 6: Recreational Spaces

Figure 7: Coastal Built Environment

2. CHALLENGES

In the administration of these marine spaces in Malaysia, the construction of a system to administer marine spaces should incorporate a "seamless onshore-offshore" objective. The importance of spatial and textual continuity traversing land-water interface is to obtain coherence of, among others - the register of interests, the unique parcel identifiers, the cadastral survey system, and the cadastral map, based on common national (sometimes international) coordinate system. [*Hoogsteden and Robertson, 1998, 1999*]

To promote continuity of land/water (sea) interface, it is argued that the technical components of marine and land administration system should be similar or at the very least, closely linked. This poses certain challenges, among others:

- *Geodetic Reference Framework*
  - different state and local geodetic systems
  - definition of vertical datum (the use of chart datum has always been a source of much confusion)
  - not possible to place monuments in marine space
- *Determination of base points*
  - Determination of base points and baselines in accordance to UNCLOS 1982 and consequently the various maritime zones
- *Scale of Base Maps*
  - Maps are the primary medium for the location of parcels. There are issues of data sources, data contents and data accuracy.
- *Records of Interest*
  - Recording interest within a water column (3D) with a temporal (t) component

It has been recognised that a consistent spatial data infrastructure is necessary whereby the rights, restrictions and responsibilities are administered and managed effectively within the marine spaces, similar to that which has been carried out within the landed environment.

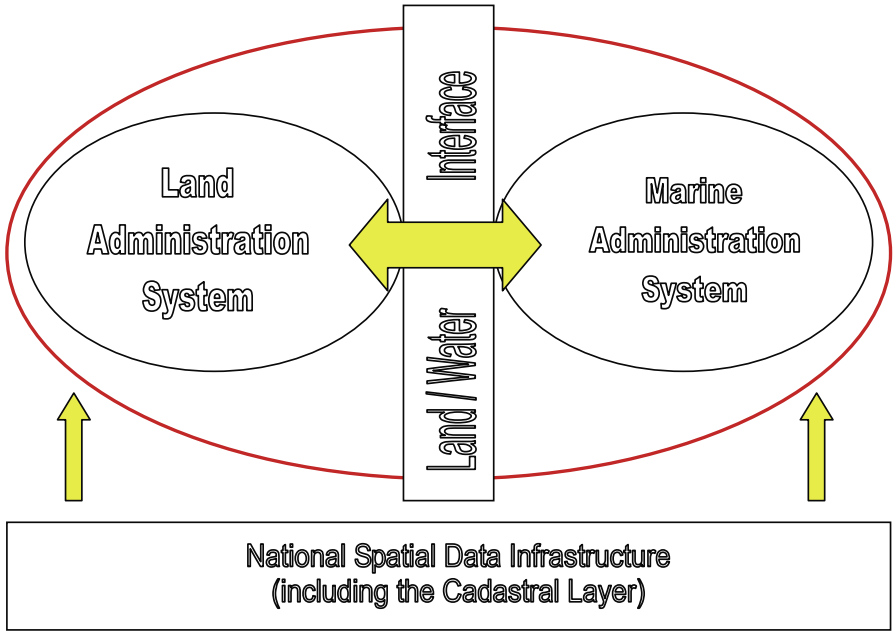

Figure 9: Land and Sea Interface[5]

[5] International Workshop for Administering the Marine Environment, Kuala Lumpur, April 2004

3. NATIONAL GEOCENTRIC DATUM (GDM 2000)

3.1 Background

National Geodetic Framework supports national development, the national economy and security of tenure within the land market. The drive for a modern, digital era friendly geodetic framework in Malaysia arises from, amongst others, the -

- Increasing use of GPS for various applications has revealed shortcomings in the existing Malaysian local datums
- Unified coordinate system referenced to a universally adopted datum is needed to accommodate needs of efficient acquisition and use of digital spatial data
- Homogeneous geodetic infrastructure would provide appropriate framework for the integration of spatial data for decision making
- The realization of the value of a homogeneous national spatial data infrastructure and the growing prominence of spatial sciences industry.

Historically, Malaysian geodetic datums has been established since 19th century using conventional surveying techniques and procedures and -

- Local datums are not aligned with global geocentric coordinates frames.
- Existing datum is not compatible with the wide spread use of modern positioning systems and international recommendations.
- Survey accuracy often degraded because of approximate coordinate transformation procedures.

The geodetic reference frame to define the Malaysian geocentric datum was realized through a set of permanent GPS stations termed the Malaysian Active GPS Stations (MASS) defined in the International Terrestrial Reference Frame (ITRF). For that purpose, long baseline connections between the MASS stations to IGS stations in the region were made. In deriving the National Geocentric Datum,

- Malaysia operated and still operating 17 MASS stations continuously (since 1998); 10 in Peninsular Malaysia and the rest in Sabah and Sarawak (East Malaysia).
- In establishing connections to IGS stations, 11 of the IGS have been used.
- GPS data from all those stations have been processed together to determine MASS station coordinates in the ITRS reference frame.
- 4 years of GPS data from all MASS stations have been utilized in the processing.
- Eventually, a highly accurate and consistent 3-D geocentric coordinates for the 17 MASS stations have been able to be determined and they define the Malaysian geocentric datum.
- Those coordinates are based in the ITRF 2000 at epoch 2nd January 2000 and accuracy of the coordinates is at 1 cm level.

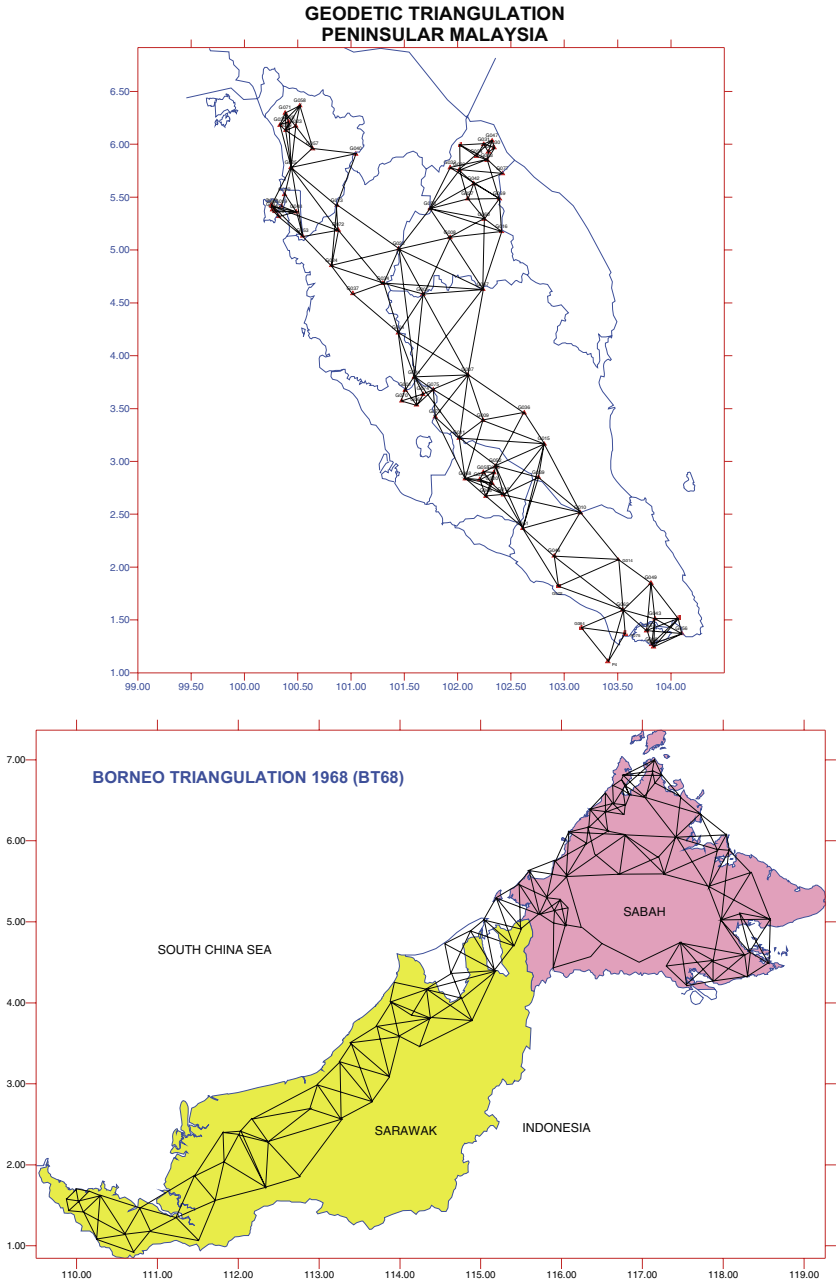

Figure 10: Triangulation Networks: Peninsular Malaysia and East Malaysia[6]

6 Provided by the Department of Survey and Mapping Malaysia

3.2 Derivation of GDM 2000

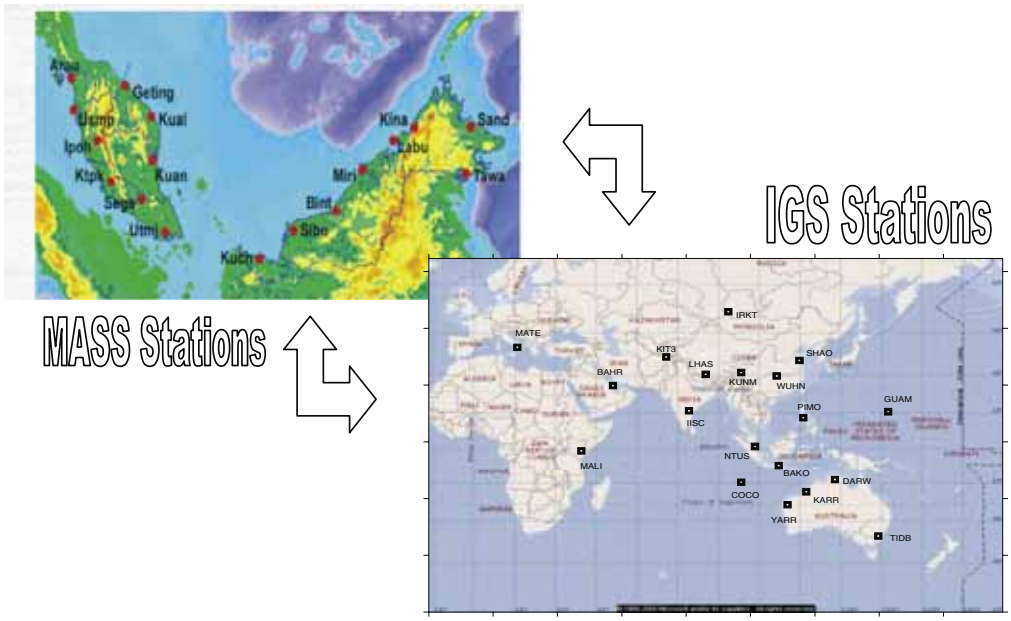

Figure 11: Permanent GPS Stations Utilised in the Derivation of GDM 2000

3.3 Features of GDM 2000

GDM 2000 is defined by the coordinates of the seventeen (17) MASS stations. They are referred to the following parameters for the GRS 80 ellipsoid and within ITRF 2000 at epoch 2nd January 2000. The salient features of the National Geocentric Datum (GDM 2000) are:

- Defined by the coordinates of seventeen (17) MASS stations.
- Referred to the following parameters:
  a = 6,378,137 meters
  1/f = 298.257222101

Figure 12: Malaysia Active GPS Stations (MASS)

The Geocentric Datum of Malaysia (GDM 2000) will provide a single standard for collecting, storing and applying spatial data at all levels – local, regional, national and international. It will facilitate the creation of an integrated national spatial data infrastructure for Malaysia considering that the country has two primary land masses and approximately 600 islands.

4. SIGNIFICANCE OF GDM 2000

The National Geocentric Datum (GDM 2000) is able to unify the various geodetic datums that were in use with reference to a geocentric reference frame defined in the ITRF system. Adoption of geocentric datum made datum unification between East and West Malaysia a reality. GDM 2000 forms the backbone for the national adjustment of all existing GPS control stations to bring all coordinates into the ITRF system.

It also herald a new era where a high accuracy, homogeneous and up-to-date datum is available for the nation, realizing that the geodetic reference frame supports a myriad of national agenda including national security, security of land tenure and security and sustainability of the land market and the built environment. GDM 2000 also provides for Malaysia an internationally compatible system for all spatial data.

The significance of GDM 2000 is not lost within the realm Marine Spaces Administration as it allows common geo-referencing of spatial data, promotes homogeneity in spatial data and will facilitate data integration and spatial analyses for decision making.

5. CONCLUSION

Most countries have a land administration system that operated as separate entities from their marine administration system. This causes management gaps at the coastal zone. The idea of having a seamless spatial data administration system that includes the marine and terrestrial environments has been well accepted.7

This is evident at the conclusion of the International Workshop for Administering the Marine Environment held in Kuala Lumpur in April 2004 which recommended that a marine dimension be added to all coastal countries national SDI in the Asia Pacific region. The development of an appropriate seamless SDI would certainly help in the integration of the two systems. Consequently, the development of a seamless SDI that includes data from land, coast and marine environments will enable the access and sharing of data between those environments to be improved.

While the country's administrators look into how best to effectively administer her marine spaces, some of the technical (spatial) challenges have been overcome by the adoption of the National Geocentric Datum (GDM 2000) introduced by the Department of Survey and Mapping Malaysia in 2002.

[7] International Workshop for Administering the Marine Environment, Kuala Lumpur, April 2004

Governing the North Sea in the Netherlands

Michael Barry, Ina Elema and Paul van der Molen

Abstract

There has been increasing interest in ocean governance and the concept of the marine cadastre recently. This is due to increasing pressure on the oceans, and the resulting tension between economic and environmental interests. A description and analysis of governance of the Netherlands North Sea contributes to this debate for a number of reasons. Commercial demands on the North Sea are intense. Shipping routes are very busy. The Netherlands is a major producer of natural gas. Naval conflicts and disputes over fishing rights involving the Netherlands date back more than 400 years. The Netherlands is hemmed in by neighbouring countries on land and at sea, and the activities in the North Sea of one country in the region can have a significant impact on the ocean environment in the other countries. There is a need to govern the pollution and alien biological organisms that the rivers flowing into the North Sea carry into the ocean. Due to these pressures, since spring 2006 the Netherlands has included the North Sea as an integral part of the country in their national spatial planning policy. Recently, reflecting a more holistic approach, the European Commission introduced the Green Paper on Maritime Policy for Seas and Oceans which advocates a European approach to North Sea management and governance.

1. INTRODUCTION

There is a long history of attempts to acquire and formalise exclusive and restrictive rights to particular areas of the ocean and its resources by means of proclamations, laws, treaties and naval force. Claims, disputes, laws and treaties over navigation, fishing and trading can be traced back through the histories of various European nations to the island of Rhodes in the ancient Greek world (Guy 2000).

As competition for and scarcity of ocean resources and usage rights increases, so too do the tensions between the desire to retain the sea as a pristine environment, the desire to harvest economic resources and the desire to use it as a waste disposal site (Carr 1998, Hoogsteden 2001). There is increasing concern over access and usage of the ocean as a result of a number of factors such as technological advances in mining and fishing, and the many harmful environmental impacts associated with these activities. There are continual incidents of pollution. Poaching and over fishing have endangered certain biological species. Moreover, certain species are being exploited commercially, even though we have insufficient scientific knowledge to estimate what are sustainable levels of exploitation.

Developments in the international law of the sea have encouraged nations to extend their areas of sovereignty in order to protect, manage and exploit the ocean environment and resources. In some cases this involves a substantial area. For example, New Zealand's exclusive economic zone amounts to more than 15 times that country's land area.

Consequently, there has been an increase in negotiations over ocean boundaries between nations.

The tensions concerning rights of access, usage and possession of the ocean and the concomitant obligations pertaining thereto are similar to those pertaining to land. Grant and Williamson observe that modern ecological thinking draws on hunter-gatherer land tenure philosophies. These populations "could not conceive of their territory in terms of the separation of water and other resources from the land, anymore than they saw trees as distinct from their roots" (Grant and Williamson 1999). To these communities, ownership of a parcel of land is a foreign, if not objectionable, concept. In contrast, Carr (1998) argues that largely due to unsustainable exploitation practices in the oceans, hunter-gatherer philosophies are impractical. Administration of rights of access and usage of the ocean should mirror those on the land, with parcels, owners, laws and limits. Arguably, it is this latter school of thought that is driving the current interest in the notion of a marine cadastre.

Management and governance of the oceans have become increasingly important in modern times. The question of ocean governance, ocean tenure, boundaries, and the notion of the marine cadastre to support ocean governance, have recently been the subject of a number of research projects in Australia (e.g. Grant and Williamson 1999, Collier *et al* 2000), Canada (e.g. Nichols *et al* 2000, Ng'anga *et al* 2001), (New Zealand e.g. Robertson *et al* 1999, Hoogsteden 2001), South Africa (e.g. Rommelaere 1983, Watermeyer 2001, Wonnacott 2001) and the USA (e.g. Fowler and Treml 2001).

By management we mean the development of overarching systems of philosophy and values, the formulation of policy and strategy, and the implementation of strategy. Governance overlaps management to an extent, as both involve promulgating legislation, but governance is more directed toward setting the parameters and rules of conduct for managing a complex situation (Commission on Global Governance 1994, Centre for Governance 2000). Governance is aimed at accommodating conflicting, diverse interests and galvanising cooperative action.

Extending the operational definitions of Nichols *et al* (2000) and Robertson *et al* (1999), ocean governance involves the following activities:

- adjudication, definition and allocation of rights, interests and stewardship over the sea and its resources;
- monitoring, information gathering and management of the information infrastructure relating to the above;
- regulation of allocated rights, interests and stewardship and the allocation processes and structures;
- policing and enforcement; and
- management of conflict.

The structure and culture of a governance system and its various sub-systems are shaped by a number of forces. Culture reflects the philosophy and values embodied in how the rules of the game are formulated, and the manner in which things are done. Structure is reflected in the institutional structure, the power and mandates vested in different institutions and individuals (who does what?), and enabling policy and legislation. Broadly

categorised, these forces fall into the social, economic, political, physical, technological and legal milieu. Historical influences tend to be strong across these classifications (Barry and Fourie 2002). However, our interest is in how instruments, processes and structures that influence day-to-day administrative practices develop. In our observation, three forces shape these:

1. Directory and peremptory instruments - e.g. policies, treaties, laws, edicts, decrees, regulations and proclamations;
2. Dialectic processes – continual cycles of reconciliation, reconstruction and synthesis resulting from criticism, contradictions, conflicts and compromises pertaining to the status quo; and
3. Ad hoc policies and strategies – responses to unforeseen situations arising for which incisive, formal directives do not exist.

A description and analysis of ocean governance in the Netherlands can inform the debate on ocean governance and the marine cadastre. There is a long history of intense conflict and competition in the North Sea. Underlying this dialectic is the political geography of the Netherlands. Unlike the nations referred to earlier where the marine cadastre is a subject of research, and neighbouring states influence a very small part of their coastline and ocean territory, the Netherlands is hemmed in by adjacent and opposite countries.

Figure 1: North Sea Catchment Area

The activities of the Netherlands' neighbours have a strong influence on its part of the ocean. The relatively small area of the North Sea over which the Netherlands has sovereignty is surrounded by England, Belgium and Germany. Other European states are in close proximity and many of them have parts that fall in the North Sea catchment area. And, unlike nations such as Australia and the USA mentioned earlier, competition for rights and access to the Netherlands' North Sea has been intense. This competition dates back more than 400 years.

The primary influences in the international law of the sea are occidental (Guy 2000). Much of this has been shaped by Netherlands experience and authoritative legal writings such as Grotius' Mare Liberum.

Moreover, due to the number of nations that border on the North Sea or fall in the catchment area for rivers running into the North Sea, there is a far greater need for a regional management focus than in many other regions of the globe.

We briefly describe relevant aspects of the Law of the Sea. Then we describe the history of conflict in the oceans, the competing demands on the North Sea in the Netherlands and the regional system of governance of the North Sea. Subsequently we describe the institutions

and processes in the Netherlands which govern the Netherlands EEZ and the information systems that are being used and developed to support planning, policy formulation and day to day operations management. Finally we analyse the case of ocean governance and the marine cadastre in the Netherlands in relation to what has been discussed above.

2. LAW OF THE SEA

Recent developments in the international law of the sea have prompted many nations to define their maritime limits and negotiate their maritime boundaries. In terms of the United Nations Convention on the Law of the Sea (UNCLOS), territorial waters may extend up to 12 nautical miles (nm) away from the baselines that, in general, are representations of the low water line (UNCLOS art. 2, 3, 5). A baseline is a natural ambulatory line. This means, every time the position of the baseline is changed in nautical charts due to natural or human causes, the limits which are based on it change too.

The contiguous zone is the area seaward of the territorial zone up to a limit of 24 nm from the baseline. The coastal state may exercise control in this zone to prevent infringement of its law and regulations. The contiguous zone is not an automatic right conferred on a state and it has to be claimed. The Netherlands is in the process of establishing a contiguous zone.

Moreover, a nation may lay claim to an Exclusive Economic Zone (EEZ), beyond and adjacent to the territorial sea extending up to 200 nm from the baselines used to establish the territorial sea. In the EEZ, a coastal State has sovereign rights to explore and exploit, conserve and manage the natural resources and conduct other activities for the economic exploitation and exploration of the zone. Examples of “other activities” are the production of energy from the water, currents and winds (UNCLOS art. 56, 57). Resources include mobile and sedentary species and renewable and non-renewable resources (Guy 2000). In essence, rights to the resources belong to the coastal State, but all other States enjoy the freedoms of navigation and communication (United Nations 1976, Guy 2000). The Netherlands claimed an EEZ in 2000.

The continental shelf contains the sea-bed and subsoil of the submarine areas that extend beyond the territorial sea. It excludes super adjacent waters as well as the fish in these waters. The coastal state has sovereign rights for exploration and exploitation of the natural resources of the sea-bed and subsoil, including mineral and other non-living resources and living organisms belonging to sedentary species. Other states may lay submarine cables and pipelines on the continental shelf. The coastal state has the right to delineate the course of such cables and pipes. The continental shelf can extend beyond 200 nm in case the natural margin is situated more than 200 nm from the baseline. Article 76 of UNCLOS sets out the conditions under which a coastal state may be entitled to claim an extended continental shelf beyond 200 nm from the baseline. In the most complex situations, the outer limits of the extended continental shelf can be defined by a combination of lines, which are derived from geophysical, hydrographic and geomorphologic data. Worldwide, a number of countries are conducting surveys in order to claim a continental shelf which extends beyond 200 nm from the baseline.

Adjudicating and positioning maritime boundaries with other countries could involve a number of technical problems. For example, nations could use different definitions for their chart datum. The low water line (baseline, which is used in boundary computations) is dependent on the chart datum. Until recently, many different graphical and mathematical models were used to determine offshore boundaries. The median line is in most cases the starting point in maritime boundary negotiations. Inaccuracies in baseline positions and effects of the geometry of baseline configurations are propagated into the precision of computed boundaries (Wonnacott 2001, Guy 2000, Elema and de Jong 2001, Watermeyer 2001, Rommelaere 1983). The final ratified boundary may be moved off a median line when political and equity considerations are taken into account.

3. HISTORY OF CONFLICT OVER THE OCEANS

There is a long history of competition and conflict relating to access and usage of the ocean for trade and fishing in the Netherlands. The modern doctrine of freedom of the seas, and the right of innocent passage, has largely been attributed to the Dutch jurist Hugo Grotius' *Mare Liberum* and English and Dutch naval campaigns against the Spanish and Portuguese. The *Mare Liberum* was published anonymously in 1608, during the 80 years war between present day Netherlands and Spain. It was written in response to the Treaty of Tordesillas of 1494 and papal edicts by Alexander VI (*Inter Caetera,* 4 May 1493) and Julius II (*Ea Quae*, 24 January 1493). These awarded the western part of the Atlantic Ocean to Spain and the remainder of the Atlantic Ocean and the whole of the Indian Ocean to Portugal (Guy 2000 citing van der Linden 1916). However, the legitimacy of these attempts to grab ownership of the oceans had also been challenged by naval force. The *Mare Liberum* was preceded by naval conflicts between the Spanish empire (which included present day Portugal) and the English and Dutch in the latter half of the 16th century. Moreover, English and Dutch mariners raided and plundered Spanish and Portuguese merchant ships in various parts of the globe.

There is also a long history of attempts to govern fishing and access to natural resources in the North Sea. For example, in 1609 James I of England issued a proclamation directed at the Dutch herring fleets, which attempted to place a levy on foreign fishing in English waters (Guy 2000). This tension over rights and access to fishing in the North Sea continues today.

4. COMPETING DEMANDS IN THE NETHERLANDS NORTH SEA

The Netherlands sovereignty over the North Sea includes an area of more than 57 000 km^2, approximately one and a half times the surface area of the country's land mass. Although it is a small, densely populated country with a population of around 16 million people, it has a strong economy reflected in a gross domestic product (GDP) that is at present the 14th highest in the world. Competing demands for space in the North Sea are considerably greater than the 57 000 km^2 available. Current estimates of demand amount to three times the space available (Netherlands 2006). Aspects of this intense competition are portrayed in figures 2 and 3.

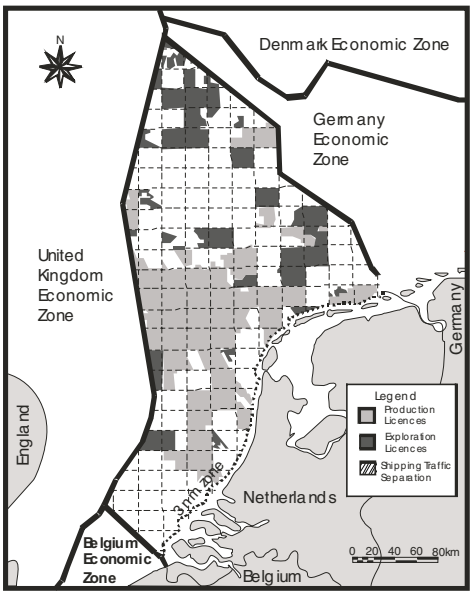

Figure 2: Netherlands North Sea Oil and Gas Permit Areas

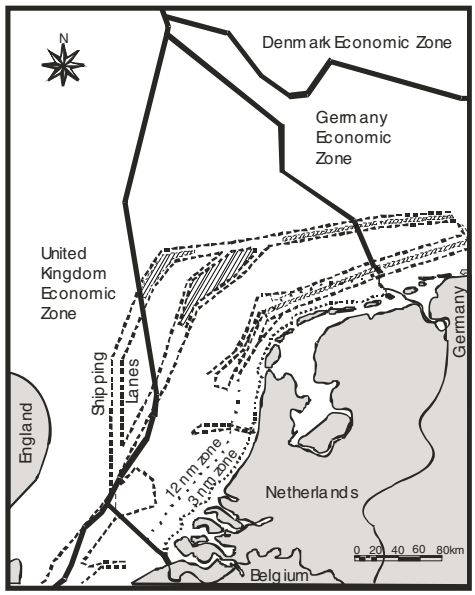

Figure 3: North Sea Shipping Routes

Fishing and North Sea oil and gas and their associated industries make an important contribution to Netherlands' (GDP). The Netherlands is Western Europe's largest natural gas producer. Trade, transportation and telecommunications are also important contributors to GDP, and they have a significant impact on shipping traffic in the North Sea. Rotterdam handles the highest tonnage of any seaport in the world, while all traffic for German Bight and Scandinavian ports pass over the Netherlands EEZ.

Nowadays, in addition to the historical uses relating to trading and fishing, there are many competing, overlapping demands on the North Sea for access to space for infrastructure, the exploitation of natural resources, military use and the preservation of the natural environment. This necessitates increasing levels of formal governance. Expected growth in telecommunications and utilisation of smaller oil and gas fields will greatly increase the demands on space for cables and pipelines. Other demands on space in the next 30 years will be for mineral extraction, defence purposes, wind energy, shipping routes, airports, seaports, recreation and sea defences (Netherlands 2006, *Nota Ruimte*). These demands are summarized in table 1 below.

Table 1: Access and Usage Demands on the Netherlands North Sea
(after Netherlands 2006)

Usage	Nature of Demand
Mining and Minerals Exploitation	Subsurface oil and gas. Mining of sand for land reclamation and sea defences.
Cables and pipelines	Oil and gas pipelines and undersea telecommunications and electricity cables.
Fishing and Aquaculture	Herring, mackerel, and demersal fish. Mussels are farmed in the Waddenzee.
Shipping and Transportation	Shipping routes, traffic separation schemes, ship queuing spaces and port sites.
Military Exercise Areas	Firing and practice ranges, ammunition depots.
Land Reclamation	Land reclamation has been practised in the Netherlands for centuries. The siting of a new international airport in what is currently open sea is under consideration.
Wind Energy	Proposals to locate wind energy farms in the North Sea are under consideration.
Recreation Areas	Beach and shoreline recreation and water-based recreation e.g. yachting.
Nature Conservation and Archaeological Sites	Ecologically sensitive areas, preservation of sea birds and marine fauna and flora. Preservation of view from the coast.
Scientific Research	Research relating to marine fauna and flora, fishing catches, sea water and seabed chemical composition, water stratification and mixing, meteorology, currents, sediment transport and deposition, geomorphologic processes.
Pollution Management	The Bonn Agreement of 1983 is a commitment by North Sea coastal states together with the European Union relating to pollution in the North Sea.
Dumping Sites for Dredged Material	There are designated areas for dumping of unpolluted sand and mud from dredging operations.

There are three features to the Netherlands' North Sea governance. The first feature comprises regional and international treaties, conventions and legislation. These establish the philosophy and value system relating to the North Sea region and a number of regulations relating to its usage. They address the environmental and economic conflicts by seeking debate and synthesis over the many competing demands for rights and access to the North Sea outlined in table 1.

Secondly, in the Netherlands, there exists at the national level a formal institution to debate, coordinate and manage conflict relating to policies, strategies and legislation affecting access to and usage of the North Sea.

The third feature is a drive toward integrated spatial information systems to support policy and strategy formulation and day-to-day administration. Networks of spatial and non-spatial databases in various government, parastatal and research institutions underlie this information infrastructure.

5. GOVERNANCE AND MANAGEMENT OF THE NORTH SEA REGION

Certain policies and regulations relating to the North Sea region are determined internationally. Further policy development and harmonisation takes place within international bodies, including developments like the European Marine Strategy currently in preparation and a recent European Commission initiative, a Green Paper on Maritime Policy. The Green Paper will be an open document in which the Commission on policy and maintenance of the seas and oceans make a number of suggestions relating to issues such as spatial planning and maritime governance.

Issues that are negotiated and regulated regionally are the positions of international boundaries, fishing practices and quotas, shipping traffic management and management of the natural environment.

5.1 Boundaries

International boundaries of the Netherlands' territorial sea and the continental shelf have been negotiated with Belgium, Germany and the United Kingdom over the past fifty years. Boundaries relating to the continental shelf have been ratified with Belgium, Germany and the United Kingdom. The adjacent territorial sea boundary with Belgium has also been ratified. However, there are still boundary issues to be finalised. A line with Germany up to 3 nm offshore has been defined for certain purposes in the Ems-Dollard treaty (see figures 2 and 3), but the territorial sea boundary with Germany between 3 and 12 nm is still under negotiation.

Moreover, besides geometrical determinations based on the equidistance from baselines method, the principle of equity is often applied. Equity considerations have overridden pure technical definitions in two boundary adjudications involving the Netherlands. The continental shelf boundary with Germany was decided after the case had been brought before the International Court of Justice, which ruled in favour of Germany in 1969. Using the equidistance method, the German continental shelf would have been completely enclosed by Denmark and the Netherlands, which the Court deemed inequitable. Consequently, the continental shelf boundaries were adjusted to fit the pattern depicted in figures 1, 2 and 3. More recently, the continental shelf part of the maritime boundary between the Netherlands and Belgium involved a technical determination of the boundary being adjusted from equidistance to provide a delimitation that was considered more equitable to Belgium before the boundary was ratified by the two nations.

Because there are both technical and equity considerations in these boundary negotiations, there are several actors involved in the process. The Ministry of Foreign Affairs is mandated to negotiate Netherlands' international boundaries. Technical assistance on the application of the law of the sea is provided by the Royal Netherlands Navy's Hydrographic Service, which also adjudicates and calculates technical definitions of international boundaries. Furthermore often the Ministry of Transport, Public Works and Water Management is involved in maritime boundary negotiations.

Although the international boundaries have largely been determined in the North Sea, a number of conflicts and inconsistencies over territorial sea and continental shelf/EEZ boundaries remain unresolved. Two main reasons for this are, firstly different institutions use different definitions for the baselines from which boundaries are determined, and secondly, lags in updating national legislation to bring Netherlands' and European laws into line with the international law of the sea. For instance until recently, European fishing authorities did not change fishery limits although baselines changed on the nautical charts (Elema and de Jong 2002).

5.2 Fishing

Conflicts between economic interests and preservation of certain fish species in the North Sea are continual. For example, over-fishing has resulted in a number of fisheries being in danger of collapse (e.g. cod) (Ananova 2003). The European Union's (EU) Common Fisheries Policy, revised in 2003, applies to the North Sea and is binding on member states. At present, the EU holds emergency powers that permit it to make ad hoc decisions that may override existing directives and policies. For example, the cod fishing season was closed temporarily in 2001 as the resource had been over fished to the point of collapse (European Commission 2003, Reuters 2001).

As a member of the European Union (EU), the Netherlands is bound by EU fishing laws and policies in the EEZ, but not in its territorial sea. The determination of quotas, closed seasons and closed areas for breeding are major areas of conflict between the EU and member states. Sustainable practices that affect the region have to be balanced against the survival of commercial operations and the livelihoods of fishermen in individual countries. Attempts to reduce the size of fishing fleets and impose EU quotas are continually challenged and debated. Vessels from neighbouring North Sea countries are permitted to fish in Dutch coastal waters: Belgium is allowed to operate within the 3-mile zone and Germany, France, Great Britain and Denmark between the 3 nm and 12 nm boundaries.

5.3 Shipping

Shipping routes in the North Sea are among the busiest in the world. Shipping routes and traffic separation schemes, shown in figure 3, were introduced in the 1970's. In consultation with coastal states, these are established by the International Maritime Organisation in terms of the International Convention for the Safety of Life at Sea (SOLAS, ch V, s8) (IMO 1998). However, as mentioned above, a coastal state may determine shipping routes in its territorial waters in terms of UNCLOS.

5.4 Natural Environment

Management of the natural environment is performed under a system of regional co-governance. European Union laws and directives, specifically the Directives relating to Birds (79/409/EEC) and Habitats (92/43/EEC) affect the governance of the North Sea (EU Nature Legislation 2001). In addition, the Council of Europe influences policy in a number of ways. For example, the Netherlands is a signatory to the Convention on the Conservation of European Wildlife and Natural Habitats, the Bern Convention. Moreover, the Council produces Guiding Principles for the Spatial Development of Europe (Council

of Europe 2001). The Netherlands is also a signatory to the Convention on the Conservation of Migratory Species of Wild Animals (1979).

At ministerial level, there have been six International Conferences on the Protection of the North Sea attended by the ministers responsible for the protection of the North Sea environment and the rivers entering the North Sea. Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, United Kingdom and the European Commission participate in these conferences. (Norway is not an EU member). Arising out of these conferences and the declarations pertaining to them, there are regular meetings of the Committee of North Sea Senior Officials (CONSSO), which comprises senior officials representing the North Sea states and the European Commission. Aspects of the Declarations have been codified in international and European Union law (North Sea Conference 2002).

The main tasks of CONSSO are to organize the work necessary to follow up on the conference declarations, to review progress in the implementation of the actions agreed upon by the previous conferences, and to organise further conferences. The first three declarations relate to the control and enforcement of regulations to reduce emissions, which affect the North Sea environment. More recently, the scope of the Convention has, *inter alia*, been extended to cover fisheries, habitats, spatial planning, the protection of species control over the release of genetically modified species into the environment, and the prevention of eutrophication (North Sea Conference 2002).

The Wadden Sea is viewed as being of special environmental significance (North Sea Conference 2002). Regional co-governance of the Wadden Sea between the Netherlands, Germany and Denmark is addressed through the Trilateral Governmental Conferences, of which the 9th was held in October 2001. At this conference, it was decided to submit an application to the IMO for the designation of the Wadden Sea as a Particularly Sensitive Sea Area (PSSA). The nomination of the Wadden Sea national parks and nature reserves, or parts of them, as a Natural World Heritage Site is also being explored (Wadden Sea 2001).

5.5 Pollution

Pollution is a major factor in busy sea-lanes and offshore mining areas. The Bonn Agreement (1983) between Belgium, Denmark, France, Germany, the Netherlands, Norway, Sweden, the United Kingdom and the European Community set guidelines for practical, operational and technical cooperation relating to pollution of the North Sea. Its primary aims are 1) to offer mutual assistance and cooperation in combating pollution; and 2) execute surveillance as an aid to detecting and combating pollution and to prevent violations of anti-pollution regulations (Bonn Agreement 1983).

The Netherlands is also a signatory to the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR 1992), which seeks to avoid pollution from land-based sources, dumping or incineration, and pollution from other offshore sources. Moreover, there is a commitment to share relevant research results between signatories.

OSPAR is now working, through the North Sea Regional Task Team, on an assessment of all aspects of the marine environment of the North Sea as part of its overall assessment of the marine environment of the convention's maritime area. OSPAR will undertake work on species and habitats by collecting and evaluating information on the impact on the marine environment (including species and habitats) of human activities identified by OSPAR, other than those leading to inputs of substances (OSPAR 1992).

Pollution, fishing, shipping traffic, natural environmental management and pollution control are the main factors that require regional co-governance in the North Sea.

We now describe national structures, instruments and processes that govern the North Sea.

6. NETHERLANDS OCEAN GOVERNANCE STRUCTURES

At the national level, formal institutions for the coordination of North Sea governance and policy formulation have been in place for nearly 30 years. The most prominent institution in terms of overall national governance is IDON, an abbreviation that translates loosely as interdepartmental deliberations over North Sea policy and governance. The primary purpose of IDON is to debate and coordinate policies, directives and legislation pertaining to the North Sea that various ministries formulate. IDON was created in 1998. It superseded a similar body, the Interdepartmental Coordinating Committee for North Sea Affairs (ICONA), which was created in 1977. We begin by discussing members of IDON and then discuss other relevant actors outside of this institution.

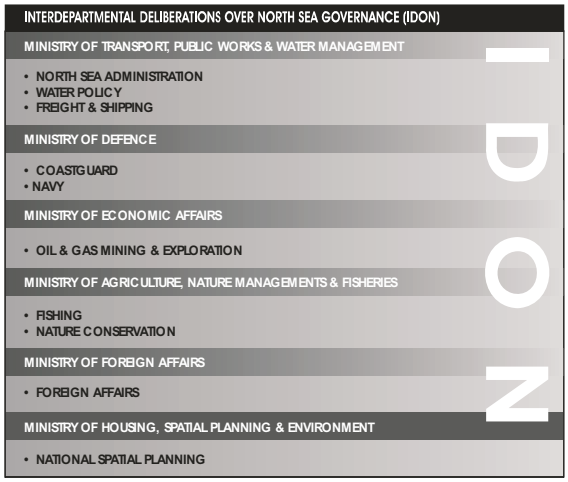

Figure 4: IDON

As portrayed in figure 4, IDON is made up of 10 representatives from different government sub-structure levels (e.g. agency, directorate general, directorate, department) in six ministries. Largely for historical reasons, some of the functions of the different ministries and their sub-structures overlap. For example, the Ministry of Transport, Public Works and Water Management administers certain terrestrial surface mining activities (e.g. sand mining) and performs certain nature management activities. Other ministries conduct similar activities. For instance, the Ministry of Economic Affairs manages production and exploration licenses for sub-surface mining of oil and gas. The Ministry of Agriculture, Nature Management and Fisheries holds overall responsibility for management of the natural environment.

The Minister of Transport, Public Works and Water Management coordinates North Sea policy and is publishing the Integrated Management Plan for the North Sea 2015 (IMPNS 2015) with the approval of the Minister of Housing, Spatial Planning and the Environment (VROM), the Minister of Economic Affairs (EZ) and the Minister of Agriculture, Nature and Food Quality (LNV).

As mentioned earlier, *Nota Ruimte* (Spatial Planning Policy Document) has included the North Sea in national spatial planning since February 2006. The document incorporates a spatial plan for the whole of the Netherlands extending to 2020.

The *Nota* incorporates relevant aspects of international agreements and obligations and national policy frameworks. The Integrated Management Plan for the North Sea 2015 sets out how the North Sea will be managed in the coming ten years. *IMPNS 2015* describes the policy comprehensively in context and outlines the scope for new initiatives as referred to in the *Spatial Planning Policy Document*. *IMPNS 2015* sets out the boundaries of four areas in the North Sea in which the ecological features are to receive extra protection.

It is important for management tasks and instruments to be embedded in law. As human use expanded in the EEZ, the scope of statutory instruments needed to be extended accordingly from the territorial waters to the EEZ. A list has been made of legislation that needs to be extended to include the EEZ. This extension of the scope of these laws is a development that is running parallel to the *IMPNS 2015*.

Building on table 1, specific activities at sea that need to be managed to achieve these objectives are:

- Shipping routes, traffic separation and anchoring areas are laid down in national policy. Activities that impede shipping are excluded from these areas in accordance with the Mining Rights Map.
- The coastal zone may not be undermined by objects in the sea.
- Unobstructed views from the coast are to be maintained. Structures that are proposed within 12 nm of the coast will only receive permits if significant public interest is at issue. Moreover, good design is important.
- Cables and pipelines should be combined and limited to specific routes.
- The removal of unused cables and pipelines should become obligatory.
- The North Sea is part of the National Ecological Infrastructure
- 2nd National Military Training Grounds Structure plan will determine how much of the North Sea is required by the Ministry of Defence.
- Sand dredging for land reclamation is only permitted at depths of more than 20 metres

The Ministry of Transport, Public Works and Water Management has mandated a number of sub-structures to administer various aspects of the North Sea. Directorate-General for Civil Aviation and Transport (DGTL) deals with general freight transportation policy, shipping policy, safety and civil aviation. What is of interest in the context of ocean governance is the determination and management of shipping routes and traffic separation schemes. These are determined by the IMO, but proposed, demarcated and managed by the Ministry of Transport, Public Works and Water Management.

The Directorate-General Public Works and Water Management, largely through its North Sea Directorate (DNZ), is mandated with the governance of North Sea business related to shipping, fishing, dredging, sand mining, the ocean environment and recreation. It has a fleet of ships which are tasked with performing certain hydrographic surveys (e.g. survey of navigational hazards), demarcating shipping routes and harbour approach routes, and pollution clean-ups. It is responsible for implementing the Bonn agreement of 1983. As stated earlier, this relates to regional management of pollution in the North Sea. The North Sea Directorate maintains one of the major information systems in the North Sea, which we describe below. Environmental work relating to seabird counts is also conducted by the North Sea directorate (DNZ).

The Ministry of Defence has representatives from the Coastguard and the Department of Defence on IDON. The Coastguard involves a partnership between four Ministries. Since March 2006, the Coastguard is transformed into a more clear and intensive cooperation. The administration of all means is under the Department of Defence. The Ministry of Transport, Public Works and Water Management makes the policies, plans the activities and makes the yearly budget. Furthermore the ministries of Agriculture, Nature Management and Fisheries and the Ministry of Financial Control are involved in the Coastguard.

The Defence member represents military interests (e.g. military exercise areas) and the Hydrographic Service. The Hydrographic Service is responsible for conducting hydrographic surveys and publishing charts and other nautical information covering the Dutch Continental Shelf and adjacent waters, together with the waters surrounding the Netherlands' Antilles and Aruba. As mentioned above, it also provides technical support to the Ministry of Foreign Affairs relating to the United Nations Law of the Sea.

The Ministry of Economic Affairs, mainly through the Directorate-General for Competition and Energy and the State Supervisor of Mines, administer subterranean mining and mineral exploration, which in the North Sea currently pertains to oil and gas. The Netherlands continental shelf is divided into blocks of 10′ x 20′ (N x E) for licenses relating to exploration and production. These fixed term licenses are governed by the Mining law. Since 2003 the mining legalisation on land and on the North sea are integrated in one law. This law has integrated all mining legalisation which existed before (e.g. Mining of the Continental Shelf Act (1965)). As can be seen in figure 2, it is also possible to have a license of a part of the blocks. Conflict between mining and other interests is managed through debates in IDON and a number of formal instruments. In terms of a series of Royal Decrees, there are restrictions on production and exploration activities in certain areas. Other areas are closed to these activities (e.g. military exercise areas). Locating production and exploration drilling platforms close to shipping routes is determined in conjunction with the Ministry of Transport, Public Works and Water Management's North Sea Directorate.

The State holds the rights to minerals in the Netherlands. Oil and Gas exploration and production is done as a partnership between the State and private organisations. The license holder holds an agreement of cooperation with Energy Control Netherlands (EBN), which falls under the Ministry of Economic Affairs. EBN contributes 40% of the

production and exploration costs, and in turn receives 40% of the profits from oil and gas production ventures.

The Ministry of Agriculture, Nature Management and Fisheries has two representatives on IDON, one for fisheries and the other for nature conservation and management. Commercial fishing permits are governed by EU quotas. However, the distribution of quotas allocated to the Netherlands is decided by fishing organisations themselves.

Actors not directly represented on IDON include the Geological Survey of The Netherlands, various scientific organisations and the Netherlands Cadastre.

In general, the Netherlands Cadastre plays a passive role in North Sea governance. The Netherlands territorial sea has been divided up into a series of parcels. Parcels that are within 1 km of the shoreline are registered in ownership in the name of local authorities. Parcels extending from this 1km line to the 12 nm boundary of the territorial sea have been registered in State ownership. As stated above, central government has administrative authority on the North Sea (starting from one kilometre out from the baseline). In addition, there are no landowners on the North Sea. The interested parties are therefore mainly the users and the special-interest organisations that represent them. However, these State owned parcels of ocean are not used in the processes to govern the territorial sea.

7. INFORMATION SYSTEMS

Accurate geographic information as integral to planning, policy formulation and administration has long formed a tool of the Netherlands' North Sea management strategy. A North Sea Atlas for Netherlands Policy and Management was produced for ICONA in 1992 by various substructures in the Directorate-General Public Works and Water Management, Ministry of Transport, Public Works and Water Management. The Atlas contained information about ocean biology, minerals, shipping, water composition, recreation, data and a number of other relevant themes. It was primarily a government working document as it included tools for performing overlay analyses by tracing different thematic maps. In 2003 the successor was printed on paper as well as accessible on internet through www.noordzeeatlas.nl.

Several GIS systems are in use by several organisations. The primary GIS for North Sea governance is run by the North Sea Directorate (DNZ). An initiative to ensure that comprehensive information relating to various proposed projects and locations is incorporated and accessible through a single user interface is the Law and Policy Information System (BREIN) project. The objective is to provide a facility whereby a user can access all the law and policy information relating to a particular location in the North Sea (e.g. a proposed wind farm) using the GIS. A survey and analysis of more than 60 documents relating to the North Sea, which incorporate laws, regulations, policies, covenants, international and national conventions, and guidelines has been prepared for this purpose by the Netherlands Institute for the Law of the Sea (Oude Elferink and Dotinga 2000).

A number of central government organisations are active in the North Sea. They work closely together in preparing policy, enforcing rules and regulations and providing

services. However, when it comes to regulating usage (through, for example, permitting and management plans) cooperation is limited. The North Sea Management Network (*Beheerdersnetwerk Noordzee* - BNN) established for *IMPNS 2015* and coordinated by the North Sea Department of the Directorate-General for Public Works and Water Management (*RWS Noordzee*) will strengthen this cooperation so that individual management tasks can be better coordinated and citizens and users can be better served. The North Sea Management Network's main tasks are enhancing knowledge and information management thus reducing the burden for users. For example, the North Sea Office (*Noordzeeloket*) will be expanded to include up-to-date information about procedures, permits and permitting conditions. This information will also improve enforcement effectiveness, because it will give North Sea enforcement agencies a better idea of what is going on (including in other departments). The administrative burden will be reduced by streamlining and harmonising the permitting process (IBN2015 2004).

Besides the DNZ GIS, there are a number of other purpose-specific GIS's, such as the Navy's Hydrographic Service which produces nautical charts. GIS is also used for fisheries and environmental management. The Geological Survey of The Netherlands, the institution that manages geological data, owns a GIS for their own purposes. Data is shared and exchanged between a number of governmental and scientific institutions and private companies such as oil and telecommunications companies. However, data that are confidential to a particular institution are not shared. For example, NITG-TNO hold mineral exploration data that have been acquired through large private investments. These data are not released into the public domain.

To date sharing of data to govern and manage the North Sea tends to be done through informal networks. As a result of applications for access and usage rights being examined by a number of different government institutions, certain role players discovered that they were duplicating the collection of data produced by others. This has resulted in particular institutions being designated "owners" of certain data and others update their data from them. Data sharing takes place, but formal data exchange standards have not been established and not all institutions keep meta-data. A possible explanation for this is that, until recently, many international spatial data infrastructure initiatives have tended to ignore ocean data. Moreover, meta-data do not exist for certain data sets that were collected when it was not common practice to generate meta-data.

The Netherlands Oceanographic Data Committee intends to improve this situation. The National Oceanographic Data Committee (NODC) is the Netherlands platform for oceanographic data exchange and advisory services on oceanographic data management. The goals of NODC are: to enhance the availability of high quality oceanographic data for a wide group of users now and in the future, to decrease the thresholds for making oceanographic data available between NODC participants. Modern Internet technologies are used to give an overview of available data and access to oceanographic data, managed by the network of NODC participants. The NODC website (www.NODC.nl) functions as a spider in the NODC web with meta-information (i.e. information on data) on oceanographic datasets and collecting activities and, if possible, with direct links to related institutes and data.

8. ANALYSIS AND CONCLUSIONS

In conclusion, there is a long history of conflict over access and usage of the North Sea. Long-standing tensions have compelled different international actors to consult and cooperate. Managing and governing the tension between intense economic activity, demands for space that exceed availability and environmental interests, is a major challenge.

The main lessons provided by the Netherlands case, and the North Sea case in general, is that firstly, given the nature of the dialectic, effective ocean governance requires continual, transparent debate over economic and environmental concerns. It is necessary to debate policies, management strategies, laws, permits and other similar instruments at regular intervals at international, ministerial and operational level to achieve an integrated system of cooperative governance. And it is necessary that action extend beyond mere debate. Thus, an institution such as CONSSO has been tasked with implementing resolutions and measuring the effectiveness of various strategies that are formulated at various forums. Moreover, the fact that IDON, and its predecessor ICONA, have existed for more some 30 years underlines the need for such institutions at the national level.

Secondly, the tension between economic interests and environmental needs is inherent in the situation and conflict is continual and natural. Different actors can be expected to strive to maximise the benefits of their particular constituencies in debates and negotiations. The challenge is to achieve compromise and synthesis of different objectives. However, even legal decrees that may be regarded as peremptory, such as the EU requirement to reduce fishing fleet sizes, may be ignored at times. Institutions such as the European Court of Justice form part of the infrastructure required to deal with these incidents.

Thirdly, the democratic culture of the North Sea situation encourages good governance. Although there are numerous tensions and conflicts, in the long term, most of the actors in western Europe understand what needs to be done and are prepared to make compromises. Moreover, there is a great deal of transparency in the governance processes. The European Green Paper on Maritime Policy is another step in this process.

Fourthly, the land and sea should not be seen as separate. The entire North Sea catchment area has been included in the North Sea Conferences' area of interest and Netherlands spatial planning policy documents now emphasize this principle.

Fifthly, the debates over management and governance, and the planning, formulation and implementation of various strategies need to be underpinned by good quality, integrated spatial information. Formal and informal networks, instruments and structures and a culture of cooperation underpin this information infrastructure, which the Netherlands has been working towards for a number of years.

At a glance, the formal arrangement of rights of occupation, usage and access to the Netherlands North Sea resembles a cadastre that supports tenure security and fiscal and environmental management. However, unlike most land-based cadastral systems, the system's properties emerge from a number of institutional structures and processes that are

loosely coordinated. In fact, interviews during the study revealed that many of the people involved in this system are unaware of how it all fits together.

The Netherlands Cadastre as an institution plays a minimal role in this system other than to divide the territorial sea into parcels and register them in ownership in the name of the State or local authority. In terms of the Law of the Sea, the State is not empowered to own parcels of ocean in the EEZ. Moreover, other than the State owned parcels in the territorial sea, parcel boundaries are determined according to usage only (e.g. minerals, aquaculture). There is not a market in ocean parcels where parcels are subdivided and consolidated and sold off, nor is the system designed to support this.

It has been necessary to adjudicate and determine the continental shelf boundaries with Netherlands' adjacent and opposite states. Based on this international boundary parcel, the continental shelf and parts of the territorial sea have been divided up into parcels for the purpose of exploring and mining oil and gas. Rights of passage in the shipping lanes that overlap these parcels are servitutal in nature and superior to those of mining and mineral exploration. Other rights that are servitutal in nature pertain to cables and pipelines, albeit that their duration is limited to the useful lifespan of the cable or pipe. However, similar to many arrangements of mining and mineral exploration on land, holders of North Sea mining and exploration rights are limited to performing these activities. Holders of fishing rights are not impeded by mineral parcel boundaries, providing they do not interfere with mining and exploration operations.

Although there are calls to divide the oceans up into different parcels (Carr 1998), the North Sea case does not suggest that these should be for the allocation of long term or perpetual individual rights. Private ownership is absent as a system of tenure in the Netherlands North Sea. In consultation with various international bodies, the State has taken on the role of custodian of rights, access and usage of the oceans. Rights of access and usage are seldom allocated in perpetuity and the State retains the power to intervene on an ad hoc basis in response to unforeseen circumstances. Fishing, aquaculture and the harvesting of other marine species require permits, which although renewable, tend to be allocated for short periods. Often, the rights associated with these permits (e.g. quotas) change from year to year and can be cancelled at short notice if a species becomes threatened. Mining and mineral exploration rights are of limited duration and they are likely to take the form of a lease or prospecting permit. Moreover, generally these carry a concomitant obligation to rehabilitate the ocean floor.

In conclusion, the system of governance in the Netherlands North Sea is based on cooperation. It is a system of permits, leases and servitudes of limited duration, where the State retains substantial power. Specialists in different ministries allocate permits. Coordination is done through legislation and policy and institutions such as IDON and CONSSU. Rights are not allocated to third parties on the basis of ownership. Moreover, they are of limited duration. This allows flexibility, which is sensible given the environmental sensitivity of the oceans and our lack of knowledge of the effects of intervention and other factors that affect renewable marine stocks.

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Using Canadian MPAs to Highlight the Need for Improved Tenure Information Management

Sam Ng'ang'a

Abstract

The administration of activities, interests and uses, is an important process in marine environmental management. In this paper, the role of marine tenure information in administering marine activities and interests will be highlighted: in the context of Canadian marine environmental management. This paper focuses on the Canadian MPA program, as an example of a marine environmental management approach, and identifies: (1) opportunities in the marine tenure information management approach; and, (2) a strategy for addressing these opportunities.

1. THE ROLE OF TENURE INFORMATION IN RESOURCE MANAGEMENT

Resource management decisions have traditionally been enhanced by information systems that highlight rights, responsibilities, and restrictions individuals/ groups have with respect to the allocation of land, its use, and enjoyment of its produce [Larsson, 1991].[8] These information systems have existed for a long time[9] and provide the information for decision makers to be able to balance resource type, location, quantity, quality and environmental factors against associated public and private property rights [see for example Oberlander [1985]; Bernstein [1985]; Dale and McLaughlin [1988]; McLaughlin and Nichols [1989]).

Property is defined as an enforceable claim to the use or benefit of some valuable thing [Macpherson, 1978, p.3]. Property information therefore describes a "thing" and the enforceable claim one might have to the "thing"[10]. Land tenure can be defined very broadly as the set of relationships that outline the acquisition, use, transfer and distribution of land [McLaughlin, 1973; Crocombe, 1974; Barnes, 1985] or more specifically as the rights, restrictions and responsibilities that people have with respect to land [McLaughlin, 1975; Nichols, 1992]. In this paper, property is viewed as a subset of land tenure.[11]

[8] These information systems are referred to as cadastres – parcel based information systems that provide information on ownership, use, and value.

[9] The origins of what has come to be accepted as the modern cadastre concept are to be found in the development of the fiscal or land taxation cadastres of Continental Europe during the 18th and 19th centuries. One of the earliest attempts to establish a fiscal cadastre was the Milanese cadastral mapping program carried out between 1720 and 1723. This program provided a series of estate maps at a scale of 1:2000 for the Italian provinces of Milan and Mantua acquired by the Austrians [McLaughlin, 1975].

[10] Property is conceptualised as consisting of the rights, objects, and subjects. In this paper, property information describes the resource, individual/s with an enforceable claim, and type of resource use claims.

[11] Nichols [1992] suggested that property, with its emphasis on 'rights' is a subset of land tenure, which is a much broader term with emphasis on 'rights', 'restrictions' and 'responsibilities'.

On land, tenure information plays a significant role in the implementation of various land use regulatory policies [Denman, 1971[12]; McLaughlin, 1975; McLaughlin and Nichols, 1989]. This is because regardless of the scale and intent of such policies, their effect will be felt at the spatial extent exercised by individual (or group) stakeholders. Implementation of land use regulatory policies also needs to be socially and politically justified - a task made easier by highlighting the effects of the policies at the proprietary land unit (or property holding) level [McLaughlin, 1975].

Several authors (e.g., Jones [1971]; McLaughlin and Epstein [1976]; Nichols [1981]; Nichols [1983]; McLaughlin and Nichols [1989]) have historically documented the need for information systems that capture tenure/property information. This can be extended to marine space based on two observations, namely: (1) coastal zone planning depends on a decision maker accessing information on, among other things, the legal framework of ownership and control; and (2) there is a need for information systems (integrating property information) for shared and integrated decision-making in marine space.

These observations are valid in Canada today as: (1) the focus remains on collection of data on the physical marine space and the characteristics that define this space; and, (2) less emphasis is put on providing integrated information at the appropriate "rights" resolution. The first point highlights the problem of understanding the vast frontier of the Canada's coastal and marine spaces.13 The second point highlights the problem of not investigating the utility of property (and tenure) information in land management. This paper addresses this second problem.

2. THE POINT OF CONJECTURE REGARDING MARINE TENURE INFORMATION

Coastal and oceans resource management consists of policies and programs that (a) affect a specific spatial extent; (b) manage resources within that extent; and, (c) affect rights to resources enjoyed by individual (or group) property holders. As such, it is reasonable to suggest that tenure information will have an effect on policy, programs, and regulations that might be proposed. More specifically, irrespective of the land/marine physical distinction, tenure information might be useful in: (1) making land use planning decisions; and, (2) justification and implementation of coastal and marine policies, programs and regulations.

This paper suggests that this is also true in a Canadian marine space context. In order to arrive at this conclusion, it is necessary to show the hypothesis to be true for Canada's coastal and oceans management approach. Specifically, this means demonstrating that

[12] Denman suggested, " if we fail to recognise that land use is a function of property rights in land, our cognisance of the truth is deficient by a whole dimension or reality" (as cited in [McLaughlin, 1975]).
[13] In the specific case of Canada, what is known today about Canada's ocean frontier is similar to what Canadians knew of the Prairies and the Arctic in the 18th and 19th centuries [Ocean Mapping Group 1999]. Internationally, Hoogsteden and Robertson [1998] observe that the vastness of ocean space has lad to scattered explorations of marine territory have been made primarily in pursuit of narrow goals, e.g., development of identified oil and gas reserves, communication infrastructure, and coastal navigation. The vastness of ocean space leads to information systems being prioritised as monitoring and prediction systems for marine phenomena and processes [Jacob et al., 2003].

tenure information has a role in the existing policy, program, and regulatory structure described by Canada's national approach to coastal and oceans management. To demonstrate this, the next section begins by outlining the framework for Canada's coastal and oceans management approach.

2.1 Canada's Approach to Coastal and Oceans Management

Canada's *Oceans Act* [1996] represents a legislative commitment to a comprehensive approach for the protection and development of Canada's oceans and coastal waters [Canada, 2002]. To achieve this commitment, the *Act* calls for the federal Department of Fisheries and Oceans to lead and facilitate the development of plans for Integrated Management (IM).[14] The IM concept involves: (1) comprehensive planning and managing of human activities to minimize conflict among users; (2) a collaborative approach; and, (3) a flexible/transparent planning process that respects divisions of constitutional and departmental authority [Canada, 2002a]. The concept calls for an IM plan which aims to guide ocean management decisions by sharing information, consulting with stakeholders, and stakeholder advisory/management participation in the planning process [Canada, 2002a, 2002b]. Integrated Management is also a fundamental element in Canada's *Oceans Strategy* and *Oceans Action Plan*.

In the *Oceans Strategy*, a number of elements are identified as essential in Integrated Management for coastal and ocean areas [Canada, 1997b]. These elements describe a roadmap for applying the integrated management approach. A snapshot of these elements, dealing with the management of activities and interests, includes [Canada, 2002a,p.8]:

- Using existing governance structures, or establishing new ones that address multiple interest and user conflicts.[15]
- Analyzing implications of development, conflicting uses, and interrelationships between natural physical processes and human activities.[16]
- Considering cumulative effects of current and approved future human activities.
- Integrating data collection, research, synthesis, and information sharing, communication and education.[17]

The *Oceans Action Plan* asserts how this will be accomplished by targeting the development of IM plans for Large Oceans Management Areas (LOMA) and Coastal Management Areas (CMAs)[Canada, 2002a, 2002b]. The DFO *Policy and Operational Framework for Integrated Management of Estuarine, Coastal and Marine Environments in Canada*[18] indicates that the establishment of IM plans includes the development of a

[14] A review of the *Oceans Act* [1996] indicates that there are several principles that are central to the Canadian approach to coastal and oceans management. Section 30 of Canada's *Oceans Act* [1996] provides for the *Oceans Strategy* to be based on the principles of sustainable development, integrated management of activities, and the precautionary approach [Canada, 1997b, 2002a,2002b].
[15] Includes encouraging all resource managers to consider social, cultural, economic and environmental impacts of decisions.
[16] Includes promoting linkages and harmonization among sectoral coastal and ocean activities.
[17] As part of a full range of relevant knowledge to be applied to the planning and decision-making processes.
[18] The policy and operational framework document outlines: (1) the policy concepts and principles; and, (2) an operational framework with governance, management by areas, design for management bodies, and type of planning processes involved [Canada, 2002a].

system of Marine Protected Areas (MPA) - arising from the legislative mandate outlined in section 35(2) of the *Oceans Act* [1996] [Canada, 2002a]. MPA implementation is a core tactic in Canada's *Oceans Act* [1996], *Oceans Strategy* and *Oceans Action Plan*.

2.2 An Important Opportunity in Canada's Approach

The design of the previously mentioned *Policy and Operational Framework for Integrated Management of Estuarine, Coastal and Marine Environments in Canada* involves (among other things) establishing an IM plan, and a network of MPAs within the plan. In this design, individual MPAs are considered the building blocks of this network. Although different in scale, IM and MPA management plans in Canada have several similarities. Both plans [Canada, 1998; 2002a]:

1. fall within multiple jurisdictions (i.e., provincial, territorial or community);
2. take into account specific policies, plans and legislation that apply in an area;
3. are tailored to environmental settings and existing proposed oceans uses;
4. may be presented as a series of recommended management actions directed towards specific oceans uses;
5. may be presented as a zone identifying areas of preferred oceans use; and,
6. are built through collaboration as a governance model, and adaptive management as a key philosophy.

In general, both plans suggest spatial management of resources, a focus on rights to resources, and the interaction of individual (or group) stakeholders. MPA plans are narrower in scope since they manage human activities within designated coastal and marine spaces by regulating them more stringently than elsewhere, typically to achieve certain conservation objectives (see Canada [1997a]; *Oceans Act* [1996]). IM plans are broader in scope since they focus on managing shared use of ocean spaces through governance strategies.

The effectiveness of both plans is based on the assumption that there exists: (1) a consistency and completeness in documenting interests, activities and uses involving resources; and, (2) an integrated inventory of this information across departments, agencies, governments and general stakeholders. Both assumptions are incorrect (see for example, Monahan and Nichols [1999]; Nichols et al [2001, 2002]; Ng'ang'a et al [2004]). This paper further analyses the reasons why both assumptions are incorrect in an attempt to highlight possible areas of improvement in tenure information management.

To accomplish this, this paper *clarifies, describes,* and *demonstrates* tenure information use in Canada's coastal and oceans management. Specifically, it reviews this in an MPA establishment and management context. The next section outlines the MPA program in Canada.

2.3 An Overview of Canadian MPAs

The Canadian Government has three formal protected area programs for the marine environment [Canada, 1998, 2002c]. These are administered by Canadian Heritage (Parks Canada), by Environment Canada and most recently by Department of Fisheries and Oceans (DFO). These are outlined in Table 1 below.

Table 1: Federal Marine Protected Areas Programs (after Canada [2002c])

Agency	Legislation	Protected Areas Program
DFO	Oceans Act	Marine Protected Areas
Parks Canada	National Parks Act	National Marine Conservation Areas (NMCA)
Environment Canada	Canada Wildlife Act	National Wildlife Areas and Marine Wildlife Areas
Environment Canada	Migratory Birds Convention Act	Migratory Bird Sanctuaries

As shown in Table 1, the DFO-MPA program is one of three federal marine conservation programs. It stands out for several reasons [Canada, 1997a; 1998]. First, it allows the designation of MPAs under broader guidelines than those provided by other programs (*known for dealing with specific habitats or species*). Secondly, designation of MPAs provides protection that is much greater than that afforded by other programs.[19] For these two reasons, DFO MPAs provide additional management tools that can be used to enhance stewardship of marine resources and their habitats [Canada, 1997a, 1998]. Therefore, reference to an MPA (or MPAs) in this paper is with reference to the DFO-MPA program.

2.4 The Need to Administer Activities and Interests in MPAs

MPAs are meant to address a wide range of marine resources and management dilemmas. They can be established for numerous reasons, and as a result, can take a variety of forms and *approaches*.[20] It is generally accepted that well-planned MPAs not only protect critical habitats and general ecosystem functions but also meet the needs and even enhance the opportunities of many different stakeholders living in the region [National Research Council, 2001]. MPAs attempt to highlight critical habitats/ecosystems; as well as human actions (interests, activities and uses) lying within a spatial extent;[21] in a formal attempt to control these actions. In other words, an important component of MPAs is the administration of activities and interests.

From the foregoing, this paper concludes that there are two information categories that are important in MPA establishment and management. These information categories: (1) highlight conservation values and, (2) identify human actions on the environment. The first information category depends on science information, and is used to set the parameters (goals, objectives and indicators) for conservation. The second information category depends on information on human actions (interests, activities and uses); identified in land management research as tenure information (see for example Denman [1971]; McLaughlin [1975]).[22] It is therefore reasonable to conclude that tenure information is important in managing MPAs.

[19] For example, MPA management plans can define buffer areas adjacent to the MPA boundaries whereby certain activities are restricted [Canada, 1997a].
[20] Generally, it is accepted that MPAs are established for: helping to preserve important fisheries, for protecting historical and cultural resources, for conducting scientific research, for preserving natural communities and freeing them from exploitation, and for establishing parks for diving [Canada, 1997a].
[21] MPAs are implemented within a specific spatial extent within which regulatory restrictions are imposed.
[22] As mentioned in the first section, human actions can be equated to land use.

3. WHAT ARE THE OBSTACLES IN IMPROVING MPA TENURE INFORMATION MANAGEMENT?

Generally speaking, information on the marine environment, its resources, and uses, is considered critical in identifying, evaluating, and managing MPAs [Canada, 1997a; Canada 1998]. However, several publications (e.g., Canada [1997b]; Fenton and Westhead [2000]) underscore that MPAs are to be identified, established and managed with a focus on ecological data. [23] This leads to two observations: (1) there is a focus on science as the basis for MPA establishment and management; and, (2) this focus on science results in a de-emphasis on resource use, activities and interests.

The first observation suggests that science information is the basis for MPA establishment and management (see for example Canada [1997a; 1998]). This is reinforced by the MPA program documentation, which specifically indicates that, "…ecological values may be more important than technical and socio-economic considerations [Canada, 1998, p.17]". [24] This is not surprising as MPAs are intended to protect and conserve the marine environment-and science is the best way of setting parameters for protection and conservation.

The second observation suggests that MPA activities, interests and uses are of lesser importance in planning and management than science information. This de-emphasis can be found in the grouping of tenure information with other data categories that cover several other information types. For example, umbrella terms such as "socio-economic data" or "technical data" are used to capture all other data that is not ecological. In fact, there is limited reference in MPA program documentation of property information requirements and use of this data in MPA establishment and management.

These two observations are a starting point for explaining why there is a lack of focus (and appreciation) on the importance of tenure information management in the administration of marine activities and interests. The following sections will try to highlight other possible reasons why there is the so-called de-emphasis on tenure (and other) information categories in MPA establishment and management.

3.1 Historical Bias in Marine Environmental Management Approaches

As previously mentioned, coastal and oceans management also depends on science to provide parameters for management. A framework based on goals, associated objectives, and corresponding information needs is generally used to evaluate management success.

[23] For example, when this author first got involved in MPA research in 2000, there was an increasing focus on establishing a network of MPA and the information requirements associated with this process [Canada, 1998, p.10]. As the lead agency for administering the MPA program under the *Oceans Act* [1996], DFO was initially focused on identifying the requirements and components of a "national network of MPAs", bringing together individuals that shared an interest in MPAs, and collaboratively developing the conceptual frameworks and outlining general information requirements [Fenton and Westhead, 2000, p.2].

[24] This apparently is an internationally accepted practice. For example, based on its long time MPA experience Australia proposed to Canada "…that non-ecological goals should be regarded as modifiers of the primary biodiversity or ecological goals once candidate MPAs have been identified and selected [Fenton and Westhead, 2000,p.13]". This suggests that these non-ecological goals have a negligible role in the identification and selection of MPAs.

These frameworks generally describe: (1) MPA goals and objectives; (2) indicators that measure the objectives; and, (3) data /information requirements to support the measurement of the indicators.[25]

Based on management goals and objectives, individuals or groups may exert influence on resource use from three primary perspectives: environmental, economic and institutional perspectives. The predominant view in Canadian marine management is the environmental perspective, more specifically, the primary function of conservation in marine environmental management. The term conservation consists of the management goals of protection, preservation and restoration. These management goals are value judgments that may be reflected in policy, program, or legislative objectives. As previously mentioned, marine conservation value judgments have historically been biased towards science [Agee and Johnson, 1988].

This is noted by several authors (e.g., Agee and Johnson [1988], Grumbine [1994]). Grumbine [1994] notes that responsibility for marine environmental management traditionally fell on individuals who were biologists, first, and managers, second. Therefore, it took the work of managers to ensure that planning and management "no longer discount *(ed)* the effects of humans on ecosystems." [26] In fact, the concept of ecosystem management emerged from the realisation that biologists and managers had to take into consideration the complex social context of environmental management.

3.2 Traditional Sectoral Approaches to Management

The complexity of marine space interests, activities and uses has been mentioned as a possible reason why there is a de-emphasis in tenure information management in MPAs. This has led to the impression that a comprehensive approach to managing tenure information will be difficult to implement. Some reasons why tenure information management is considered complex are outlined below.

First, there is a mix of local, provincial, and national interests in marine space, which are responsible for managing activities and uses. With regard to the nature of property in marine space, there tends to be a continuum of ownership. For example, coastal areas have a mix of public and private property and offshore areas are dominated by public property. This generalization varies across jurisdictions and cultures and is the source of great uncertainty regarding tenure-related information (see for example Cicin-Sain and Knecht [1998, p.44]).

Second, government institutions generally consist of single purpose agencies. This is because the traditional use of marine space before the 20th century was characterized by two uses: navigation and fishing [Cicin-Sain and Knecht, 1998]. Conflicts between these uses were few and as a result, separate institutions managed fishing and navigation. Thus, a

[25] Several such frameworks have been described in MPA research (see for example Fiske [1992], Kelleher et al.[1995], Kelleher and Recchia [1998],Brody [1998a,b], Hockings et al. [2000], Sutinen et al. [2000], Berkes et al. [2001], Ehler[2003], Pomeroy et al. [2004]).

[26] Although the work of Agee and Johnson [1988] and the reflections of Grumbine [1994; 1997] were in the context of (dry) land resource management, these ideas and concepts are similarly valid, and valuable, in marine space.

sectoral approach to marine management emerged. Additionally, within some fishing sectors, a single species approach was implemented based of the economic value of the species. The single species and sectoral approach to marine management produced several independent programs that were narrow in scope and vision (i.e., they did not consider the long-term, direct and indirect impacts on the social, economic and environmental dimensions [Bowen and Riley, 2003; Ehler, 2003]). This has produced a "silo" approach to tenure information management.

Third, the physical characteristics of marine space provide certain tenure administration challenges. For example, the water, living resources (e.g., fish), and non-living resources (e.g., sand and gravel) change location over time, in a vast water-filled frontier that spans much of the earth. This fluid and dynamic nature is further complicated by the intricate relationships that exist between diverse marine ecosystems and the environments that support them [Cicin-Sain and Knecht, 1998]. This provides for a complex physical environment in which marine activities and uses are managed.

3.3 Difficulty in Applying Land Administration Concepts to Marine Space

Tenure administration in marine space differs from land for several reasons. The primary reason is that marine spaces are not physically occupied, owned, or used, to the same extent as (dry) land space. This is important as it indicates that these traditional tenure concepts cannot be similarly used to uniquely identify and manage marine space. An ownership unit in marine space, similar to one found on land, might be difficult to wholly replicate (although waterlots and similar units may be the exception). Not only is this is a source of divergence between land management concepts and those for marine space; it also affects the information systems that are used to manage marine space.

To overcome this, tenure information systems may use alternative management units in marine space. Surrogates for ownership that have traditionally been used in land management include *use* and *value* (see for example Moyer and Fisher [1973]). For example, land *use* units have been used to provide information that is used in land management. *Value* units based on what constitutes an "assessable parcel of land" have also been used in land management. In marine space there are several instances of such *use* and *value* parcels and it may be more appropriate to manage marine space at these resolutions.[27] However, the lack of a standard unit for tenure information management is an obstacle for improving (and integrating) information in marine space.

3.4 Implicit Bias in the Policy and Program and Legislative Framework

Canada's *Oceans Act* [1996] provides a framework for coastal and oceans management initiatives and mandates the preparation of a national strategy. *Canada's Oceans Strategy* (COS) responds to this by providing a policy framework intended to guide the co-ordination and management of marine activities [Canada, 1997b; 2002b].

[27] Oil and Gas lease and licence management in Canada provides an example of a hybrid *use* and *value* based management approach. Similarly, the spatial extent of fishing licences and quotas in Canada is outlined in the zones of the *Fishing Zones of Canada Orders* (C.R.C., c. 1547, 1548 and 1549).

Three policy objective (or outcomes) of COS have been identified for the advancement of coastal and oceans management activities [Canada, 2002a]: (1) understanding and protecting the marine environment; (2) supporting sustainable economic opportunities; and, (3) international leadership.

The management objectives used to accomplish the previously mentioned policy objectives are defined in Canada's Oceans Strategy (COS) as guiding principles. These three principles (or management objectives) are [Canada, 2002a; 2002b]: (1) sustainable development, (2) integrated management, and (3) the precautionary approach. These are shown in Figure 1.

The precautionary approach management objective is seen as emphasizing the environmental objective in marine management, as well as the primary goal of conservation [Canada, 2002b]. This approach is defined in the Oceans Act [1996] as "erring on the side of caution" and provides a priority to maintaining ecosystem health and integrity when managing human activities.

The important point to note is that the precautionary approach is an important principle that is always taken into consideration in coastal and oceans management decision-making. This suggests that science (used to set ecosystem health and integrity parameters) has priority in marine environmental management. And although sustainable *development* and *integrated management* objectives suggest the importance of other information types in decision-making, they are mitigated by this approach.

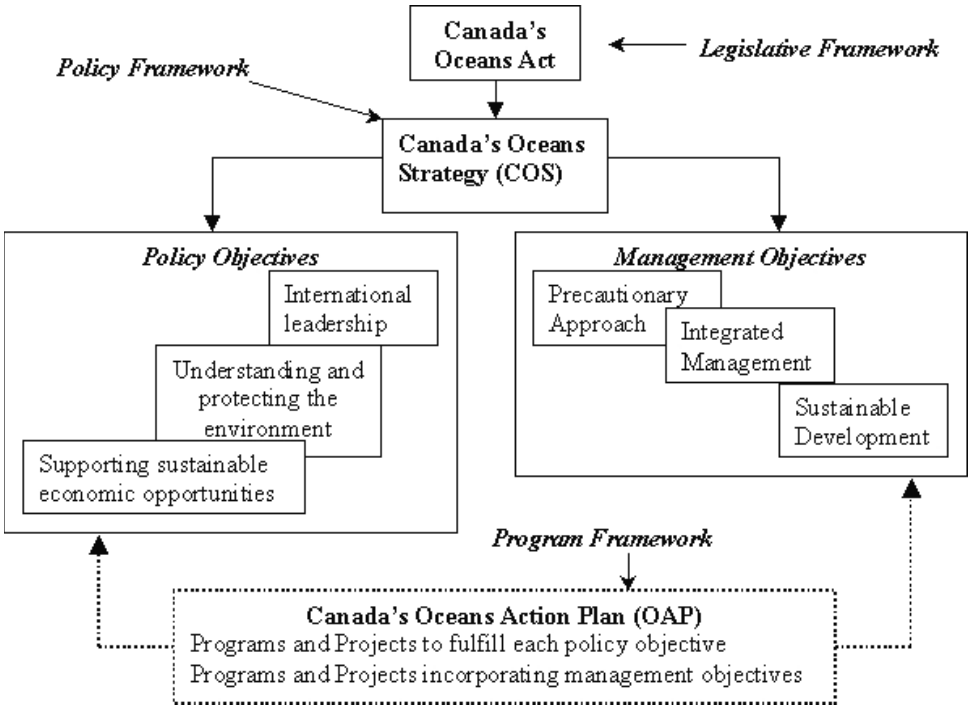

Figure 1: Canada's marine environmental management framework
(from Ng'ang'a [2006])

3.5 The Legacy of Fragmentation in Policy and Program Approaches

In Canada, federal and provincial governments departments conduct regulation of human activity in marine space. As a result, human activities face a complex, duplicative and costly array of approval processes. Policy and program based solutions are being proposed to alleviate this fragmentation.

Canada has embarked on an ambitious program called Smart Regulations, which represents a pro-active approach to improving the administration of activities. 28 This approach is meant to motivate public decision making to be inclusive and the general idea is to make the system of policy, programs and legislation less complex. It facilitates the evaluation of proposed activities using a standardized and harmonized approach across jurisdictions. Strategies for this approach are summarised in Figure 2.

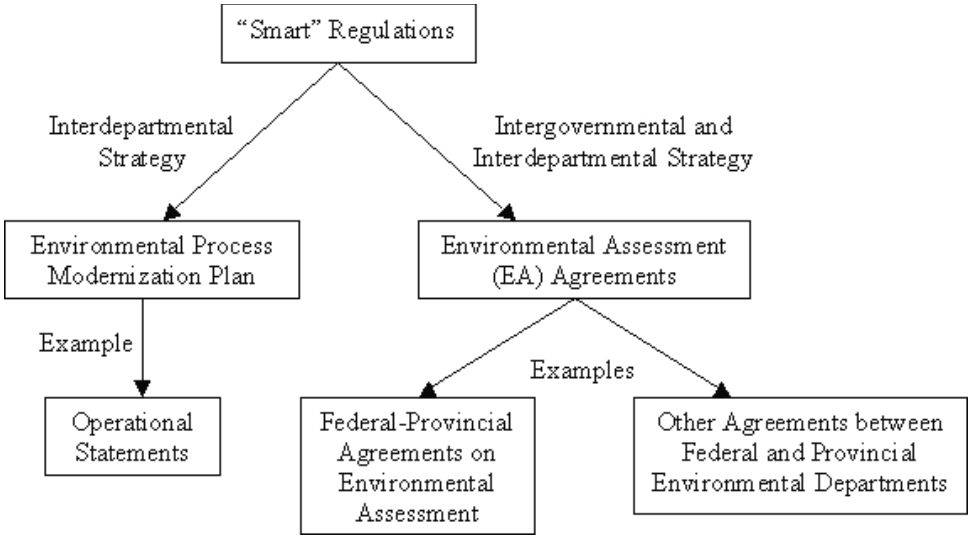

Figure 2: *Smart Regulations* activities and examples (from Ng'ang'a [2006])

[28] *Smart Regulations* is a federal government initiative whose objective is to "modernize regulation to enhance conditions for an innovative economy while finding improved ways to meet high standards of social and environmental protection"[Canada, 2005b]. See the website at http://www.pco-bcp.gc.ca/smartreg-regint/

Table 2: Tenure administration challenges not addressed by *Smart Regulations* initiative

Tenure Administration Challenges	Description
No emphasis on improving tenure information management	It focuses on simplifying policy, program and regulatory complexity by addressing the application process for licences and leases. There is no mention of what happens with the tenure information arising from the application process.
Does not incorporate other tenure information sources	There is an implicit assumption in this initiative that the regulatory instruments being harmonized are the primary source of tenure information. There is no acknowledgement of other tenure administration options.
Does not explicitly address tenure administration continuity	While new applicants may benefit from the regulatory harmonization, there is no mention of a standard approach to handling conflict from previously approved applications.
Does not address the sectoral management approach	Specific programs in the *Smart Regulations* initiatives do not address the sectoral management approach. This means that activities in other sectors may be overlooked especially if these sectors don't have similar programs.
Does not address vertical integration of management approaches	This initiative may address challenges across Federal/Provincial department and agencies but may not address other government institutions e.g., First Nations and Municipalities.

The *Smart Regulations* initiative can be considered a form of tenure policy, program and regulatory reform. The focus is on simultaneously trying to improve the administration of activities controlled by public authorities, and the comprehensive enforcement of public interests. This represents an important first step but does not by any means address, or even emphasise, tenure information management. Examples of marine tenure administration challenges that are not addressed by this initiative are outlined in Table 2.

3.6 Lack of (Explicit) Emphasis on Tenure Information Management

A review of *Canada's Oceans Strategy* (*COS*) and Canada's *Oceans Action Plan* (*OAP)* indicates that there is an integrated information management approach, which consists of two primary strategies. First, *COS* advocates an approach focused on inclusive information management i.e., the inclusion of local and traditional knowledge [Canada, 2002b, p.22]. Second, *OAP* adopts an approach that is primarily focused on governance reform: improving information management through [Canada, 2005a, p.8]: (a) governments working together; (b) bringing sectors and citizens together using more open and transparent management and advisory bodies; and, (c) pursuing ecosystem-based approaches.

However, both strategies only provide a starting point for improving tenure information management as part of their integrated information management approach. There are several other issues that also need to be addressed as shown in Table 3. From this, one can

suggest that the *COS* and *OAP* integrated information management strategies may be indirectly contributing to the de-emphasis of tenure information management.

Table 3: Marine tenure information management recommendations regarding *COS* and *OAP* integrated information management strategies

Integrated Information Management Strategies	Marine Tenure Information Management Recommendations
Canada's Oceans Strategy (*COS*) advocates an approach focused on inclusive information management i.e., the inclusion of local and traditional knowledge.	▪ Use of this information is contingent on it being provided in a form and format that can be reconciled with other tenure information. Therefore, a technical strategy for including local and traditional knowledge should also be included.
Canada's *Oceans Action Plan* (*OAP)* adopts an approach of improving information management through governance reform.	▪ There is an unproven assumption that governance reform will result in improved marine tenure information management ▪ The direct focus on governance suggests a lack of emphasis on the importance of information management in administering marine activities and interests.

3.7 Lack of Interest in Tenure Information Management

A review of Canadian MPA management literature (see for example articles in SAMPAA conference [Munro et al., 2003]) indicates vague descriptions regarding: marine activity and interests information sources; their use in the decision-making process; and their specific characteristics. There is little knowledge whether coastal zone information systems being assembled are adequate for establishing or managing MPAs. Additionally, little is known about how organizations and groups will be able to share their information within these systems; or the appropriate form, format, and content of their information.

The collaborative and co-management approaches (in the MPA IM approach) suggest that stakeholder groups may have certain types of information that may impact on decisions. However, there is little guidance as to the types of information these agencies and groups may have in their possession. There are also no examples of how it is to be used and whether any information sharing protocols and standards are established. In summary, the issue of tenure information management is still flying under the coastal and oceans management radar.

3.8 Bias in Tenure Information Systems Development

In Canada, there has been a legacy of information systems dealing with specific programs, uses, and activities [Hildebrand, 1989; McLean and McLaughlin, 1989]. A review of Canadian authors works on information systems gives the impression that tenure information management is considered in the very narrow context of managing a specific resource or species e.g. fishing, petroleum drilling, mining, construction of public utilities, aquaculture etc [Butler et al., 1986; McLean and McLaughlin, 1990; Coffen-Smout and

Herbert, 2000]. This narrow focus of tenure information (in the context of managing specific resources) has affected the development of inclusive and complete tenure information systems.

This "single" resource-based focus on tenure information management is a legacy of traditional information systems development (see Butler [1986]). It is further fragmented by jurisdictional and administrative responsibility, and complicated by data custody issues (arising from "silos" of information in the custody of various agencies, departments and institutions [Nichols et al., 2001; 2002]).

This paper suggests that there are three categories of tenure information systems that need to be integrated as a starting point for an inventory of tenure information in marine space. These are: (1) near shore examples of tenure information systems that extend "dry" land registration concepts to the intertidal zone e.g. registration of water lots and aquaculture leases [Nichols, 1983; Nichols et al., 1997];(2) information systems that focus on the spatial extent of tenure in environmental areas e.g. marine parks, marine protected areas, heritage areas, bird sanctuaries etc [Nicholls, 1998; Jamieson and Levings, 2001;Ardron et al., 2002]; (3) information systems focusing on tenure instruments needed for economic activities of particular resources e.g. petroleum leases. All three categories need to be further investigated.

4. CONCLUDING REMARKS - REITERATING THE NEED TO IMPROVE TENURE INFORMATION MANAGEMENT IN MPAS

The previous sections have noted the obstacles in improving tenure information management by analysing the MPA establishment and management framework in Canada. From this review, the importance of improved and integrated tenure information management has been inferred. However, there is a need to reiterate the need for improved tenure information management in the administration of human activities, uses, and interests.

There is no doubt that there should be greater focus on tenure administration and improving tenure information management. After all, MPA establishment and management involve engaging a diverse range of parties with a decision-making role, interest, or specific knowledge of the area. This collaborative management approach depends on a shared understanding so that "dialogue can occur on the issues, objectives and options" [Canada, 2002a, p.26].

This might include being able to visualize how existing and proposed regulations will affect rights of individuals, community, and other stakeholders (see for example, LSLK [2002]). Additionally, it might be necessary to not only implement but also justify land use regulatory policies associated with the MPA. This depends on tenure information identification and management. Therefore, an investigation into tenure information requirements, and the role of tenure information in MPA establishment and management, is essential.

MPAs are created to protect a specified location from certain human impacts. This implies that marine activities and interests are important. Therefore, the information systems used

to establish marine activities and interests are as important as the ones used to determine the state of the marine environment in which activities take place.

This paper concludes with the following observation : protecting marine ecosystems involves more than a cursory inspection of other information types. This also applies for information on marine activities and interests. As observed by some researchers, "…science by itself cannot answer all the (*planning and management*) questions…[LSLK, 2002, p.10]". The conference on "Making the Linkages work in Canada's MPAs" provided direction on the need to improve tenure information management by recommending that,

> *"MPAs are about managing peoples activities and therefore their success depends on how well cultural, economic and social values are integrated. Issues like land-use, property rights, distribution of income, community decisions cannot be considered separately from ecological objectives. If certain values are considered separately or ignored, then the overall effectiveness of an MPA as a management tool is diminished [LSLK, 2002,p.32]".*

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Institutional Frameworks in the Administration of Coastal and Marine Space in Africa

Isaac Boateng

Abstract

This paper reviews institutional frameworks in the administration of coastal and marine space in Africa. A basic law of human nature is that Man's needs and wants are unlimited; however, the natural resources of the earth are limited. This makes it obvious that resources need to be managed so as to ensure their sustainability. Coastal and marine spaces have a multiplicity of use, which leads to conflict among users; to avoid conflict there must be rules. Institutions have evolved throughout history, not only to control man but also the way he uses natural resources including coastal and marine space. Therefore, effective administration of any kind of natural resource requires clear understanding of available institutional frameworks and their consequent impact on the management of that resource. Different institutional approaches are needed in different contexts due to variations in cultures, values and societal norms. This paper also considers the nature of resources in coastal and marine spaces and the need for surveyors and other stakeholders to be aware of the importance of institutional frameworks in managing these resources. The paper concludes that in order to meet global challenges, institutional frameworks in Africa have changed from an informal regime to a more formal (constitutional) regime without progressive transition in many cases. This has often led to poor administration of coastal and marine space, lost of right and livelihood of many indigenous peoples who subsist on coastal and marine resources. It therefore, recommends the involvement of all stakeholders' especially local resource users at all levels of institutional change.

1. THEORETICAL BACKGROUND

Institutional frameworks are the criteria for decision-making. Thus, institutional frameworks are the various processes groups of people go through to make collective decisions that govern the group (Organization for Economic Co-operation and Development "OECD", 1993). We live in different societies and communities, which have different environments, cultures, norms and values. These influence our behaviour and the way we think. Hence, we have different criteria for decision-making, which implies different institutional frameworks.

Institutional arrangements are essentially the "rules" influencing human behaviour and include both *formal* and *informal* rules. The formal institutional arrangements are codified in constitutions, statutes, regulations plans and policies. The informal institutional arrangements are manifest in social expectations such as the rules governing relationship within a family, firm or community (Smajgl et al, n.d.)

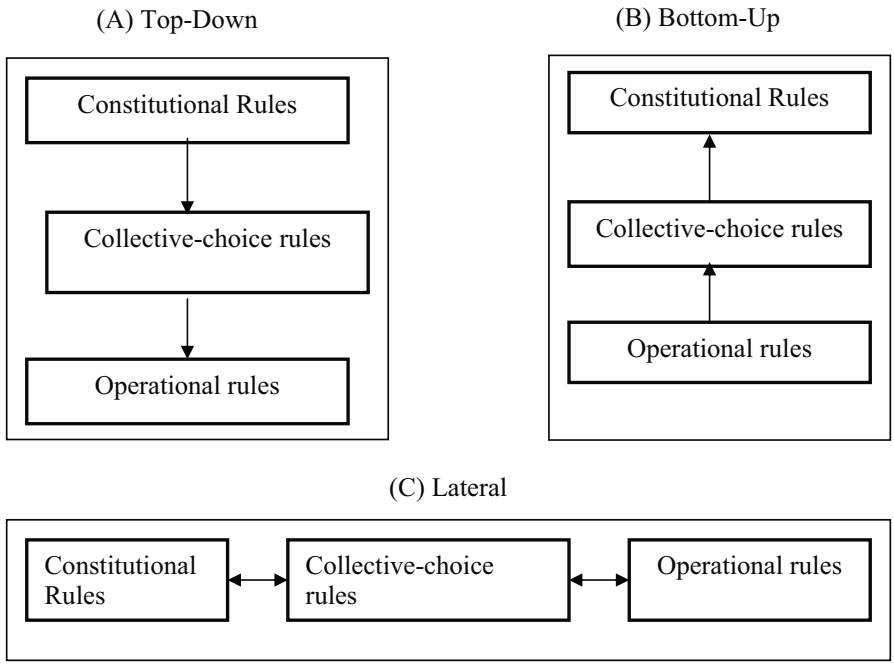
Coastal and marine space administration on the other hand is broad in scope and meaning and therefore may vary slightly in different settings. Resource management is concerned

with the physical or biological functioning of part of the environment but also with the allocation of resource products within the framework of particular legal and cultural settings (Mather and Chapman 1995). This means that coastal and marine space administration tries to ensure that the uses of coastal and marine resources are physically possible, economically viable, culturally acceptable and sustainable. However, each of these dimensions is complex.

Mather and Chapman (1995) identified that the basic objective of resource management (administration) is to ensure that present levels of exploitation are consistent with the replacement of stocks to ensure long-term sustainability. Therefore, any management approach (Sectoral, Integrated and Collaborative management) can be adopted in the administration of coastal and marine space provided it does not conflict with the basic objectives of resource management.

1.1 Types of Institutional Arrangement That Have Evolved

Ostrom (1990) distinguishes three levels of institutional arrangements as: operational rules (day-to-day working rules made by resource users), collective-choice rules (rules used by users and external agents) and constitutional-choice rules (determine eligibility to participate in the system and set out rules that will be used to design collective-choice rules). Ostrom's levels of institutional arrangements have been used to illustrate types of formal institutional arrangements as shown in Figure1.



Figures 1: Types of Institutional Arrangements
After Ostrom, (1990)

Institutional arrangements broadly viewed may be "Top-down", "Bottom-up" and "Lateral" (collaborative). The Top-down refers to a decision-making process that starts from the constitutional-choice level (national) through collective-choice level (regional/counties) to operational level (local). This is shown in Figure 1(A) where the arrows linking the various levels point from the top (constitutional rules) to down (operational rules), thus indicating that rules and decision are made at the top and then passed on to the bottom.

"Bottom-up" is the opposite of the "Top-up" (from operational through collective-choice to constitutional rule). Figure 1(B) shows "Bottom-up" arrangement and thus the arrows pointing from down to the upper level indicates that rules and decisions are made at the local level and they are then passed on through the regional/counties to the national level.

The "Lateral" (collaborative) arrangement also refers to the process whereby stakeholders from all the three levels come together as partners to make decisions or rules. This is shown with the arrows pointing to each rectangle at the same level in figure 1(C). This implies that rules and decisions are made through collaboration of all the three levels. The three institutional arrangements explained above could be observed in different contexts with different management approaches in coastal and marine space.

2. EVOLUTION OF INSTITUTIONAL FRAMEWORK IN AFRICA

Institutional arrangement in Africa has evolved from Pre-colonial era through colonial era to post-colonial era. The pre-colonial era as indicated in figure 2, refers to the period from the ancient time to the 15th century. During this period, Africans evolved from "no Institutions" (hunting and gathering, subsistence and nomadic age) to informal institutions (empire and kingdom age). At this era institutions were mostly informal and include customs, norms and taboos. They were made collaboratively by group of people who came together as a kingdom or an empire. It is important to mention that there are historical evidence that indicates the existence of formal and somewhat 'top down' institutional frameworks in Africa at this era but these were not related to coastal and marine issues. During this time, administration of coastal and marine space was not an issue since people's attention were on the control of land, territories and land-based trade routes.

The colonial era is the period between the late 15th century and mid 20th century. This era in Africa saw the transformation of institutions from mostly informal and "lateral" arrangement to a formal but "top down" arrangement. The change met a strong opposition at the beginning but the colonial powers generally used undemocratic means to suppress the opposition. During this era, the issue of coastal and marine administration was very strong due to the struggle amongst both Europeans and Africans over the control coastal territories, marine routes and the hinterland for trade. These struggles led to the signing of treaties (formal institutions) among European merchants and the partition of Africa into many colonies (which later became countries).

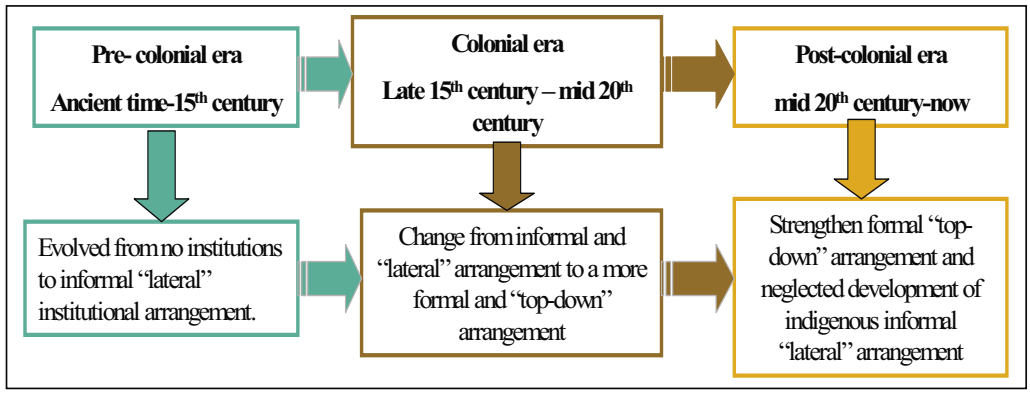


Figure 2: Time line of evolution of institutions in Africa.

The period between the mid 20th century and now can be classified as the Post-colonial era. This period saw the rise of nationalism, and Africans came to identify that colonisation is a form of oppression: hence the fight for independence (British Broadcasting Corporation; BBC). However, after independence, Africa leaders adopted and strengthened the formal "top-down" institutional arrangement of their previous masters and neglected the development of the indigenous informal, "lateral' (collaborative) arrangements. The reason is that after independence African governments realised that in order to secure the power to govern and to carry out development, there is the need to control land and other valuable national resources, which were controlled by tribal chiefs and ethnic groups. To be able to achieve these objectives, governments in Africa resorted to the use of "top-down" institutional arrangements left by the colonial rulers. This led to displacement, loss of rights and livelihood of many indigenous people who subsisted on coastal and marine resources and space where Western development had been established.

The issue of administration of coastal and marine space during this period does not only relate to national and international conflict over coastal settlement, trade and sea routes, but also over-exploitation of coastal and marine resources, international rights over coast and high seas, pollution, endangered species, conservation and sustainability. These problems have led to the development of many National, Regional, Intra-national and International actions and institutions such as (UNEP, 2002):

- United Nations Convention on Law of the Sea (UNCLOS) adopted in 1982;
- United Nations policy on environment and sustainable development (Agenda21) adopted in 1992;
- Convention on Fishing and Conservation of the Living Resources of the High Seas (Geneva, 1958);
- African Convention on the Conservation of Nature and Natural Resources (Algiers, 1968);
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar, 1971);
- Convention for the Protection of the World Cultural and Natural Heritage (Paris, 1972);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (Washington, D.C., 1973).
- Convention on Migratory Species of Wild Animals (Bonn, 1979);

- African Convention on the Conservation of Nature and Natural Resources (1968);
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973).

It is important to note that institutional arrangements in Africa have gone through three stages of evolution and two transitions as illustrated in Figure 2. The two transitional periods (pre-colonial era to colonial era and colonial era to post-colonial era) were "revolutionary" (based on force) rather than education, collaboration and building of consensus for change. Therefore the new institutional framework in Africa (formal & top-down) met strong opposition. Due to this, the informal institutions operated alongside the new institutions without integration. The formal "top down" institutions also became difficult to enforce since they were not developed on consensus among the population and therefore, lacked general acceptance. This situation, possibly, led to numerous problems and the subsequent ineffective administration of coastal and marine space in Africa.

However, the new international "order of thinking" in respect of environmental resource management, which gives preference to the involved stakeholders (participation) at all levels in the decision-making process, compels African leaders and policy makers to change their institutional arrangements. The pressure comes in the form of African countries accession and ratification of international conventions, resolutions and policies, example Agenda 21, which gives clear guidelines for their implementation.

3. COASTAL AND MARINE RESOURCES

The coast is the area where the land and sea interact. The marine area also refers to the entire ocean and the associated high-energy coastline. Coastal Zone is a dynamic system and is a result of interaction with atmospheric processes, the operation of varied ecosystems and coastal processes, and catchments activities as well as the different degree of development present (OECD 1993).

Coastal and marine resources are numerous. They range from land, forest, coastal waters, (lagoons, estuaries, inland waters, wetlands), reefs, seawater, waves, minerals and hydrocarbons to living marine organisms. The competing demand for these resources often generate conflicts between different users, such as developers, shipping, conservationists, indigenous people, as well as within user groups (OECD 1993).

Figure 3 shows clearly that the Coastal and marine space have multiplicity of uses, which often leads to conflict. OECD, (1993) identified that to avoid conflict, in a multiple use resource there must be rules, hence the importance of institutions frameworks in the administration of coastal and marine space.

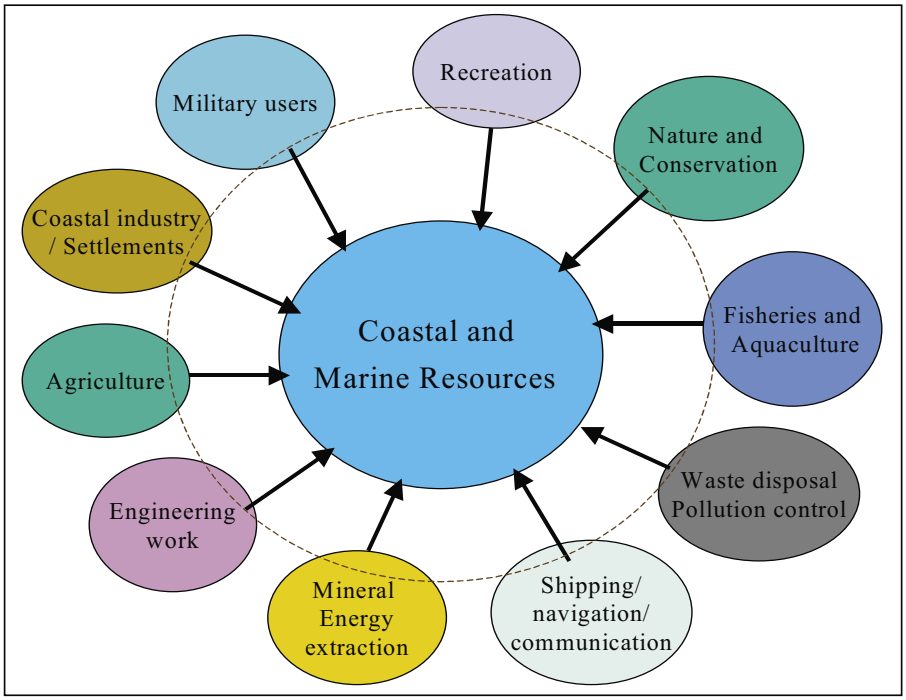


Figure 3: Competing Demand For Coastal And Marine Recourses

Because resources are scarce in relation to the demand for it, the scramble for the usage of resources at the coastal and marine space by man is ubiquitous and from antiquity. This has resulted to different property rights. The property rights in coastal and marine space range from open access (no specific right), common access (access by membership), common pool (access by identified group) and private property (clearly defined access) to public or state property (access right for public held in trust by the state) (McKean, (1992). Using nautical distance, UNCLOS sets out clearly coastal and marine areas that nations can apply these rights (http://www.globelaw.com/LawSea/lsconts.htm).

The resource types on the continuum in Figure 4 differ in terms of rights over the resource. According to Steins and Edwards, (1996) any open access resource does not become a common property until the users have agreed on the establishment of a set of working rules determining decision-making structures, resource allocation, excludability and pay-offs. However, the agents of institutional transformation in Africa, possibly, did not follow this change process.

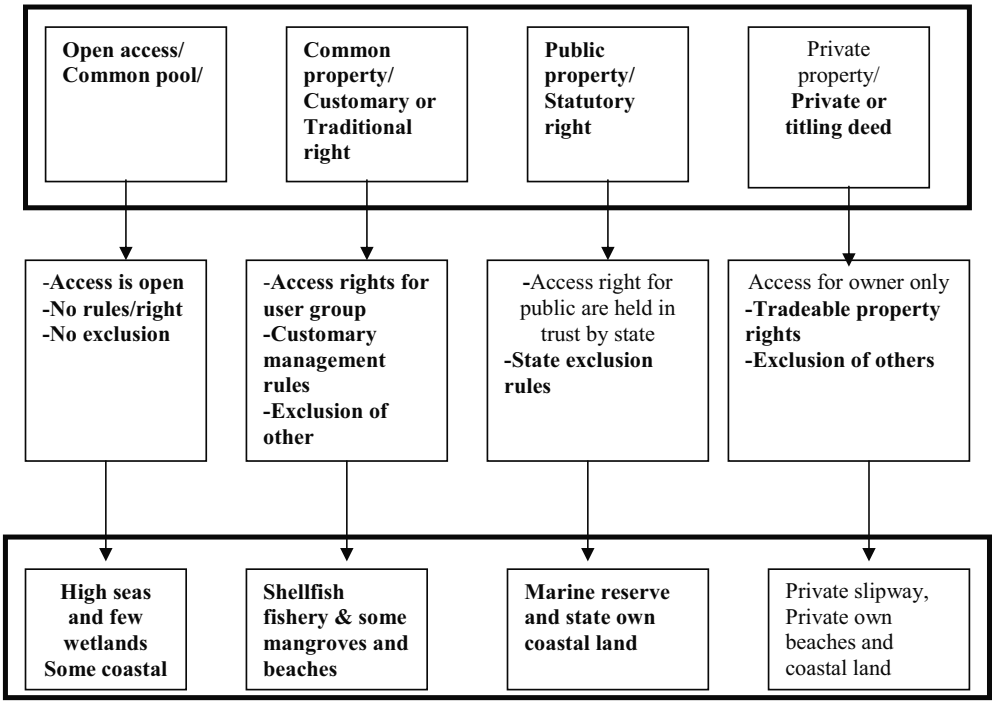


Figure 4: Continuum of Coastal and Marine Right
(Source: After McKean (1992))

4. ADMINISTRATION OF COASTAL AND MARINE SPACE

Mather and Chapman (1995) reported that there are side effects of resource use, which impinge on persons other than the user. They call these side effects 'external costs'. External costs are passed on to society as whole or even future generations. The use of coastal and marine space is not without "external cost". Institutions are therefore, needed to make the use of coastal and marine space equitable and sustainable.

Bryson and Crosby (1992) argued that no one alone could reverse environmental damage (external cost). Instead, in order to marshal the legitimacy, power, authority, and knowledge required to tackle any major public issue, organisations and institutions must join forces in a "shared-power" world. This implies that administration of coastal and marine space requires the involvement of all stakeholders.

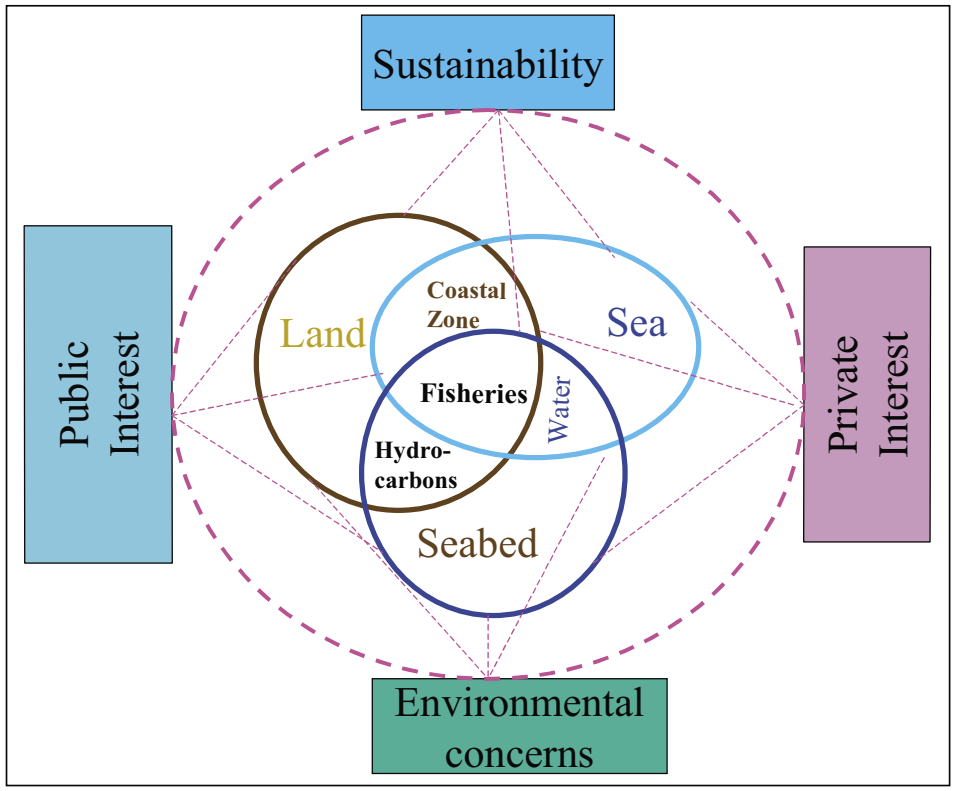


Figure 5: Relationships, Interest and Concerns in the Administration of Coastal and Marine Space

Figure 6 illustrate the complexities of issues and interest in the administration of coastal and marine space. The interactions between land, sea and seabed give out fisheries. Land and seabed provide hydrocarbons, seabed and sea also leads to seawater while interaction between land and sea gives coast zone and its ecology. Exploitation of all these sets either by public or by private investors raises environmental concerns and the issue of sustainability. These concerns are difficult to resolve due to related problems, which are many.

Four problems are related to the administration of coastal and marine space:

- It has no clearly defined boundaries;
- International in nature (because water travels);
- It is dynamic, due to the interaction of physical and human processes;
- It is characterised by multiple users.

These problems have enormous impact on the management of coastal and marine space. Surveyors and all stakeholders involve in its administration need to have knowledge of the nature coastal and marine resource and the associated management problems outlined above. In addition, they need to be aware of the type of formal and informal institutional

arrangements available and how it impact on the current management. This knowledge will help in the appraisal of the current management issues and the development of appropriate institutional framework for sustainable management. It must be noted here, that society is different in terms of culture, values and norms. Therefore, there are different interaction processes between peoples and a resource. This implies that different institutional frameworks may work for different contexts in the administration of coastal and marine space.

Chapter 17 of the UN Conference on Environment and Development (Agenda 21) in 1992 was devoted to the marine environment and stresses the need to reach integration, to apply preventive and precautionary approaches and aim at full participation of public (Cicin-Sain and Knecht, 1993).

Agenda 21 advocates for the move away from the "top-down" institutional framework to a more "lateral" and "bottom-up" approach in the management of coastal and marine space. This is because it has been identified that users' participation is an essential part in the management of a pressured resource. This is because any institutional arrangement, which attempts to change or undermine the "status quo" of resource access without the participation of the users, can be futile (Islam, 1998). This implies that the former "top-down" approach was a recipe for failure. There is, therefore, a ring of truth to the rationale that local communities are likely to be the best caretakers of the environment, as it is primarily in their own interest to manage their resources sustainably.

In Africa institutions and policies regarding management and access to coastal and marine space are not effectively developed to ensure participation and equity. Against this background is rapid population growth, urbanisation, rural to urban migration, increased tourism and industrialisation. These have increased pressures on the coastal and marine space, which is the 'cradle' of development, economic activities. Agenda 21 was to have a significant impact on development of internationally acceptable institutional framework for sustainable management of environmental resources in Africa.

However, only South Africa has formally adopted a national Agenda 21 strategy. Although Cameroon, Cote d'Ivoire, and Ghana have not formalized national plans, they have implemented national policies and laws that address issues related to sustainable development. For example, laws have been promulgated on environmental impact assessment; sustainable use of water, forests, and biodiversity; and management of solid wastes. It is important to note that as at 2002, ten year down the inception of Agenda 21, only 28 out of the 53 countries in Africa has implemented activities that are related to Agenda 21. It is worth noting here that 6 of the 28 countries that have implemented Agenda 21 related programmes are landlocked and have no coast or marine related issues.

Table 1: African Countries with Local Agenda 21 Activities

Country	Number of Local Agenda 21 Initiatives
Algeria	3
Benin	1
Burundi	**2**
Cameroon	1
Congo, Democratic Republic of	2
Egypt	7
Gabon	1
Ghana	3
Kenya	11
Libya	2
Madagascar	5
Mali	**2**
Malawi	**4**
Mauritania	1
Morocco	5
Mozambique	2
Namibia	5
Nigeria	5
Rwanda	1
Senegal	3
South Africa	20
Sudan	1
Tanzania	13
Togo	2
Tunisia	1
Uganda	**5**
Zambia	**4**
Zimbabwe	**39**

Source: National Academic Press (NAP)(2002)

Non-coastal countries

The challenges of implementing Agenda 21 were discussed at three regional consultations by African leaders in 2002. The challenges, identified, include the following (NAP 2002):

- Inappropriate institutional frameworks in most countries, particularly a lack of co-ordination among ministries and across sectors;
- Inadequate co-ordination between governments, NGOs, and the private sector;
- Lack of appropriate legal frameworks;
- Lack of national consultation prior to signing international agreements and the proliferation of those agreements, which results in signing conventions without full

knowledge of the implications to the countries and without having the capacity to translate these agreements into action;
- Poverty, illiteracy, and lack of awareness create problems in the development and implementation of sustainable development programmes.

The challenges outlined above illustrate the inadequate experience and poor legal framework to adapt to a more participatory and democratic institutional arrangement for managing resources in Africa. The reason could be that previous institutional transitions were not based on participation and democratic principles. Hence African governments perceive the current participatory approach as a new phenomenon, which is time-consuming and difficult to implement given the available institutional structures. There is therefore the need for policy-makers, surveyors and other social scientists to get involved in the dialogue and discussion to develop appropriate mechanisms that will ensure the realisation and sustainability of participatory institutional approach to the management of environmental resources in Africa.

5. SUCCESS STORIES IN AFRICA

It is very important to indicate that in spite of the numerous setbacks encountered in the development of institutional frameworks for managing coastal and marine space in Africa, some successes have been achieved in many African countries. These occur where either government agencies or NGO acknowledge the importance of local institutions and resource users and therefore adopt participatory, integrated and collaborative approach to manage coastal and marine resource(s) in a specific area within a country. Below are three of such success management stories in Africa.

5.1 Collaborative Mangrove Management of Tanga: Tanzania (Nurse and Kabamba, 1999)

Tanga is one of the Northern regions of Tanzania. It coastline covers approximately 130km from the Kenyan border in the North, to Sadani Game Reserve in the South. About 150,000 people live in coastal villages and rely on a number of activities to maintain the household economy. Artisinal fishing and farming are the most important of these activities.

In Tanga, the larger fragments of coastal forest (mangrove) are under some form of reserve status (traditional sanctuary sites). Following a period of one party rule under a socialist model, indigenous management system for common pool resources broke down with the formalisation of power in the villages. This led to resource management problem. The key issues related to coastal forest management in Tanga are:
- Increase pressure on the coastal forest from local and various commercials;
- Ineffective protection and policing by the forestry field staff;
- Lack of habitat restoration and development;
- Deprivation of communities' subsistence by local and commercial users;
- Degradation of the coastal forest; and
- Growing conflict over resources between local community and the government.

5.1.1 Change Process

A recent move towards multi-party democracy offered opportunity to build partnerships for conservation and development with institutions other than government at the village level. With technical assistance from IUCN and funding from Irish Aid, an integrated programme aimed at building capacity in local communities and in government was developed and implemented to ensure that coastal resources can be protected, utilised and managed for the benefit of present and future generations of residence.

The programme planners adopted a collaborative management approach because of the strong desire by the villages to maintain the mangrove as a common pool resource, rather than retain it as state controlled resource or private land. Following a community led planning process with programme staff, the villages established a number of committees (local institutions) to deal with management of Tanga natural resources.

These local institutions come together to form the 'village government'. Other institution involve were: Ministry of Land and Environment (MOLE), responsible for the management of natural resources in the country; Ministry of Agriculture (MOA), responsible for the management of agriculture; and Forestry Department (FD), responsible for protection and policing of forest resources. Figure 7 shows institutional arrangements and interactions of Tanga mangrove management.

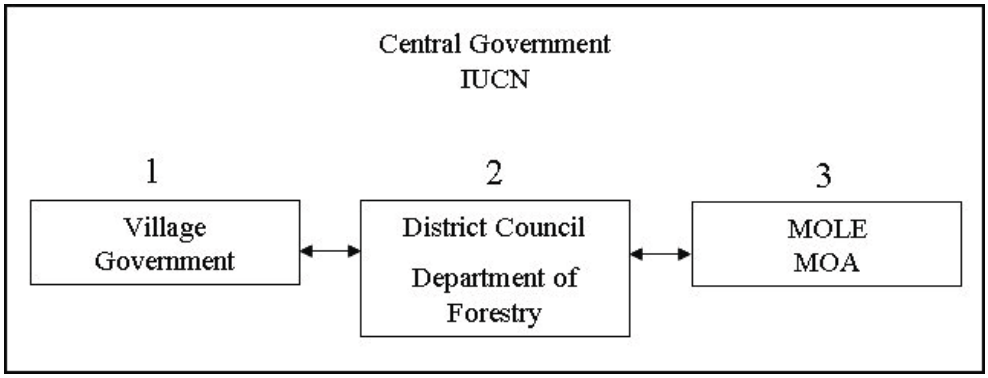


Figure 6. Institutional Arrangements of Tanga Mangrove Management

The rectangle numbered 1, 2, and 3 indicate operational, collective-choice and constitutional rules respectively the position of the arrows show the level of interaction, while the big rectangle stands for the Physical and technical attributes of Tanga and the socio-economic characteristics of the user group. The criteria for decision-making or rules as shown in figure 5 are collaborative. Thus all the stakeholders come together as partners to make rules. The Village Government (village committees), District council and Department of Forestry (district interest) and MOLE and MOA (national interest) come together as partners and collaborate to make rules. The Central government and IUCN above the rectangles were not part of the decision-making process; however, they provide advice and assistance on Demand.

5.1.2 Outcomes

The outcomes of the programme were as follows:

- Improved resource base to satisfy the livelihood need;
- Helped the communities to re-gain their sense of ownership thereby reducing the conflict;
- Define clearly boundaries of access, reserve and use;
- Increased awareness among user on sustainable management of the mangrove;
- Increased habitat restoration; and
- Reduced the cost of protection of the mangrove.

5.2 Integrated coastal zone management in Madagascar (Wildlife Conservation Society)

In Madagascar, the Antongil Bay region is known for its rich biodiversity. Half of all currently known floral species in Madagascar occur in the area. Overall, the strong impacts of several anthropogenic pressures threaten the integrity of the terrestrial and marine ecosystems in and around the bay. Wildlife Conservation Society (WCS) a non-governmental organisation (NGO) is not only concerned with the conservation of the environment, but with the well being of the local population. WCS has initiated ICZM procedures that ensure all concerned parties are included in the creations of a strategy and an action plan for the management of resources, and will work together to implement it.
Key marine threats faced by Madagascar, many of which are common to countries around the region, are:

- Uncontrolled industrial fishing, especially by illegal unlicensed unregulated vessels;
- Industrial trawling, especially on shallow continental shelf seas and sea mounts;
- Degradation of coral reefs through over-fishing, climate change effects and sedimentation;
- Hunting or incidental capture of large marine fauna (dugong, dolphins, sea turtles, sharks and sawfish);
- Local extirpation of high-value species such as sea cucumbers;
- Conflicts between resource users over access to resources;
- Insufficient protection for marine environment;
- Insufficient capacity and information management.

WCS activities that have contributed greatly to sustainable management of coastal zone of Madagascar and Antongil Bay in particular include:

- Promotion of the collaboration with potential partners (international, national, regional et local)
- Implementing ICZM procedures listed below:
- The preparation of a consultation process, to deal with the identification of concerned parties and their problems in relation to their interests concerning resource management.
- The consultation: bring together the environmental managers (authorities, users, technicians and researchers) at one table to find a common management approach.
- Activities following consultation: finalize and implement the integrated management plan
- Put together an Information, Education and Communication (IEC) program

5.3 Community Participation for Conservation of Marine Turtle in Ghana (Olesu and Baidu, 1998)

In Ghana, the Wildlife Conservation Regulation, L.I 680, 1971, protects marine turtles and the hunting, capturing or destruction is absolutely prohibited. These wildlife regulations notwithstanding, marine turtles continue to face various forms of threat, which are responsible for the increased mortality rate on the Ghanaian beaches. Past studies reported the occurrence of five species of marine turtles on the Ghana coast. These were: the Leatherback, the Green, Olive Ridley, Hawksbill and the Loggerhead. But a more recent study carried out in 1994 by the Coastal Wetlands Management Project did not record the hawksbill and the loggerhead. The major threats to marine turtle population in Ghana were;

- Predation on eggs and juveniles by domestic animals especially pigs and dogs,
- Human exploitation also contributes to the decline in turtle population in Ghana.
- Coastal erosion and beach development, which destroy some good turtle nesting habitats
- Dumping of rubbish on the beaches has also contributed to the mortality of turtles.

5.3.1 The Change Process

The initiative by the Ghana Wildlife Society to adopt a strategy, which actively involves the local coastal communities in the conservation of marine turtles, emerged from the fact that the past policies which excluded local communities in the management of wildlife resources were ineffective. The community participation process in the conservation of marine turtles started with a national workshop in, 1995. The workshop brought together chiefs, representatives of communities living along the coast, scientists and conservationists from the universities and relevant government departments. Some of the important recommendations from this workshop, among others were that:

- The District assemblies should be encouraged to formulate byelaws to regulate the rearing of domestic animals, which prey on turtles.
- Animal owners should be assisted to construct structures to ensure better husbandry.
- Community task forces should be formed to be responsible for education and turtle conservation activities.
- Alternative economic activities to be promoted to reduce pressure on turtles as a means of livelihood.
- Fishermen whose nets are destroyed by turtles should be compensated as an incentive to release them back into the sea.

Immediately after the workshop, the Ghana Wildlife Society started consulting and working with the communities to form the Turtle Conservation Task Force. The communities, through the chiefs, District assemblymen and other opinion leaders nominated two members from each of the 17 main communities in the project area (Volta estuary and Prampram near Accra; 80km stretch) for inclusion in the Task Force. The 34-member task force was formally inaugurated in June 1996. The role of the community turtle task forces include:

- Educate the communities about the status of marine turtles in the country and the need to stop the killing and egg collection.
- Report killing and egg collection to the chief in the first instance

- Identify important nesting sites and protect any nests found from predators and natural hazards such as erosion to ensure successful hatching of the eggs.
- Liaise with fishermen to release any turtles caught accidentally in fishing nets.
- Assist in the collection of scientific data needed for the management of turtles
- Serve as a link between the coastal communities and the Ghana Wildlife Society.
- Play a lead role in mobilising the people in community projects initiated by the Society aimed to enhance marine resources conservation.

A series of training programmes were organised by the Society for the task force members to enable them to perform the above functions effectively. The turtle conservation strategy advocated is grounded in partnership between the local communities, the Ghana Wildlife Society as an NGO and relevant Governmental agencies such as the Wildlife Department. In this partnership the coastal communities are recognised as the key stakeholders who play a central role in the turtle conservation efforts with assistance from the external agencies.

5.3.2 Outcomes

The most important achievement of the turtle conservation project has been a dramatic change in people's attitude and behaviour towards marine turtles. This may be attributed to an increased awareness of the turtle problem due to the activities of the Society and the community turtle task forces. Task force members have reported that fishermen often invite them to come and witness the release of turtles accidentally caught back into the sea. Hitherto, accidentally caught turtles were killed. The formation of the turtle task forces also provides an immediate point of contact for community people who want to report egg collection or killing of turtles.

The Task Force members assist in collecting data on nesting turtles, which are required for long term monitoring of marine turtle populations on the Ghana Coast. This information will also be used to evaluate the turtle conservation project as a whole.

In the long term it is planned that the communities will be involved in the promotion of community-based eco-tourism in the turtle concentration zone. Revenue from this enterprise will be used for the development of the communities. Community-based eco-tourism will also provide an employment avenue for some of the unemployed youth in these communities.

6. CONCLUSIONS

Institutional arrangements have been developed which now adequately protect the values of nature-based systems and deliver improved socio-economic conditions for people in communities. However, institutional arrangements can be unpopular and possibly, make resource management ineffective if the arrangements are changed without due recognition of informal institution. Knowledge in the available formal and informal institutions and their effects in enhancing or detracting resource management help in designing and implementing integrated institutional framework for current and future resource management in a sustainable way.

Participation of the stakeholders (resource users) is very important in the administration of coastal and marine space. Any institutional arrangement or management plan, which does not involve the resource users, is likely to conflict with users' interests as well as the informal institutions of the users. Such conflict normally brings ill feeling among users and may possibly cause more resource degradation and depletion rather than resource management. Surveyors and other coastal and marine space administrators need to be aware of this.

The process of developing institutional frameworks for the management of coastal and marine resources in Africa encountered some setbacks; hence there have been gaps that need to be bridged.

African leaders and policy makers should recognise the indigenous institutions and the need to integrate the formal institutional frameworks to the informal (indigenous) institutional frameworks. This can be achieved through education and research, strong community participatory and collaborative decision-making approach. If this is done, it will broaden the ownership of the laws and policies, empower their people and also increase their commitment to implementation, which could likely lead to sustainable management of coastal and marine space.

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Impacts and Management of Oil Spill Pollution along the Nigerian Coastal Areas

Peter C. Nwilo and Olusegun T. Badejo

Abstract

Nigeria has a coastline of approximately 853km facing the Atlantic Ocean. This coastline lies between latitude 4^o 10' to 6^o 20' N and longitude 2^o 45' to 8^o 35' E. The Nigerian coast is composed of four distinct geomorphology units namely the Barrier-Lagoon Complex; the Mud Coast; the Arcuate Niger Delta and the Strand Coast. In 1956, Royal Dutch Shell discovered crude oil at Oloibiri, a village in the Niger Delta, and commercial production began in 1958. Today, there are about 606 oil fields in the Niger Delta, of which 360 are on-shore and 246 offshore. Nigeria is now the largest oil producer in Africa and the sixth largest in the world, *averaging 2.7 million barrels per day (bbl/d) in 2006. Nigeria's proven oil reserved is 35.2 billion barrels. Nigeria's economy is heavily dependent on earnings from the oil sector, which provides 20% of GDP, 95% of foreign exchange earnings, and about 65% of budgetary revenues. Since the discovery of oil in Nigeria in 1956, the country has been suffering the negative environmental consequences of oil exploration and exploitation. Between 1976 and 1996 a total of 4647 incidents resulted in the spill of approximately 2,369,470 barrels of oil into the environment. In addition, between 1997 and 2001, Nigeria also recorded a total number of 2,097 oil spill incidents. In 1998, 40,000 barrels of oil from Mobil platform off the Akwa Ibom coast were spilt into the environment causing severe damage to the coastal environment. Several oil spill management policy and efforts are in place to reduce the menace of oil spill incidents in the country. Some of these policies and efforts were made by the Federal Government, Non governmental agencies and oil firms in the country. The use of oil trajectory and fate models is also incorporated in oil spill management policy in the country. We have developed a new oil spill trajectory model. The results from a hypothetical simulation with the model from a point around OPL 250 located about 150km off the Nigerian coastline shows that the simulated oil spill for wet season reached the shore (around Penington River) after 104hours (about 4.5 days). Also during the dry season, the results from the model indicate that the oil spill reached the shore (at the entrance of Benin River) after 162hours (6.5days).*

1. INTRODUCTION

Nigeria is bordered to the North by the Republics of Niger and Chad, to the West by the Republic of Benin, to the East by the Republic of Cameroon and to the South by the Atlantic Ocean (Dublin Green et al, 1999). Nigeria has a coastline of approximately 853km facing the Atlantic Ocean. This coastline lies between latitude 4^o 10' to 6^o 20'N and longitude 2^o 45' to 8^o 35' E. The terrestrial portion of this zone is about 28,000 km^2 in area, while the surface area of the continental shelf is 46,300km^2. Figure 1 below is the Map of the Nigerian Coastal Areas.

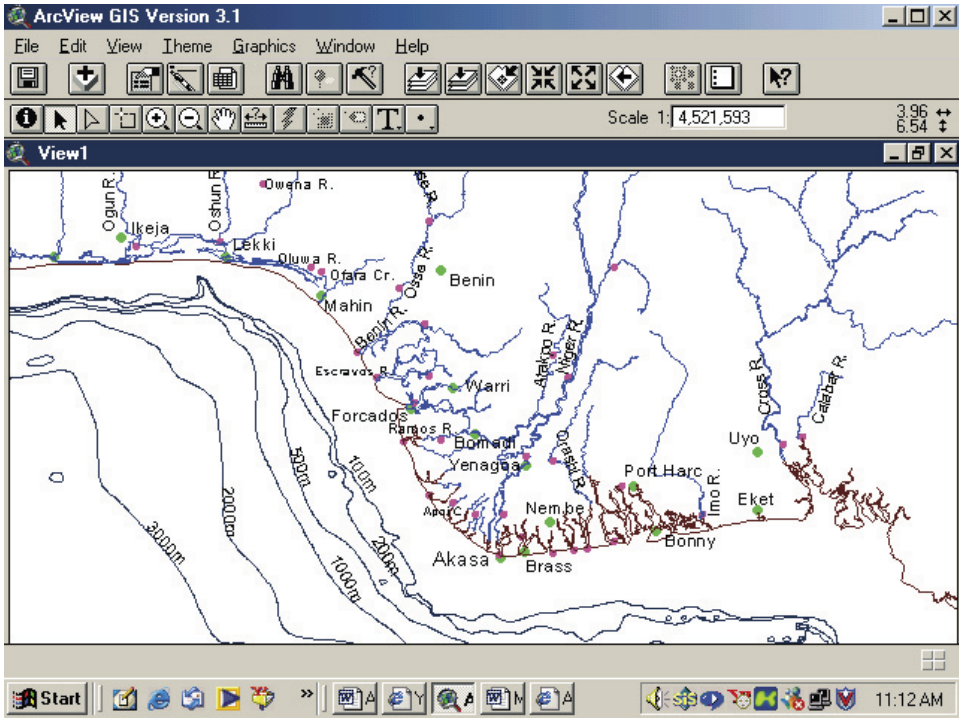

Figure 1: Map of Nigerian Coastal Areas

1.1 Climate of Nigeria's Coastal Areas

The coastal area is low lying with heights of not more than 3.0 m above sea level and is generally covered by fresh water swamp, mangrove swamp, lagoonal mashes, tidal channels, beach ridges and sand bars (Dublin- Green *et al*, 1997). Nigeria's total land and water area is 923,768 sq km, with the area of the land being 910,768 sq km while that of water is 13,000 sq km (CIA World Fact Book, 2005).

The Nigerian coastal zone experiences a tropical climate consisting of rainy season (April to November) and dry season (December to March). High temperatures and humidity as well as marked wet and dry seasons characterize the Nigerian climate. The coastal areas have an annual rainfall ranging between 1, 500 and 4,000 mm (Kuruk, 2004).

The Nigerian coastal area experiences mainly the south westerlies which are onshore and confined generally to azimuths of 215^{o}-266^{o} with velocities of 2-5m/s. During the rainy season, wind speed increases to about 10m/s especially during heavy rainfalls and thunderstorms.

Temperatures in the coastal areas are moderated by the cloud cover and by the generally damp air. However, mean monthly temperature vary between 24^{o} C and 32^{o} C throughout the year.

The surface water of the Nigerian coast is basically warm with temperature generally greater than 24^{o}C. Sea surface temperatures show double peaked cycles, which match quantitatively the cycle of solar heights. Between October and May, Sea surface temperatures range from 27^{o}-28^{o}C, while during the rainy season of June to October, the range is between 24^{o} and 25^{o}C. (Dublin Green et al, 1999). The surface water is typically oceanic surface water of the Gulf of Guinea with salinity generally less than 35.00%. (Dublin Green et al, 1999).

1.2 Hydrology of Nigeria

The hydrology of Nigeria is dominated by two great river systems, the Niger-Benue and the Chad systems. With the exception of a few rivers that empty directly into the Atlantic Ocean, all other flowing waters ultimately find their way into the Chad basin or down the lower Niger to the sea. (Kuruk, 2004).

The inland water system includes thirteen lakes and reservoirs with a surface area of between 4000 hectares and 550,000 hectares, and has a total surface area of 853,600 hectares, which represents about one percent of the total area of Nigeria. They include lakes Chad, Kainji, Jebba, Shiroro, Goronyo, Tiga, Chalawa Gorge, Dadin Kowa, Kiri, Bakolori, Lower Anambra, Zobe and Oyan. With the exception of Lake Chad, all the lakes are man-made (Kuruk, 2004).

The Lagos lagoon is one of several lagoon systems in the West African sub region and most extensive. The lagoon is part of the barrier lagoon coasts of Nigeria. The water is shallow and covers an area of about 208km^2 (Ekundayo and Akpata, 1978). The lagoon is fed mainly by the rivers of Ogun, Shasha, Oshun, Agboyi and Majidun; the Ogudu creeks and waters of Epe and Lekki lagoons. The Lagoon empties into the Atlantic Ocean via Lagos harbour. The southern margin of the Lagos Lagoon is bounded by the Five Cowrie Creek, the eastern margin by the Palavar Islands and its northern border by Ikorodu. The lagoon is 40 – 64km long and has two arms; one connects the Lekki Lagoon while the other leads northward into the hinterland (Allen, 1965). The lagoon is shallow with depths of 1.5 – 3m (Ibe, 1988), and made up of muddy and sandy bottom. Its bottom relief is negligible.

Deltas and estuaries, with their saline wetlands have a total surface area of 858,000 hectares, while freshwaters cover about 3,221,500 hectares. Other water bodies, including small reservoirs, fish ponds and miscellaneous wetlands suitable for rice cultivation cover about 4,108,000 hectares (Kuruk, 2004).

The entire Gulf of Guinea is highly stratified with a thin surface layer of warm fresh tropical water (Longhurst 1964). The stratification of the upper water column along the Gulf of Guinea is generally very strong except in areas subject to upwelling events.

1.3 Geology of Nigeria's Coast

The Nigerian coastal geology is basically sedimentary and is dominated by the geology of arcuate Niger delta. The Niger delta is composed of an overall classic sequence which reaches a maximum thickness of 9-12 kilometers (lbe 1988). The Nigerian continental shelf is narrow

in the west (less than 30km) but relatively broad off the Niger Delta and the eastern flank where it measures 45-80 km in width. The shelf is interrupted by several submarine canyons which include Avon, Mahin and Calabar Canyons

1.4 Geomorphological Units of Nigerian Coastal Areas

The Nigerian coast in composed of four distinct geomorphological units namely the Barrier-Lagoon complex; the Mud coast; the Arcuate Niger delta; and the Strand coast (lbe 1988). The geomorphology of the Lagos Lagoon is classified under the Barrier-Lagoon Complex, which extends for about 250km from the Nigerian/Benin Republic border to Ajumo village. The Complex consists of narrow beach ridges, which are aligned parallel to the coast. The beach sediments varied from medium to coarse-grained sand.

1.5 Vegetation of Nigeria's Coastal Areas

The vegetation of the Nigerian coastal area is characterised by mangrove forests, brackish swamp forests and rain forests. The country's extensive mangrove ecosystem, a great proportion of which lies within the Niger Delta and found mainly in the Rivers, Delta, Cross River, Akwa lbom, Lagos and Ondo states, is estimated to cover between 500,000 and 885,000 hectares. Freshwaters start at the northern limit of the mangrove ecosystems and extend to the Sahelian region (Kuruk, 2004).

1.6 Oil Exploration and Exploitation

In 1956, Shell British Petroleum (now Royal Dutch Shell) discovered crude oil at Oloibiri, a village in the Niger Delta, and commercial production began in 1958. Today, there are 606 oil fields in the Niger Delta, of which 360 are on-shore and 246 off-shore. (Nigeria Country Analysis Brief, 2005). Nigeria is now the largest oil producer in Africa and the sixth largest in the world, averaging 2.7 million barrels per day (bbl/d) in 2006. Nigeria's economy is heavily dependent on earnings from the oil sector, which provides 20% of GDP, 95% of foreign exchange earnings, and about 65% of budgetary revenues (CIA World Fact Book, 2005).

Nigeria's state-held refineries (Port Harcourt I and II, Warri, and Kaduna) have a combined capacity of 438,750 bbl/d, but problems including sabotage, fire, poor management and lack of regular maintenance contribute to a low current capacity of around 214,000 bbl/d, according to World Markets Research Center. Plans for several small, independently-owned refineries are also being developed, with the Nigerian government planning for three new refineries to come onstream by 2008. *(*Nigeria Country Analysis Brief, 2005*)*

1.6.1 Oil and Gas Reserves in Nigerian Coastal Areas

Oil and Gas Journal (2005) estimates Nigeria's proven oil reserved at 35.2 billion barrels. The Nigerian government plans to expand its proven reserves to 40 billion barrels by 2010. In February 2005, Nigeria announced the award of five oil blocks in the Joint Development Zone (JDZ), shared by Nigeria and neighboring Sao Tome and Principe (STP). The JDZ reportedly holds reserves of 11 billion barrels and could potentially yield up to 3 million bbl/d in the next 2-3 years. Development is also occurring in the waters surrounding the

JDZ. (Nigeria Country Analysis Brief, 2005). Oil and Gas Journal (2005) further stated that Nigeria has an estimated 176 trillion cubic feet (Tcf) of proven natural gas reserves, giving the country one of the top ten natural gas endowments in the world and the largest endowment in Africa.

1.6.2 Oil Spill Incidents in Nigeria

Oil spill incidents have occurred in various parts and at different times along our coast. Some major spills in the coastal zone are the GOCON's Escravos spill in 1978 of about 300,000 barrels, SPDC's Forcados Terminal tank failure in 1978 of about 580,000 barrels and Texaco Funiwa-5 blow out in 1980 of about 400,000 barrels. Other oil spill incidents are those of the Abudu pipe line in 1982 of about 18,818 barrels, The Jesse Fire Incident which claimed about a thousand lives and the Idoho Oil Spill of January 1998, of about 40,000 barrels. The most publicised of all oil spills in Nigeria occurred on January 17 1980 when a total of 37.0 million litres of crude oil got spilled into the environment. This spill occurred as a result of a blow out at Funiwa 5 offshore station. Nigeria's largest spill was an offshore well-blow out in January 1980 when an estimated 200,000 barrels of oil (8.4million US gallons) spilled into the Atlantic Ocean from an oil industry facility and that damaged 340 hectares of mangrove (Nwilo and Badejo, 2005).

According to the Department of Petroleum Resources (DPR), between 1976 and 1996 a total of 4647 incidents resulted in the spill of approximately 2,369,470 barrels of oil into the environment. Of this quantity, an estimated 1,820,410.5 barrels (77%) were lost to the environment. A total of 549,060 barrels of oil representing 23.17% of the total oil spilt into the environment was recovered. The heaviest recorded spill so far occurred in 1979 and 1980 with a net volume of 694,117.13 barrels and 600,511.02 barrels respectively.

Available records for the period of 1976 to 1996 indicate that approximately 6%, 25%, and 69% respectively, of total oil spilled in the Niger Delta area, were in land, swamp and offshore environments. Also, between 1997 and 2001, Nigeria recorded a total number of 2,097 oil spill incidents.

Thousands of barrels of oil have been spilt into the environment through our oil pipelines and tanks in the country. This spillage is as a result of our lack of regular maintenance of the pipelines and storage tanks. Some of these facilities have been in use for decades without replacement. About 40,000 barrels of oil spilled into the environment through the offshore pipeline in Idoho.

Sabotage is another major cause of oil spillage in the country. Some of the citizens of this country in collaboration with people from other countries engage in oil bunkering. They damage and destroy oil pipelines in their effort to steal oil from them. SPDC claimed in 1996 that sabotage accounted for more than 60 percent of all oil spilled at its facilities in Nigeria, stating that the percentage has increased over the years both because the number of sabotage incidents has increased and because spills due to corrosion have decreased with programs to replace oil pipelines (SPDC, 1996).

Pirates are stealing Nigeria's crude oil at a phenomenal rate, funneling nearly 300,000 barrels per day from our oil and selling it illegally on the international trade market.

Nigeria lost about N7.7 billion in 2002 as a result of vandalisation of pipelines carrying petroleum products. The amount, according to the PPMC, a subsidiary of NNPC, represents the estimated value of the products lost in the process.

Illegal fuel siphoning as a result of the thriving black market for fuel products has increased the number of oil pipeline explosions in recent years. In July 2000, a pipeline explosion outside the city of Warri caused the death of 250 people. An explosion in Lagos in December 2000 killed at least 60 people. The NNPC reported 800 cases of pipeline vandalization from January through October 2000. In January 2001, Nigeria lost about $4 billion in oil revenues in 2000 due to the activities of vandals on our oil installations. The government estimates that as much as 300,000 bbl/d of Nigerian crude is illegally bunkered (freighted) out of the country.

In Nigeria, fifty percent (50%) of oil spills is due to corrosion, twenty eight percent (28%) to sabotage and twenty one percent (21%) to oil production operations. One percent (1%) of oil spills is due to engineering drills, inability to effectively control oil wells, failure of machines, and inadequate care in loading and unloading oil vessels.

2. IMPACTS OF OIL SPILL INCIDENTS ON NIGERIAN COASTAL AREAS

Since the discovery of oil in Nigeria in the 1950s, the country has been suffering the negative environmental consequences of oil development. The growth of the country's oil industry, combined with a population explosion and a lack of enforcement of environmental regulations has led to substantial damage to Nigeria's environment, especially in the Niger Delta region.

When there is an oil spill on water, spreading immediately takes place. The gaseous and liquid components evaporate. Some get dissolved in water and even oxidize, and yet some undergo bacterial changes and eventually sink to the bottom by gravitational action. The soil is then contaminated with a gross effect upon the terrestrial life. As the evaporation of the volatile lower molecular weight components affect aerial life, so the dissolution of the less volatile components with the resulting emulsified water, affects aquatic life (Akpofure et al, 2000).

The harmful effects of oil spill on the environment are many. Oil kills plants and animals in the estuarine zone. Oil settles on beaches and kills organisms that live there, It also settles on ocean floor and kills benthic (bottom-dwelling) organisms such as crabs. Oil poisons algae, disrupts major food chains and decreases the yield of edible crustaceans. It also coats birds, impairing their flight or reducing the insulative property of their feathers, thus making the birds more vulnerable to cold. Oil endangers fish hatcheries in coastal waters and as well contaminates the flesh of commercially valuable fish.

In the Nigerian coastal environment a large areas of the mangrove ecosystem have been destroyed. The mangrove was once a source of both fuel wood for the indigenous people and a habitat for the area's biodiversity, but is now unable to survive the oil toxicity of its habitat.

Oil spills in the Niger Delta have been a regular occurrence, and the resultant degradation of the surrounding environment has caused significant tension between the people living in the region and the multinational oil companies operating there. It is only in the past decade that environmental groups, the Federal Government, and the foreign oil companies operating in the Niger Delta began to take steps to mitigate the impacts. Large areas of the mangrove ecosystem have also been destroyed. The mangrove forest was in the past a major source of wood for the indigenous people. In some places it is no longer in a healthy state to sustain this use (Nwilo &Badejo 2005).

The Idoho oil spill traveled all the way from Akwa Ibom state to Lagos state dispersing oil through the coastal states, up to the Lagos coast. This culminated in the presence of sheen of oil on the coastal areas of Cross river state, Akwa Ibom state, Rivers state, Bayelsa state, Delta state, Ondo state and Lagos state.

In many villages near oil installations, even when there has been no recent spill, an oily sheen can be seen on the water, which in fresh water areas is usually the same water that the people living there use for drinking and washing. In April 1997, samples taken from water used for drinking and washing by local villagers were analyzed in the U.S. A sample from Luawii, in Ogoni, where there had been no oil production for four years, had 18 ppm of hydrocarbons in the water, 360 times the level allowed in drinking water in the European Union (E.U.). A sample from Ukpeleide, Ikwerre, contained 34 ppm, 680 times the E.U. standard.

Following the major Texaco spill of 1980, it was reported that 180 people died in one community as a result of the pollution. On several occasions, people interviewed by Human Rights Watch said that spills in their area had made people sick who drank the water, especially children.

3. MANAGEMENT OF OIL SPILL IN NIGERIA

Several laws and policies have been taken in managing oil spill incidents at the international and national levels. These laws and policies are given in the following sections:

3.1 Oil Pollution Act (OPA) of 1990

The Oil Pollution Act of 1990 (OPA 1990) is responsible for many of the nation's improvements in oil spill prevention and response. OPA 1990 provides guidance for government and industry on oil spill prevention, mitigation, cleanup and liability. The majority of OPA 1990 provisions were targeted at reducing the number of spills followed by reducing the quantity of oil spilled. OPA 1990 also created a comprehensive scheme to ensure that sufficient financial resources are available to clean up a spill and to compensate persons damaged by a spill. It also ensures that the federal response system is adequately prepared to manage the impacts of oil spills that do occur; and mandates that industry implement prevention and preparedness measures. The OPA also mandates that tankers and inland oil facilities develop individual response plans. Furthermore the OPA also mandates enhancements to the national response system, and development of Area Contingency Plans.

3.2 National Oil Spill Detection and Response Agency (NOSDRA)

A National Oil Spill Detection and Response Agency (NOSDRA) has been approved by the Federal Executive Council of Nigeria. The Ministry of Environment, which initiated the Agency, has also forwarded to the Federal Executive Council for approval, the reviewed draft National Oil Spill Contingency Plan (NOSCP) which the Agency would manage (Alexandra Gas and Oil Connections, 2006)

The establishment of the contingency plan and the agency was in compliance with the International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC90) to which Nigeria is a signatory. The draft bill on the NOSDRA has been forwarded to the National Assembly for deliberation and enactment into law (Alexandra Gas and Oil Connections, 2006).

Apart from intensifying efforts towards compliance monitoring and enforcement of oil and gas regulations and standards, the ministry is also mounting pressure on the oil and gas operators for a gas flare-out. Effort is also being made, according to the sources, to ensure the use of environmental-friendly drilling fluid and mud systems (Alexandra Gas and Oil Connections, 2006)

3.3 The Niger Delta Development Commission (NDDC)

To reduce the rate of oil incidents along the Nigerian Coast particularly as a result of vandalisation, the Federal Government through an act of the National Assembly in 2000 passed into law the Niger Delta Development Commission. (NDDC). The Act among other things, established a Commission to carry out among other things the following tasks:

a. Cause the Niger-Delta area to be surveyed in order to ascertain measures, which are necessary to promote its physical and socio-economic development;
b. Prepare plans and schemes designed to promote the physical development of the Niger-Delta area;
c. Identify factors inhibiting the development of the Niger-Delta and assist the member states in the formation and implementation of policies to ensure sound and efficient management of the resources of the Niger-Delta;
d. Assess and report on any project funded or carried out in the Niger-Delta area by oil and gas producing companies and any other company including non-governmental organisations and ensure that funds released for such projects are properly utilised;
e. Tackle ecological and environmental problems that arise from the exploration of oil in the Niger-Delta area.
f. Liaise with the various oil mineral and gas prospecting and producing companies on all matters of pollution prevention and control.

Essentially, items (e) and (f) deal with issues pertaining to oil exploration and production and the NNDC act is a strategic way of dealing with all forms of pollution from these activities in the Niger Delta.

3.4 Petroleum Related Laws and Regulations

Part of the means of managing the environment is to have in place the necessary laws, regulations and guidelines. According to the Federal Environmental Protection Agency, Lagos Nigeria, the following relevant national laws and international agreements are in effect:

a. Endangered Species Decree Cap 108 LFN 1990.
b. Federal Environmental protection Agency Act Cap 131 LFN 1990.
c. Harmful Waste Cap 165 LFN 1990.
d. Petroleum (Drilling and Production) Regulations, 1969.
e. Mineral Oil (Safety) Regulations, 1963.
f. International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, 1971
g. Convention on the Prevention of Marine pollution Damage, 1972
h. African Convention on the Conservation of Nature and Natural Resources,1968
i. International Convention on the Establishment of an International Fund for the Compensation for Oil Pollution Damage, 1971.

3.5 The Environmental Impact Assessment (EIA) decree No 86 of 1992

The Environmental Impact Assessment (EIA) decree No 86 of 1992 was promulgated to protect and sustain our ecosystem. The law makes the development of an EIA compulsory for any major project that may have adverse effects on the environment (Ntukekpo, 1996; Olagoke, 1996). It sought to assess the likely or potential environmental impacts of proposed activities, including their direct or indirect, cumulative, short term and long term effects, and to identify the measures available to mitigate adverse environmental impacts of proposed activities, and assessment of those measures.(Ozekhome, 2001). The carrying out of EIAs is policed by the Federal Environmental Protection Agency, and by state environmental protection agencies.

3.6 Federal and State Agencies

A number of Federal and State agencies deal with the problems of oil spill in Nigeria. The agencies include: the Department of Petroleum Resources (DPR), the Federal Ministry of Environment, the State Ministries of Environment and the National Maritime Authority.

3.7 Efforts of the Oil Companies and Non Governmental Agencies

Due to increasing awareness in preventing and controlling spills in Nigeria, the Clean Nigeria Associates (C.N.A.) was formed in November 1981. The C.N.A. is a consortium of eleven oil companies operating in Nigeria, including Nigeria National Petroleum Corporation (NNPC). The primary purpose of establishing the C.N.A is to maintain a capability to combat spills of liquid hydrocarbons or pollutants in general (Nwilo & Badejo, 2005).

As a result of the focus on Shell's activities in Nigeria, Shell in collaboration with all the members of Oil Producers Trade Section (OPTS) of the Lagos Chambers of Commerce established the Niger Delta Environmental Survey (NDES). Shell, the OPTS and the

Rivers and Delta States governments provided the necessary funding for the activities of NDES.

The NDES was expected to provide:

a. A comprehensive description of the area, ecological zones, boundaries, and different uses of renewable and non-renewable natural resources;
b. An integrated view on the state of the environment and its relationship to local people;
c. An analysis of the causal relationships between land use, settlement patterns, industry and the environment, to provide a base line for future development planning;
d. An indicative plan for the development and management of the Niger Delta (NDES, 1996).

3.8 Oil Trajectory and Fate Models for Oil Spill Disaster Monitoring

Oil spill simulation model is used in oil response and contingency planning and as a tool in oil fate and impact assessment (Rossouw, 1998). In the event of an oil spill taking place, predictions of the slick can be supplied, provided that the necessary meteorological information is available (Rossouw, 1998). Oil spillage can also be treated or removed by natural means, mechanical systems, absorbents, burning, gelling, sinking and dispersion. Oil spillage can be removed by natural means through the process of evaporation, photochemical oxidation and dispersions (Wardley-Smith, 1977). Bioremediation can also be used for managing oil spill problems (Hoff, 1993; Prince, 1993; Atlas, 1995).

3.9 Nigerian Sat 1

The Nigerian Sat 1 Satellite has joined the Disaster Monitoring Constellation, an international early-warning satellite network transmitting real-time information about droughts, earthquakes, deforestation and man-made disasters observable from space. The Nigeria Sat-1, an Orbit Satellite for geographical mapping, would also help to check the perennial problem of oil pipeline vandalisation, and assist in combating and managing oil spill incidents. The Nigeria Sat-1, would help in monitoring oil spill by providing the spill position which would serve as input data into the oil spill model., It would also give the extent of coastal water and coastal areas polluted. These information are vital for quick clean up of oil impacted areas.

3.10 International Co-operation

To shore up the fight against oil smugglers in Nigeria, the US has donated three 56 metre (180ft) refitted World War two-era patrol oats to the navy. United Nations has also said that United States would donate additional four vessels. The Pentagon is funding each boat's refurbishment to the tune of $3.5m. The efforts of the Federal Government with the assistance of the US are already yielding fruits. The Nigerian Navy has intercepted several tankers.

3.11 Geographic Information System for Managing Oil Spill Incidents

A successful combating operation to a marine oil spill is dependent on a rapid response from the time the oil spill is reported until it has been fully combated. In order to reduce

the response time and improve the decision-making process, application of Geographic Information Systems (GIS) as an operational tool is very essential. Information on the exact position and size of the oil spill can be plotted on maps in a GIS environment. GIS offers opportunities for integration of oil drift forecast models (prediction of wind and current influence on the oil spill) in the computer program framework (Milaka,1995).

Required information for oil spill sensitivity mapping can be depicted on a set of thematic maps using GIS even though they can in theory be depicted onto a single sheet. With the use of a GIS, all the relevant information or themes can be stored in the system and produced onto maps in a format that befits the needs of the day. Alternatively, modelling exercises using the GIS can be conducted to assess the adequacy of any given oil spill contingency plan (Parthiphan, 1994).

The creation of regional spill response centres along coastlines will help in managing oil spill problems (Smith and Loza, 1994). The centres will use oil spill models for combating oil spill problems. Using data collected with an airborne system to input one or several new starting point(s) into the model, will improve the accuracy of the further predictions (Sandberg, 1996).

3.12 Environmental Sensitive Index (ESI) Mapping

ESI maps are basemaps that show the sensitivity of given locations or areas to a particular stress factor (such as exposure to petroleum products) on a scale of 1 to 10, 10 being most sensitive. The maps may contain physical and geomorphic features (e.g., shorelines), biological features, and socioeconomic features such as agricultural fields. Some ESI maps contain features of particular interest to oil spill planning and response, such as the recommended positions of booms or skimmers. The sensitivity of a given feature to a stress factor may be indicated by the color given the symbol or pattern used to represent it.

Standards for the development of the environmental sensitivity index maps for the coast of Nigeria have been developed by the Environmental Systems Research Institute (ESRI). These standards are used by all the oil companies to prepare ESI maps for their areas of operations in Nigeria.

3.13 Creating of Awareness

Awareness creation on the impacts of oil spill is an integral part of management programme for oil spill along the coast of Nigeria. This is being carried out by government at different levels and agencies such as the Niger Delta Development Commission (NDDC).

4. SIMULATION OF OIL SPILL ALONG THE NIGERIAN COAST

We have developed a new oil spill trajectory model. The results from a hypothetical simulation with the model from a point around OPL 250 located about 150km off the Nigerian coastline shows that the simulated oil spill for wet season reached the shore (around Penington River) after 104hours (about 4.5 days). Also during the dry season, the results from the model indicate that the oil spill reached the shore (at the entrance of Benin River) after 162hours (6.5days). Figures 2 and 3 below show the oil spill trajectories for

the wet and dry seasons respectively. It is obvious from the figures below that the season of occurrence of an oil spill is a major in determining the oil spill trajectory for an area. The wet season trajectory went east-west wise while the dry season trajectory went northwards. Areas to be affected by an oil spill to a reasonable extent depend on the period of the oil spill.

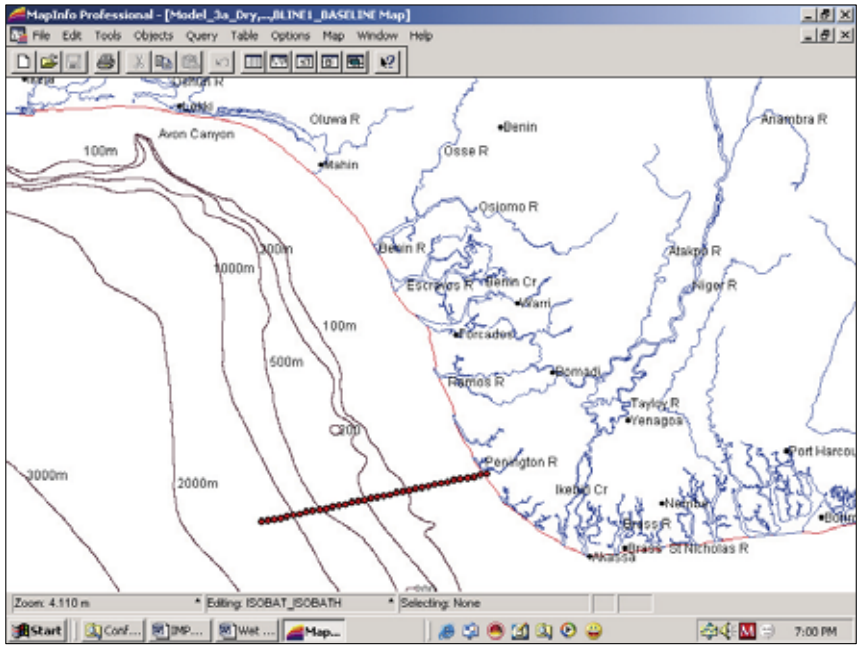

Figure 2: Oil Spill Trajectory for Wet Season on Nigerian Coastal Waters

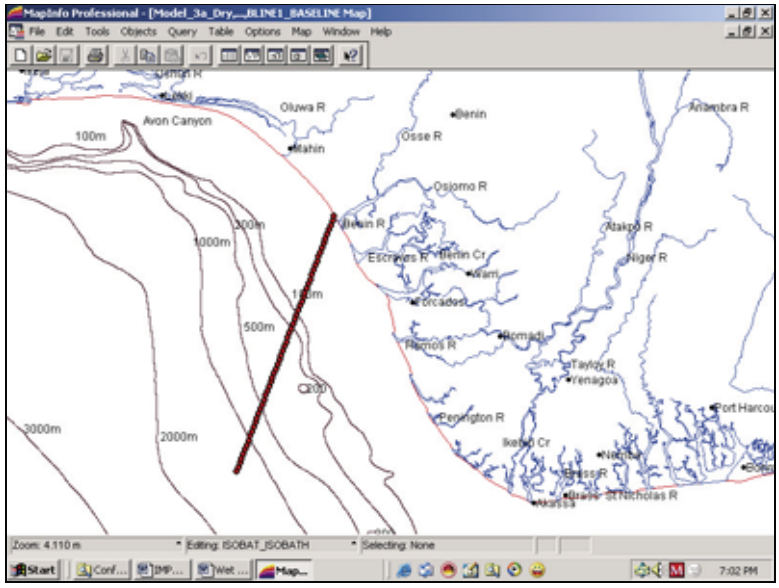

Figure 3: Oil Spill Trajectory for Dry Season on Nigerian Coastal Waters

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

Since the discovery of oil in Nigeria in the 1956, the country has been suffering the negative environmental consequences of oil development. Sabotage has been a major cause of oil spillage in the country. Oil spill incidents have destroyed the coastal vegetation, polluted drinkable water and led to ethnic and regional crises in the Niger Delta. Several oil spill management policy and efforts are in place to reduce the menace of oil spill incidents in the country. Some of these policies and efforts include:

a. The formation of the National Oil Spill Detection and Response Agency (NOSDRA) by the Federal Executive Council of Nigeria.
b. The putting in place of relevant acts and regulations on oil spill pollution.
c. The passing into law of the Niger Delta Development Commission (NDDC).
d. The establishment of the Niger Delta Environmental Survey
e. The incorporating oil trajectory and fate models into oil spill management policy in the country.
f. The development of standards for the development of the environmental sensitivity index maps for the coast of Nigeria

All these efforts have assisted in detection and management of oil spills along the Nigerian coast.

Results from a hypothetical simulation with the model from a point around OPL 250 located about 150km off the Nigerian coastline shows that the simulated oil spill for wet season reached the shore (around Penington River) after 104hours (about 4.5 days). Also

during the dry season, the results from the model indicate that the oil spill reached the shore (at the entrance of Benin River) after 162hours (6.5days).

5.2 Recommendations

The Nigeria Sat-1, would help in monitoring oil spill by providing the spill position which would serve as input data into the oil spill model. It would also give the extent of coastal water and coastal areas polluted. These information are vital for quick clean up of oil impacted areas.

In order to reduce the response time and qualify the decision-making process, application of Geographic Information Systems (GIS) as an operational tool has been suggested. Information on the exact position and size of the oil spill can be plotted on maps in GIS and a priority of the combat efforts and means according to the identified coastal sensitive areas can be carried out.

The creation of regional spill response centres along coastlines would help in managing oil spill problems. The centres will use oil spill models for combating oil spill problems. Data collected with an airborne system could serve as inputs in the model.

The petroleum industry should work closely with government agencies, universities and research centers to combat the menace of oil spill incidents.

More funds should be provided by all the stakeholders in the oil industry for further research in the development and use of oil spill models in the country. The adoption of the model developed in this research work and the procurement of other oil spill models would serve as a basis in carrying out more research in this area.

The creation of NDDC by the Federal Government would go a long way in reducing the tension in the oil rich communities. However, the Federal Government, State Governments and other non-governmental agencies should ensure that the social amenities and needed infrastructures are provided for the oil rich communities.

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The Douala Coastal Lagoon Complex, Cameroon: Environmental Issues

Chebo K. Asangwe

Abstract

The Littoral zone of Douala in Cameroon depicts an interesting physiography dominated by hydro-geomorphic characteristics of immense sustainable potentials to its teeming urban human population growth. The Douala coastal lagoon complex is easily the dominant feature with richly endowed natural and socio-economic resources along the littoral zone of Cameroon. It is fed mainly by the River Wouri, evolving a maze of creeks and lagoons about 50km from the Atlantic Ocean, with its largest surface extent north of Bonaberi, to the north west of metropolitan Douala. The Douala lagoon system describes a major consequence of the Tertiary to Early Quaternary period, particularly of the Holocene marine transgressions, which witnessed the drowning of the estuarine system of the River Wouri. This expansive lagoon system of Douala today is being inflicted with hydro-geomorphic changes due to rapid urbanization on the fragile land-water ecosystem. The land-water ecosystem of lagoon-creeks inlets, tidal mud flats, estuaries, mangroves and wetlands, which provide critical coastal habitats for socio-economic activities now face destruction due to increased spatial growth of the Douala metropolitan area. Easily the most urbanized center in Cameroon, metropolitan Douala has witnessed extensive spatial expansion, which has provoked certain observable environmental problems on the lagoon complex and the wetlands. These are in form of reclamation for expansion of urban sprawls, wetland conversion for industrial infrastructure and development with resultant increased discharge of effluents. In spite of the limitations and restrictions imposed by the lagoon water surface and the difficult terrain of its marginal lowlands describing wetlands, it appears that the rate of interference would continue unabated. The effects of these has seen impaired water quality in the contamination of surface and ground water sources, public health hazards, wetland loss, subsidence, flooding etc.

1. INTRODUCTION

The issues and problems of land degradation are increasingly becoming apparent as the carrying capacity of the earth is undergoing accelerated decline. The consequences of this development is known to be far reaching, however it is the increasing poverty levels that has placed the international community in dire need to reverse the trend. This has necessitated the development of the millennium goals by the United Nations organization working through it several agencies. There is no doubt that the millennium goals strictly seek to address sustainable development strategies for the third world countries, particularly in the sub-Saharan region where most of the poorest countries of the world today are found.

At the dawn of the 21st century, global concern for the earth's carrying capacity in the face of increasing human population resulted in the Rio+ 10 conference on Sustainable

Development. This 2002 World Summit on Sustainable Development in Johannesburg, South Africa, primarily reviewed the progress and global response on environmental issues since the Earth Summit in Rio de Janeiro after 10 years. The general consensus was the need to more effectively utilise science knowledge in the management of the physical environment in policy issues of Governments worldwide. The general trend of decline in global environmental quality agreed to at the 2002 World Summit on Sustainable in Johannesburg, South Africa, has further heightened concern for effective conservation and management. This pressing need for environmental management worldwide indicate that natural resources exploitation and utilisation has left a generally degraded environment. Perhaps the most obvious locality of degradation is the coastal zone where the continental system disappears into the marine waters of the oceans. This locality under the influence of increased magnitude of global environmental change processes exhibited by flooding, saline water incursions, erosion, wetland loss and the threats of sea level rise with the much-talked about global warming, is today focussed upon as a disaster zone.

Global environmental change process affecting coastal zones worldwide today is by far centred on the tripartite problems of receding shorelines, loss of biodiversity and increasing human population. Presently, the coastal zone is in principle regarded as the degrading edge of the continental system, in contact with marine waters of the oceans. Huge cries from the maritime nations, culminated in the requirements of chapter 17 of the Agenda 21, agreed to at the end of the United Nations Conference on Environment and Development commonly referred to as the Earth Summit at Rio de Janeiro, Brazil in June 1992. According to it, coastal states are required to "commit themselves to integrated management and sustainable development of coastal areas and the marine environment under their national jurisdiction". Exactly 10 years later in 2002, the World Summit on Sustainable Development (Rio+10) reviewed the programme made in this vein and further called on nation states of the United Nations to prioritise policy actions on mitigating global environmental degradation. We in Cameroon cannot afford to ignore the implementation of this call, in order to achieve sustainable development in the resource utilisation of our coastal areas. As the entire coast of Cameroon now face one form or another of degradation process, the issue of sustainability makes our understanding, monitoring and management of the coastal areas not only desirable but also imperative.

2. THE PROBLEM

Environmental issues and problems remain of global concern, despite the difficulty in reaching full consensus in signing agreements and treaties to pursue a common approach in implementing strategy to achieve a more sustainable world. The need for sustainable development was given its strongest support by the United Nations Organisation with the convening of the United Nations Conference on Environment and Development (UNCED) at the Earth Summit of June 1992, which included four main agreements: the Rio Declaration on Environment and Development; the Framework Convention on Climatic Change; the Convention on Biological Diversity; and the Agenda 21. All of these impact in someway or another on coastal environments. The Rio Declaration contains 27 principles relating to international behaviour in relating to development and the environment and requires all nations to co-operate in trying to achieve sustainable development. The Framework Convention on Climatic Change is directed towards reducing harmful emissions of greenhouse gases and specifically mentions regional programmes to lessen

the effects of climatic change and the need to incorporate climatic change into policies and actions. These are directly relevant to coastal sustainability in terms of global warming and sea level rise predictions. The Biological Diversity Convention which refers to ecosystem species and generic diversity is important in the sustainability of coastal systems, where there is greatest pressure of population growth and development today. Agenda 21 is a complex 800page action plan on global environment and development for the 21st century, which contains reference to the sustainable use of ocean and coastal resources. In order to follow up on Agenda 21 a commission on Sustainable Development was created within the United Nations and a World Summit on Sustainable Development convened in the Republic of South Africa after 10 years of the Rio Summit in 2002. It is clear that much has been achieved to improve and protect the environment for sustainable development in the last two decades. This is because it has been recognised that the growth and development of nations in the economic system is dependent on the ecological system. A major challenge facing humankind is therefore the achievement of sustainable development while utilising the natural resources that will also satisfy the needs of the increasing human population. This becomes even more pertinent as studies continue to reveal that the ecological system remain the base of the economic system in the fight against poverty in the pursuit of sustainable development particularly in sub Saharan Africa.

The quest for sustainable development to meet the yearnings of a fast growing global human population drew the attention of the international community and was considered by the World Commission on Environment and Development, which stated that it "seeks to meet the needs and aspirations of the present, without compromising the ability to meet those of the future… It is a process in which exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations". This is even more in the dynamic coastal environments, with their fragile morphological features, which are subject to flooding, saline water incursions, and ecological stress through wetland loss, erosion and eventual land loss. This becomes even more pertinent when it is realised that reasonably authentic figures suggests that, an estimated 75% of the global human population is expected to live within the narrow strip of 60km from the shoreline along the world's coastal areas. Sustainability therefore becomes crucial in the face of present day accelerated worldwide coastal zone deterioration and degradation. In the face of deteriorating environment, the continuous monitoring, detailed investigation and evaluation of procedure for natural resource exploitation and utilisation become imperative. The coastal zone with its fragile ecological system in its biophysical state has come under intense stress, with scientific evidence of degradation. Multi-disciplinary research along the coastal areas, continue to support the view, that the maintenance of biodiversity in coastal systems is an essential element for sustainability in the area. This locality under the influence of increased magnitude of global environmental change processes exhibited by inundation, flooding, erosion, wetland ecological stress and threats of sea level rise with the much-talked about global warming, is today focussed upon as a disaster zone. Over 250,000 people died in hazards affecting the coastal zone worldwide in 2004, with the most devastating being the Tsunamis, which flooded South East Asia. While the year 2005, witnessed the evacuation of New Orleans in the United States of America because of inundation caused by Hurricane Katrina from the Gulf of Mexico. It becomes more frightening, when it is realised that this zone has the greatest

concentration of human population on earth. The coastal zone is easily the fastest growing geomorphic environment of human population on planet earth. The population Reference Bureau (PRB, 2003) in acknowledging this has described the coastal environment as an area of intensive natural and anthropogenic processes, as home to a large and growing population and it is fast undergoing environmental decline.

The 1976 official national population census figures put metropolitan Douala at 458,426 and with an annual growth rate in excess of 8% per annum, the estimated population of the area is at 2.5million enjoying the fastest growing rate of urbanisation in the Republic of Cameroon. Easily the most urbanized center in Cameroon, metropolitan Douala has witnessed extensive spatial expansion, which has provoked certain observable environmental problems on the lagoon complex and the wetlands. These are in form of poor land reclamation for expansion of urban sprawls, sand dredging, expansion of highways, wetland conversion for industrial infrastructure and development with resultant increased discharge of effluents. In spite of the limitations and restrictions imposed by the lagoon water surface and the difficult terrain of its marginal lowlands describing wetlands, it appears that the rate of interference would continue unabated. The effects of these has seen impaired water quality in the contamination of surface and ground water sources, public health hazards, wetland loss, subsidence, flooding etc. (World Commission on Environment and Development, 1987; Population Reference Bureau, 2003; Centre de Recherche et d'Etudes en Economie et Sondage, 1994).

3. THE STUDY AREA

The study area is the Douala coastal lagoon in the southern lowlands of the Republic of Cameroon within the depositional sedimentary formations. Except for the rocky shores in a portion of the Limbe coast, the Cameroon costal lowlands dominated by Barrier beaches, Barrier Islands, extensive creeks and Lagoon formations runs from the Bakassi islands in the west to Tiko and Douala in the central parts of the coastline and to the sandy beaches of the Kribi area to the south of the country. The Cameroon coastal lowlands is located within a geographical area of Africa which can be readily identified on the basis of the abrupt change in direction of the west African coast into the central African sub-region. The study area of the Douala coastal lagoon complex is an integral part of the 402km long shoreline of the Cameroon coast. The hydro-geomorphic characteristics of the littoral zone of Douala in Cameroon has remained of immense sustainable potentials to its teeming urban population growth, as it is richly endowed with aquatic and terrestrial resources within the brackish and saline water environments.

The Republic of Cameroon today is estimated to have 4 million of its 15 million human population within 60km of its coastline, thus accounting for more than 25% of the population on the 6.5% area of coastal land in the country (Asangwe, 2002). Douala metropolitan area alone has a current estimate of 2.5 million people and the fastest growing rate of urbanization. With its environmental problem of scarcity of land in the face of abundant water dominated by its lagoon complex, management strategies become inevitable for its resource utilisation and infrastructure development.

The Douala lagoon system evolved during the last marine transgressions of the Tertiary to Early Quaternary period, particularly of the Holocene (wholly recent-used frequently for

the youngest epoch), which occurred about 10,000 years ago with drowning of the mouths of coastal rivers along the tropical coastlines. This period witnessed the inundation and submergence of coastal lowlands including estuarine river systems to form the broad embayment into the lagoon system from the Atlantic Ocean. The expansive lagoon system of Douala metropolitan area today is the consequence of such drowning of the River Wouri- the main river system feeding the lagoon far inland, thus giving its greatest spatial extent about 50km from the opening into the Atlantic Ocean. Asangwe (2002) in an earlier study noted "the area comes under strong influence exerted by tidal movements, episodic events of floods, storms with far reaching geomorphologic implications, which encourage further degradation". The expansive lagoon system of Douala today is under constant interaction of a fast growing urban population and the land-water ecosystem now suffer many uncoordinated large scale disturbances inflicted upon its character.

4. THE DOUALA COASTAL LAGOON ENVIRONMENT

The Littoral zone of the Republic of Cameroon presents an array of varying contrasting geomorphic attributes consisting of creeks, lagoons, sand and rocky beaches, coastal plains, wetlands and mangroves. These varying landforms show evidence of fluvial activities of sediment deposition, which has given the coastal lowlands of Cameroon a unique character, despite the imposing feature of the Cameroon Mountain. The sedimentary formation of the Camerooon coastal lowland is dominated by the lagoon-creek system within the Douala metropolitan area.

The Douala coastal environment describes a Barrier island-Lagoon formation with the Douala metropolitan area having developed on a number of such barrier islands. The Douala lagoon system is at its most extensive spatial attribute about 50km from the Atlantic Ocean and comes under the strong influence exerted by tidal movements. It is thus a flood tide dominated zone where mangrove-covered barrier islands proliferate adjacent to the shoaling lagoon and tidal inlets. The coastline of the Douala area has a broad embayment as it opens into the Gulf of Guinea of the Atlantic Ocean, which greatly enhances tidal movements, witnessing inflow of marine saline waters. Salinity varies little from a vertical perspective in the zone, however a very dynamic surface variation ranging from between 18ppt to 13 ppt in the creeks has been reported in this zone. This indicates that to a large extent, the thermohaline conditions are quite homogeneous. The variation in salinity gets pronounced as one move into the mud flats colonised by mangrove vegetation, since the silt grained composition of deposits here tends to concentrate salinity. At high tides, the marine waters surge into the creeks at a rate of about 0.5m/sec in some areas and 0.9m/sec in others. The low tide of marine waters retreat at an average of about 2.7m/sec, which occur once in the face of two high tides in a 24-hour period. There is the high magnitude monthly of seasonal tides, locally called "big water" which takes about 10 days to rise, with the waters attaining between 18 metres to 20 metres in depth. These tidal movements apart from inundating and flooding the area, further extends the mud flats and salt marshes as salinity extends further inland into the marginal areas of the Douala lagoon system to ensure proliferation of wetlands and mangroves. Progradation of muddy sediments usually occurs during prevailing low energy conditions (Chappell, 1995), which is well exemplified by the tidal movement of the Douala coastal lagoon system. Figure 1 below show a part of the mangrove and wetland of the Douala coastal lagoon at low tide. The depositional sedimentary character is further revealed by the predominantly muddy

consistency that supports mangrove proliferation and the fact that the Douala lagoon is a shoaling lagoon system.

Figure 1: Mangrove and wetland at low tide.

Coastal lagoons are shallow water bodies, running parallel to the coast, and connected to the open sea with an outlet. They are separated from the open sea by sand bars or barrier islands. According to Phleger (1969), important factors for the development of lagoons are that enough sand-size sediment is available (brought by rivers) and enough wave activity is present for the formation of a sand bar or a barrier island. Generally, lagoons are areas of shallow aquatic geomorphic attributes that have been almost completely sealed off from the marine waters of the sea or ocean by the full development of spits or barriers by oceanographic processes of wave action, tidal action, alongshore drift of materials etc. The evolution of lagoons is closely associated with sandy, swampy coastal areas of low topography, where sandy barriers, ridges or spits develop to seal off the brackish water zone of deposition by coastal rivers. The Douala lagoon system under the influence of the River Wouri and its tributaries is today colonised by mangrove swamps, wetlands, mudflats along the lagoon marginal depressions, creeks, tidal inlets etc. The massive input of sandy grained size sediments from the fluvial system of the Wouri has evolved a typical shoaling lagoon complex, which is presently the target of continuous land reclamation embarked upon to meet the demands of the rapidly urbanized Douala metropolitan area. The continued spatial growth of the Douala metropolis has invariably inflicted far reaching alteration on the hydro-geomorphic attributes of the lagoon marginal depressions which has witnessed increased residential housing structures and infrastructure development of highways, industries and wetlands conversion. In the process of carrying out these large-scale environment-disturbing programmes the natural land-water ecosystem of the lagoon complex has been unduly manipulated and this has aggravated the process of degradation in the Douala administrative region (Phelger, 1969).

5. ADMINISTRATIVE ISSUES OF THE DOUALA COASTAL SPACE

The Douala region constituting the built-up area as well as the marine and coastal space is administered under the Wouri Division of the Littoral province of the Republic of Cameroon. The Douala region, despite its urbanized growth, displays both the urban and rural landscape over the land-water ecosystem of its coastal space. This proximity to the marine environment of the Gulf of Guinea has greatly influenced the administrative setting of both the Douala metropolitan area and its rural landscape. The pertinent environmental issues faced by these two varying landscapes no doubt influenced the administration of the Douala marine and coastal space. The Douala region has a broad embayment as it opens into the Gulf of Guinea in the Atlantic Ocean, which now has the metropolis expanding on both sides of the lagoon inlet, while the rural area remain on the creeks to the north and south of the lagoon complex. Today, six sub-divisions under a Divisional Officer each administer the Douala region, while a Governmental Delegate governs the metropolitan area under the urban council. Presently five of the six divisions, which make up the Wouri Division are considered as strictly within the urban council and thus has the influence of the Government Delegate. It is the lagoon-creek environment to the south from Youpwe into the marine environment, which now cover the only division that is rural in the Douala area. The Douala region has grown on a typical marine and coastal space where the old barrier islands were colonised by the Bonandjo, Akwa, Deido, Bepanda Bassa, Bonamoussadi and the Bonaberi districts, which today support the high population density in the area. Except for the Akwa, Bepanda and Bassa districts, the Douala lagoon complex still directly influences all the other aforementioned districts. The Douala area therefore has the crucial problem of abundant aquatic terrain in the face of scarcity of land, which poses a serious challenge of coastal zone degradation in the pursuit of urban spatial growth in the area.

The Douala coastal lagoon complex continues to extend over the depositional environment of the Cameroon southern lowlands with the dynamic estuarine system of the River Wouri which ensure sediment supply into the lagoon. This is responsible for the fast silting up process evolving the shoaling lagoon character and of course the proliferation of mangroves and wetland forests. The spatial growth of the Douala metropolis necessitating the bridge over the lagoon system in order to link the metropolis to the Bonasama and Bonaberi districts led to the effective demarcation of the lagoon system into two to the north and west of the city. To the north of the metropolis the lagoon system is characterised by clusters of mangrove and wetlands forests, the other to the west where the Douala port complex is located cover a larger area depicting a shoaling lagoon which has necessitated massive sand dredging to keep the harbour facilities operational.

Douala is the economic centre of the Republic of Cameroon. The entire Central African sub-region today is influenced by the Douala coastal space. The Douala harbour directly serves the land-locked countries of Chad and the Republic of Central Africa, while countries like Equatorial Guinea and Gabon continue to use the marine and coastal space for socio-economic activities like fishing, transportation etc. The economic status of the Douala metropolitan area has further influenced its administrative status to the highest level of the presidency of the Republic of Cameroon. This is because Douala as the financial and investment base of the country serve as headquarters to a number of government establishments like the Department of Customs and the only Stock Exchange

in the country- the Douala Stock Exchange amongst others. The ecological approach to planning and management of the Douala area has witnessed conflicts with economic issues, with the political authority leaning on the economic consideration to the detriment of environmental issues. The office of the Government Delegate at the helm of decision taking concerning the Douala marine and coastal space is this political authority, which of course subjects itself to the administrative bureaucracy of the central government entailed in developmental process in sub-Saharan Africa. As environmental deterioration is a slow process of degradation, the cumulative effects towards the attainment of the state of disaster also come unnoticed and extremely difficult to reverse.

6. ISSUES OF RAPID URBANIZATION IN THE DOUALA MARINE AND COASTAL SPACE

The issue of rapid urbanization is not a new phenomenon in the developing countries, which constitutes the bulk of the third world nations. This is because these countries have had a long-term situation of primate cities, which performed purely urban functions of administrative, economic, religious and cultural centres from the early contacts with Western Europe. By far one of the most crucial contemporary problems of the Douala area is that of rapid urbanization. It has continued to grow up fast to accommodate large human population increases as a result of the attractions offered as a nodal growth centre to the rural hinterland. Douala metropolitan area within the last three decades has grown not only in spatial extent, but also in its internal and area-wide functions. The expansion of the Douala urbanized area has been achieved largely through an uncoordinated programme of land use management based on internal filling up of aquatic undeveloped terrain and the absorption of rural settlements. It is indeed common to find such areas having large concentration of people who have to cope with the inadequacies and problems of poorly managed environments in the Douala area. The Mabanda, Ondobo and Bonandale localities in the Bonaberi district present such poor physical locations with difficult terrain conditions.

The Douala lagoon complex located north of the city into the Bonasama-bonaberi districts cover an area of 85sq. km and the marginal areas are colonised by mangrove forest swamps where human settlement continue to encroach. The high magnitude runoff from the River Wouri estuarine system into the land-water interface all years round ensure that the water table remain high and thus effect constant inundation of the heavily encroached marginal depressions, with severe consequence of environmental deterioration. Flooding is a major consequence of this scenario exhibited by the dynamism of the River Wouri estuarine system on the Douala metropolitan area. The Cameroon coastal lowlands of the Douala region is characterised by low lying geomorphic features with faint slopes almost at sea level. Though the newly built up areas of Bonammousadi, Makepe and Logpom are about 50km away from the Atlantic Ocean, it is just over 16 metres above sea level, while the rapidly growing districts of the metropolis, like Bonaberi which includes Mabanda, Ndobo are between 3-7 metres above sea level. The runoff from the Wouri River into the lagoon system account for the bulk of the flooding menace the Douala area is subjected to annually at the peak of the wet season. The low lying nature of the city provoking floods is observed in the general lack of flowing drains in the core built up areas like Akwa, resulting in stagnant water due to constantly high water table which has a further consequence of increasing high rate of subsidence and tilting of residential housing

structures, particularly along the lagoon environment. This is pronounced where poor reclamation has been employed in increasing land availability using domestic and timber industry wastes on the loose sandy deposits of the lagoon margins. This frequently inundated hazardous area, which offer spaces for the development of spontaneous settlements of slum nature now suffer subsidence of residential housing structures. This study revealed that over 75% of residential buildings along the lagoon fronts of marginal depressions that have been poorly reclaimed now experience varying degrees of subsidence in the Mabanda and Bonandale localities of Bonaberi to the north and the Youpwe locality to the south of Douala. Figure 2 here show the lagoon margin where residential buildings undergo perennial flooding and inundation.

Figure 2: Residential building at the lagoon margin

7. ENVIRONMENTAL DETERIORATION OF THE DOUALA MARINE AND COASTAL SPACE

Environmental degradation of coastal areas continues to receive heightened focus worldwide, since this zone accounts for the bulk of global human population. The advancement of technological, investment and financial development is occasioned by need to enhance global energy sources for economic development. Crude oil is the world's single most important source of enhanced global energy source for now and this trend is expected to continue for quite a while. The implication is that modern industrialization depends on crude oil and its products. It has been suggested that on a daily basis people now use over 4,000 oil-derived products for routine hygiene, health and socio-economic pursuits.

Cameroon is a crude oil producer of an economic scale and runs a state owned refinery in the coastal city of Limbe with proximity to the oil rich area of Ndian division in the southwestern part of the country. Douala is however the energy utilisation centre since it has the largest concentration of industries and serves as the depot for processed or refined oil products which powers the nation economy. The utilisation of these products within the designated industrial zones and illegal locations for such activities has made the proper discharge of effluents resulting from production processes a serious environmental problem to the teeming human population of Douala. With over 70% of the industries in Cameroon located in the Douala metropolitan area, petroleum products effluents have become an integral part of the state of the environment. Petroleum products effluents are generally any processes or unprocessed liquid, viscous and gaseous evacuation of agricultural and industrial constituents that contain petroleum input into the environment. These effluents are discharged during processing, transportation and utilisation as hydraulic fluids, solvents, fertilizers, sludge etc into the predominantly aquatic terrain of Douala. They all end up in this coastal environment of Douala that is very sensitive to deterioration, particularly of the aquatic terrain leading to contamination and eventual pollution of surface water with consequent health hazards to the people. These different sources of petroleum effluents including agricultural such as fertilizers, chemical or industrial, contain enormous quantities of contaminants ranging from hydrocarbons to trace metals. Some of these trace metals include; zinc, copper, cadmium, lead, mercury, nickel, vanadium, phenol, cyanide, arsenic etc. Table 1 below presents common petroleum products and their utilisation in the Douala area.

Table1: Petroleum products and their utilisation
(Source: Fieldwork, 2006)

PRODUCTS	UTILISATION
Natural gas	Power engines and raw material for plastics production
Gasoline	Power motorized engines and raw materials for plastics
Diesel	Power automobiles, engines
Ethanol	Solvent used in manufacturing paints, cosmetics and dyes
Residue	Processed into fuels, candle wax, greases and asphalts
Petroleum gas:	- **Butane:** Used for making chemicals and fuel for industrial heating - **Ethanol:** Used for making chemicals and fuel for industrial heating - **Propane:** Used for making chemicals and fuel for industrial heating - **Kerosene:** Low energy flash fuel for domestic use - **Naptha:** Making plastics, automobile and engine fuel and chemicals - **Bitumen:** Road construction.

The sources and quantity of effluents generated over the terrestrial environment of the Douala metropolitan area was minimal at the early stages of industrial development during the seventies. The locations of the designated industrial zones of Bassa and Bonaberi districts afforded easy draining of generated effluents into streams, rivers and eventually into the Atlantic Ocean. The streams and the Rivers Wouri and Dibamba were therefore very effective in removing the wastes from the immediate terrestrial environment occupied by the human population. However, with the phenomenal increase in population, rapid urbanization, industrialization and agricultural expansion especially in the third world countries, which concentrate these various aspects in one urban centre, it is obvious that humanity's continued generation of the effluents will continue to pose degradation problems. In the Douala area these effluents end up in water bodies from city drains, spillways, into the land-water interface of the lagoon complex, with resultant damage to aquatic life, contamination of surface water for human consumption, crops and livestock.

The Douala metropolitan area as the economic hub of the Republic of Cameroon has grown with the concept of industrial agglomeration where maximum benefits are optimised by deliberate Government policy. Presently, the Douala area has two designated industrial zones namely the Bassa and the Bonaberi industrial zones. These two zones account for the bulk of industrial activities in the country, but however depict contrasting features in terms of physical landscape. While the Bassa industrial zone evolved on well drained landscape, the Bonaberi industrial zone evolved almost entirely on the aquatic terrain of the lagoon marginal depressions necessitating extensive land reclamation to obtain firm on which industrial had to be built. Furthermore while the Bassa area terminated into the estuarine-creek formation of the Dibamba River to the east of the city, the Bonaberi industrial zone complex has encroached into the lagoon itself. It becomes clearly evident that this situation most likely provoked increased discharge of effluents into the Bonaberi districts and as the fastest growing district in the Douala metropolis in terms of population density and spatial extent, the consequences becomes of disaster magnitude.

A survey of industries within the Douala metropolitan area involved in petroleum products effluents discharge into the lagoon show that contamination and eventual pollution of the

aquatic media has reached advanced degradation state. Table 2 below show a number of manufacturing and marketing companies whose operation contributes significantly in the environmental deterioration and degradation in the Douala marine and coastal space.

Table 2: Producers of petroleum products effluents in Douala
(Source: Fieldwork, 2006)

COMPANY	PRODUCT	CONTAMINANT
CIAC and PLASTICAM	Producers of plastic buckets, paints and tyres	Hydrocarbons, Tubes,
SAPCAM	Paint production	Combustible fuel oils
CONFITEX	Textiles	Acid waste oils
TOTALFINAELF	Crude oil exploitation and marketing oil products	Hydrocarbons and lead (Pb)
SCDP	Oil products storage and distribution	Oil dumps (contains lead, Arsenic, copper etc.)
SHELL/TEXACO	Aviation, petrol, diesel fuel and wax	Hydrocarbons, lead, cadmium, copper, zinc and other trace metals
CEP/Chemicals	Paints, detergents, vanish	Acid mercury, copper, lead, phosphates, trace metals etc.

The government of the Republic of Cameroon has over time particularly since becoming a member of the United Nations Organisation at independence in 1960 has always enacted legislations for the protection and management of the environment. This has come mainly through international conventions, multilateral and bilateral agreements especially when the developed countries are coming in to invest in Cameroon. The Crude oil exploration and exploitation industry, which is carried out in the coastal zone, significantly contributed to the legal framework and requirement in handling petroleum effluents discharge, accidental discharge of oil spills, blowouts, protection of aquatic terrain for socio-economic activities of fishing etc. The Ministry of Mines, Water and Energy Resources in the Republic of Cameroon is the supervisory authority of government in the legislation on petroleum effluent discharge into the marine and coastal space of Douala. The Cameroon legal code has a law relating to safe and proper discharge of petroleum effluents into the Marine and Coastal space of Douala, in recognition of the city's physical landscape and status as the economic centre of the country. The law no 96/12 of 5th August 1996 states clearly the enforcement of safe practice in the discharge of effluents in the land and aquatic ecosystems of the Douala marine and coastal space under the supervision of the Ministry of Mines, Water and Energy Resources. In recognition of the unavoidability of some of the contaminants getting into the lagoon through the drainage systems, which started as a safe way of getting rid of them in the first place, the law permits high values of concentration of zinc (5mgl). This as expected has continuously been flouted with greater content of discharge as well as uncontrolled effluent discharge into the lagoon system. This increases viscosity forming solid oil aggregates, which now cover extensive portions of the land-water interface at the lagoon margins where population is rapidly growing. These aggregates distort the penetration of solar radiation to the lagoon bottom thus inhibiting the growth of plankton and other micro life forms for increased fish production for the socio-economic pursuits of the people in this locality. These aggregates are in form of petroleum

lumps and tar balls on surface water and display light grey, brown or black sticky lumps with varying sizes. The surface serves as a substrate for developing bacteria, unicellular algae and other harmful microorganisms. The presence of green algae and a host of other organisms, which proliferate due to decomposition of the effluents on the lagoon waters, are indicators of heavily contaminated water not safe for human consumption due to its impaired quality.

8. CONCLUSION

Perhaps the greatest force that has influenced the Douala marine and coastal space is the rapid urbanization imposed on the metropolitan area due to its function as the economic centre of the Republic of Cameroon. This force on it lies primarily in the policies and actions of the government to concentrate most of the projects for socio-economic development in the Douala area, which thus attract increased population. Therefore the competition for land in this largely aquatic terrain adds more to intensify the concomitant problems associated with rapid urbanization resulting in fast degradation of the Douala environment. This paper has heightened awareness of the adverse consequences in the Douala marine and coastal space and hereby calls for urgent strategies at reverting this trend. It would be noted that from the foregoing account, that the process of rapid urbanization must have to be put under some control in order that the existing Douala metropolis may be better managed and that the quality of both its immediate and area wide environments may be preserved. The paper calls for such controls that can best be achieved through well though out land use planning which involves institutional, legal and high technological inputs. The continued undue demands on the limited land resources in the Douala coastal lagoon area necessitates a detailed mapping procedure within a technical framework that would classify stable and unstable lands imposed by the character of the area. Detailed Geographical Information System (GIS) will provide archival data on both the land and water space from which pollution hot spots from manufacturing industries could be easily monitored and controlled, effects on fish catch, impaired water quality can be controlled from time to time. It becomes clear that the ecological system of the Douala metropolitan area will be better understood and thus enhance sustainable management strategies. This is in view of preserving and maintaining environmental quality while permitting the intensive use of the lagoon system.

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The Protection, Management and Development of the Marine and Coastal Environment of Ghana

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Abstract

The marine and coastal resources of Ghana exist within a very fragile ecosystem. Current development trends and pressures exerted on these resources are steadily degrading the components of this fragile ecosystem. Landward, the area includes lagoons, marshes, estuarine swamps together with the intervening interfluve areas. Seaward, the boundary is determined as the limit of Exclusive Economic Zone (200 nautical miles).

The area is richly endowed with important resources for the promotion of tourism, fishery, industry and mining. The lagoon, estuary and delta ecosystems provide suitable environments for shellfish and fish breeding, as well as feeding, roosting and resting sites for local and migratory birds and marine turtles. The coast supports mangroves, which are an important source of fuel-wood to local communities.

The beaches, cliffs, lagoons, wildlife, cultural and historical sites and coastal landscape also provide an immense potential for tourism development. In addition, salt, deposits of limestone, silica, feldspar and other minerals have been identified within the coastal belt. There is also the possibility for hydrocarbons, for which prospecting is being undertaken. Furthermore, copra production is also an important economic activity along the coastal belt.

The coastal and marine ecosystem is under threat from a variety of man's actions which include:

1. *Increases in urbanisation caused by migration and high rates of population growth.*
2. *Greater infrastructure along the coast, industrialisation and heightened economic activities*
3. *Provision of transportation facilities including extensive road networks, rail, air and water.*
4. *Siting of two main seaports at Tema and Takoradi which handle most of Ghana's imports and exports respectively.*

This paper outlines the various mechanisms currently in place to protect Ghana's coastal and marine ecosystem.

1. INTRODUCTION

The coastal and marine zone of Ghana has been defined to include the 200 nautical mile limit which was claimed in 1977 [Territorial Waters and Continental Shelf Act 1973 as amended by the Territorial Waters and Continental Shelf Amendment Decree 1977]. The coastline of Ghana stretches for approximately 550km. It is generally a low lying area, not more than 200m above sea level and has a narrow continental shelf extending outwards to between 25 and 35km except off Cape Coast and Saltpond where it reaches up to 80km.

Ly (1980) describes the following characteristics features of the Ghanaian coast;

a. West of Cape Three Points: a flat and wide beach, backed by coastal lagoons, marks this coast. Wave height is generally low.
b. Between Cape Three Points and Tema: this aspect is of an embayed coast of rock headlands and sandbars or spits enclosing coastal lagoons. The surf zone is a medium to high-energy environment with wave heights often exceeding 1 metre. The south-westerly prevailing winds cause oblique wave approach to the shoreline, which generates an eastward littoral sediment transport.
c. East of Tema: the shoreline is sandy and is characterised by the eroding Volta delta. Wave and sediment dynamics are similar to those between Cape Three Points and Tema.. It is known that rocky shores and rocky reefs are restricted to the area between Axim and Tema. It is also known that the rocky shores support a wide range of organisms in the intertidal zone.

The vegetation types of the coastal zone from east to west and reflecting the rainfall gradient are coastal shrub and savanna to Winneba, Southern marginal forest to the east of Sekondi, dry semi-deciduous and moist semi-deciduous forest to the east of Cape Three points estuary and wet evergreen forest in the extreme southwest of the country

The zone is well endowed with natural resources, which are exploited by different sectors of the economy. The major primary activity of the zone is fishing. Other activities of economic importance that occur in the zone are agriculture, transportation, salt production, oil and gas exploration, sand and stone winning, recreational and industrial developments. The zone is also known to be important internationally, for the provision of feeding, roosting and nesting sites for thousands of birds especially migratory species. The coastal zone is also currently used for the disposal of industrial and municipal wastes, an activity that is being given urgent attention. Ghana's coastal zone represents about 6.5% of the land area of the country, yet houses 25% of the nation's population.

This small strip of land now hosts about 80% of the industrial establishments in Ghana. Environmental degradation of coastal areas has been identified as a key issue in Ghana's Environmental Action Plan. Poverty in the coastal area is also extensive. Coupled with ailing human health, rapid urbanization, the poverty and environmental degradation potentially contribute to a vicious circle that inhibits human development.

Seven main environmental issues are identified for the marine and coastal environment theme. These are domestic sanitation, fisheries degradation, wetland & mangrove degradation, industrial pollution of water resources in the coastal zone, coastal erosion, Biodiversity loss and aquatic weed encroachment. Five of these are considered as priority

areas. They include domestic sanitation, fisheries degradation, wetland & mangrove degradation, industrial pollution of water resources in the coastal zone and coastal erosion.

The present strength of the Ghanaian economy is derived principally from export earnings in agriculture, mining and forestry. Domestic industries and services provide employment opportunities for coastal populations growing at the rate of 3% per year. Over 60% of industries are located in the zone.

The marine environment is characterised by two seasonal upwellings. A major upwelling, which occurs from either late June or early July to late September or early October, and a minor upwelling, which occurs between January and March.

The upwelling is known to have considerable influence on both the local and sub-regional fisheries. Although the origin and mechanism of the upwelling is still not clear, different proposals have been put forward to explain the origin and mechanism of the coastal upwelling off the coast of Ghana but none is sufficiently conclusive to be accepted by most oceanographers.

The position and dynamics of the upwelling are variable. The upwelling influences the migratory patterns of pelagic fishes and is linked with the marine fish catch in Ghana (Armah and Amlalo, 1998).

2. ENVIRONMENTAL-RELATED CONVENTIONS

Environmentally related conventions ratified by Ghana include:

- International Convention for the Prevention of Pollution of the sea by Oil: 21 October 1962
- Convention on the Africa Migratory Locust: 25 May 1962
- Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water: 5th August 1963
- International Convention for the Conservation of Atlantic Tunas: 4 May 1966
- Africa Convention on the Conservation of Nature and Natural Resources: 15 September 1968
- International Convention on Civil Liability for Oil Pollution Damage: 29 November 1969
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Causalities
- Convention on Wetlands of International Importance, Especially as Waterfowl Habitats: 2 February 1971
- Treaty and Prohibition of the Emplacement of Nuclear Weapons of Mass Destruction on the Seabed and the Ocean Floor and in the Subsoil Thereof: 11 January 1971
- International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage: 18th December, 1971
- Convention Concerning the Protection of World Cultural and Natural Heritage: 16 November 1972
- Convention on International Trade on Endangered Species of Wild Fauna and For a: 3 March 1973

- Convention on the Military or Any other Hostile Use of the Environmental Modification Techniques: 10 December 1976
- Convention on the Conservation of Migratory Species of Wild Animals: 23 June 1979
- Convention for the Cooperation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region,1981(Abidjan Convention)
- United Nation Convention on the Law of the Sea: 10 December 1982
- Montreal Protocol on Substances that Deplete the Ozone Layer: 24 July 1989
- Convention to Combat Drought and Desertification
- Framework Convention on Climate Change: June 1992
- Convention on Biological Diversity,1992

3. POLICIES

A number of Environmental related Policies exist in Ghana however there is no specific policy on the coastal zone. These include:

- The National Environment Policy
- National Wetlands Policy
- Agricultural Policy
- Tourism Development Policy
- Land Management Policy
- National Health Policy
- Energy Policy
- Minerals Policy
- Wildlife Conservation Policy

The main thrust and orientation of national policies on the protection, management and development of the marine and coastal environment is pivoted on the following three major areas:

- Integrated coastal zone management and sustainable development
- Marine environmental protection, both from land-based activities and from sea-based activities; and
- Sustainable use and conservation of marine living resources (both of the high seas and under national jurisdiction)

For the above three issue areas, the important and definite steps including plans have been pursued to ensure the realization of prudent management of the marine and coastal environment. These include:

- Coastal Zone Management Indicative Plan, 1990
- National Environmental Action Plan, 1994
- Draft Integrated Coastal Zone Plan, 1998
- Coastal Zone Profile of Ghana 1998
- National Oil Spill Contingency Plan with specific reference to the marine environment, 2002
- Environmental sensitivity map of the coastal areas of Ghana, 1999 and 2004

4. REGULATIONS

Though several legislations exist on coastal protection and sustainable development, there is no omnibus legislation on the environment. Legislations relating to the area include the following:

- Beaches Obstruction Ordinance, 1897 (Cap 240)
- The Mineral and Mining Law, 1986 (PNDC 153)
- Rivers Ordinance, 1903 (Cap 226)
- Land Planning and Soil Conservation Ordinance No 32 of 1953 as Amended by the Land Planning and Soil Conservation (Amendment) Act, 1957 (No. 35 of 1957)
- Maritime Zones (Delimitation) Law 1986 (PNDCL 159) urban planning and development
- Town and Country Planning Ordinance (Cap 84)
- Wild Animals Preservation Act, Act 235 1964
- The Towns Ordinance (Cap 86)
- National Building Regulations 1996 (LI 1630)
- Volta River Development Act, 1961
- Fisheries Act 2002, Act 625
- Fisheries Law, 1991 (PNDC 256)
- Fisheries (Amended) Regulations, 1977 and 1984

The sustainable use and conservation of marine resources are encouraged through legislation, regulations, education and awareness creation programmes as well as the enforcement of existing regulations and legislation

The legal framework for coastal zones issues and management in the country are contained in the following documents

- The 1992 constitution
- EPA Act, 1994 (Act 490)
- Environmental Assessment Regulations, 1999 (LI 1652)
- Local Government Act, 1993 (Act 462)
- Environmental Standards and Guidelines

In addition, there are other specific legal frameworks, which include:

a) The legal framework for Ecosystem Protection, which are:
   - Wild Animals Preservation Act 1961 (Act 43)
   - Wildlife Conservation Regulations 1971 (LI685)
   - Wild Reserves Regulations 1971 (LI 740)
   - The Wetland Management (Ramsar sites) Regulation, 1999
   - Oil in Navigable Waters Act, 1964 (Act 235)

b) The legal framework for Fisheries Resources, which are:
   - Fisheries Law 1971 (PNDCL 256)
   - Fisheries Act 2000

c) The legal framework for Oil and Gas Industry
   - Petroleum (Exploration and production) Law 1984 (PNDCL 84)

- Mineral (Offshore) Regulations 1963 (LI 257)
- Mineral (Oil and Gas) Regulations 1963 (LI 256)
- Oil and Mining Regulations, 1957 (LI 221)

d) The legal framework for Tourism Promotion (including coastal tourism)
   - Ghana investment Promotion Centre Act 1994 (Act 478)
   - Companies Code 1963 (Act 179)
   - Free Zone Act 1995 (Act 504)
   - Ghana Tourism Board
   - Ghana Commission on Culture

5. ACTIVITIES OF CONCERN TO THE CONVENTION

Over the years, several activities have been undertaken which are of concern to the Convention. These include:

- Ghana Environmental Resource Management Project in Coastal Wetlands Management Component
- Gulf of Guinea Large Marine Ecosystem Project
- Fisheries Sub-sector Capacity Building Project
- Establishment of a Protected Wetland Ecosystem on the coast
- Development and Implementation of Oil Spill Contingency Plan
- Monitoring of fish stock levels and associated oceanographic parameters
- Institution of a programme of Monitoring, Compliance and Surveillance of the marine environment
- Development of industrial pollution standards
- Development of University course on Coastal Zone Management
- Increased public education on sound coastal and marine environmental practices

6. RELEVANT INSTITUTIONS

With regards to protection, management and development of the marine and coastal environment, the following ministries and agencies have been identified as key stakeholders:

- Ministry of Environment, Science and Technology
- The Environmental Protection Agency
- Ministry of Tourism and the Modernisation of the Capital City
- Ministry of Local Government and Rural Development
- Ministry of Ports and Harbours
- District Assemblies
- Ghana Ports and Harbours Authority
- Hydrological Services Department
- Ministry of Food and Agriculture
- Ghana Tourist Board
- Ghana Investment Promotion Centre
- Fisheries Commission Ministry of trade, Industries and PSI
- Ministry of Lands, Forestry and Mines
- Ministry of Energy

- Ministry of Health
- Ministry of Education, Youth and Sports
- Ministry of Defence
- Ghana Navy
- Non-Governmental Organisations (Resource & Environmental Development Organisation, Friends of the Earth, Green Earth, Wildlife Society, Recerca e Cooperazione), Centre for African Wetlands.
- Ghana National Petroleum Corporation
- Volta River Authority
- Geological Survey Department
- Forestry Commission (Forestry and Wildlife Division)
- Traditional Rulers and their analogous ministry and laws
- Ministry of Works and Housing
- Ministry of Roads and Transport
- National Development Planning Commission
- Council for Scientific and Industrial Research
- Universities and Research Institutions
- Ghana Meteorological Agency; and
- Town and country Planning Department
- Water Resources Commission

7. PARTNERSHIPS

Few formal partnerships exist. Support for coastal conservation activities have been received from the private sector as well as from Government. Some financial institutions have supported NGOs in marine conservation activities.

Regional and sub-regional collaboration efforts occur at various levels albeit sectoral in many respects. Some to a large extent seem to be paper agreement with little financial inputs from the partners involved. Not much impact has been gained on issues relating to the management of the Gulf of Guinea by the science and technology unit of the ECOWAS. The bilateral arrangements between Ghana and Cote d'Ivoire in the management and data sharing of straddling Sardinella stocks exist and on-going. The sub-regional initiatives like WACAF and the GOG-LME have made tremendous strides in the area. The emerging partnership within the NEPAD framework among the coastal states of Africa on marine and coastal management is also promising in this regard.

7.1 Technical and financial support

The country has enjoyed enormous technical support in the form of training, research and project implementation from national, bilateral and multi-lateral sources.

Financing of activities in the sector is primarily supported from the national budget. However, donor support from both bilateral and multilateral sources has also been obtained for specific programmes, such as the World Bank sponsored Fisheries Sub-sector Capacity Building Project; UNOPS sponsored Environmental Sensitivity Map for Coastal Areas, The Ghana Coastal Wetland Project of the World Bank, UNEP's WACAF Programmes,

and The Darwin Marine Biodiversity of West Africa Project by DFID implemented by the University of Ghana.

8. ACTIVITIES

Activities undertaken in the country of importance to the marine and coastal area are outlined in the following sections.

8.1 Environment-related activities

- Ecological Baseline studies of Korle Lagoon (1990-2000). This was carried out to satisfy EIA requirement and as a result pollution status of the lagoon was established.
- Lower Volta Mangrove Project (1996-1998). The objective is to ensure sustainable management of mangrove stands and as such baseline information was documented.
- Save the Seashore Birds Project (1985-1995). This was to protect the seashore birds and as a result conservation awareness of seashore birds was achieved.
- Ghana coastal wetlands management project (1996-1999). In this, management of the five coastal wetlands designated as Ramsar Site was put in place
- Darwin Marine Biodiversity of West Africa Project. It is a training project in marine biodiversity assessment.

8.2 Coastal area management

- Climate and vulnerability and adaptation assessment on water resources, agriculture and the coastal zone Projects. (1997-1999). The projects assessed the vulnerability of the coastal zone to climate change.
- Coastal area management plan for Princess Town (1998-2000), which aimed at providing a plan for the management of Princess Town.
- Keta Sea Defence Project Work (2000-2004). The project aimed at protecting the Keta and its environs from the episodes of erosion faced in the area and also to ensure improvement in environmental and socio-economic conditions at Keta and its immediate surroundings.

8.3 Regional Programmes

- Gulf of Guinea Large Marine Ecosystems Project (1996-1999). The project developed an effective approach to prevent and control pollution in the Gulf of Guinea and conserve its biodiversity. As a result, regional institutional capacities were strengthened and also a coastal zone management profile and plans produced.
- UNEP WACAF Projects 1 & 2. This aims at institutionalising and coordination of national contingency plans, monitoring of pollution in the marine environment and control of coastal erosion.

8.4 Other major programmes

Other programmes and activities in place for the marine and coastal environments are the following.

- Ghana Environmental Resources Management Project in Coastal Wetlands Management Component
- Fisheries sub-sector Capacity Building Project
- Establishment of a Protected Wetland Ecosystem on the coast
- Development and Implementation of Oil Spill Contingency Plan

9. ONGOING PROJECTS

Ghana is currently implementing several projects in the marine and coastal area. Some of these projects are linked to developmental projects for which impact assessments are required under the Environmental Assessment Regulations of 1999. Some of the projects are large scale in nature with extensive baseline and monitoring studies like the Keta Sea Defence Project and the West Africa Gas Pipeline project. Others are projects being implemented under the auspices of the United Nations agencies and non-governmental organisations include:

- Combating Living Resource Depletion and Coastal Area Degradation in the Guinea Current LME through Ecosystem-based Regional Actions.
- Amansuri Conservation and Integrated Development Project (ACID)
- Danida Water and Sanitation Sector Programme II: Support to Integrated Water Resources Management (IWRM) Component (2004-2008):The Densu Basin aspect of the IWRM component.
- Reduction of Environmental Impact from coastal tourism.

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- Minerals Commission
- Volta River Authority
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- Ghana Wildlife Society
- Department of Fisheries and Oceanography, University of Ghana
- Ricerca e Cooperazione, Ghana

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A Note on Marine Administration in Small Island Developing States (SIDS)

David Neale

Abstract

Small Island Developing States (SIDS) claim special circumstances that complicate their adoption of formal marine administrative systems. The special circumstances include their size, their vulnerability to natural hazards, their dependence on marine resources and their technical and administrative resource limitations. In the context of the Eastern Caribbean Islands, these factors seem to manifest in present marine administrative weakness. This paper presents a brief discussion on these issues.

1. INTRODUCTION

There is no widely accepted definition of a Small Island Developing State (SIDS). The SIDS network however includes more than fifty countries around the world whose primary physical geography are considered to be that of 'small islands.' Associated with these small island states, is a varied and well-defined relationship with the sea and the resources within it. Indeed, when applied to the SIDS, the United Nations Convention on Law of the Sea provides for claims of relatively vast marine area spaces adjacent to these small islands. Such potentially large extensions of sovereignty for a small state can not only enrich that state but also burden it with the responsibility of the administration of vast areas. Spatially, SIDS occur in all parts of the world but many are located within the tropics with 20° North and 20° South. The largest SIDS is the State of Papau, New Guinea (426840 km^2) in Australasia and the smallest is Nauru (21km^2) in the Pacific Ocean. Table I below lists SIDS, their sizes and their coastline lengths.

The convening of the SIDS conference in Barbados in 1999 (United Nations 1994) served to recognize and document the special status of SIDS in development sectors. The conference identified many of those features of SIDS that were unique or significant factors affecting development and development activity within the attending member States. Coastal resources, all aspects of land and the role of land administration structures were among the associated development activities identified. This paper considers one area of land administration: marine administration, and the special circumstances that challenge the adoption of marine administration systems in SIDS.

Table 1: List of SIDS, their sizes and coastline lengths
(Compiled from data published by the United Nations Department of Social Affairs, Division for sustainable Development)

STATE	AREA (KM2)	COASTAL LENGTH (KM)
American Samoa	199	116
Anguilla	102	61
Antigua and Barbuda	442.6	153
Aruba	193	68.5
Bahamas	13940	3542
Bahrain	665	161
Barbados	431	97
Belize	22966	386
British Virgin Islands	153	80
Cape Verde	4033	965
Comoros	2170	340
Cook Islands	240	120
Cuba	110860	3735
Cyprus	9250	648
Dominica	754	148
Dominican Republic	48730	1288
Federated States of Micronesia	702	6112
Fiji	18270	1129
French Polynesia	4167	2525
Grenada	344	121
Guam	541.3	125.5
Guyana	214970	459
Haiti	27750	1771
Jamaica	10991	1022
Kiribati	811	1143
Maldives	300	644
Malta	316	196.8
Marshall Islands	11854.3	370.4
Mauritius	2040	177
Montserrat	102	40
Nauru	21	30
Netherland Antilles	960	364
New Caledonia	19060	2254
Niue	260	64
Northern Marianas	477	1482
Palau	458	1519
Papa New Guinea	462840	5152
Puerto Rico	13790	501
Samoa	2944	403
Seychelles	455	491
Soa Tome and Principe	1001	209
Solomon Islands	28450	5313
St. Lucia	616	158
St.Kitts and Nevis	261	135
St.Vincent and the Grenadines	389	84
Suriname	163270	386
Timor Leste	15007	706
Tonga	748	24
Trinidad and Tobago	5128	362
Tuvalu	26	24
U.S. Virgin Islands	1910	188
Vanuatu	12200	2528

The paper continues with a review of some of the special circumstances identified in the literature and are associated with marine administration in SIDS. The circumstances are illustrated in one geographic grouping of SIDS: the islands of the Eastern Caribbean.

2. SIDS SPECIAL CIRCUMSTANCES

There are both an emerging and a growing literature on SIDS. These include national reporting from numerous United Nations Conferences since the initial SIDS conference in 1998, case study research as published in academic journals and presentations at professional forums including those supported by both Governmental and Non-Governmental Organisations. From this literature it is possible to identify many of the special aspects of SIDS that are important to the administration of marine spaces. This brief paper, while acknowledging there may be many other important aspects, will concentrate on perhaps the most four (4) significant features of SIDS:

- their size,
- their vulnerability to natural hazards,
- their dependence on marine resources and
- their technical and administrative resource limitations

2.1 Size

Island state size is one of the primary parameters in defining a SIDS, the other is its status as a developing country. As defined, a SIDS is small. Here the term 'small' is used to characterize many aspects of SIDS. One way to theorize this term is in a physical geographic sense where 'small' is a description of the relative relationship between the physical size of a state and its ability to affect the larger environment around it. For example, a small low relief island within the tropics tends to have relative little singular effect on larger physical oceanographic and meteorological forcing. In many instances, the flow of large-scale ocean currents or weather systems is little affected by the presence of small islands.

The Eastern Caribbean chain of islands comprise of more than thirty inhabited islands. Some are little more than raised reef terraces (for example, Barbados) or isolated rocks. Some like Trinidad are associated with the larger geological features of the South American land mass. Several are of volcanic origin and have presence of volcanoes in various life stages (for example, St. Kitts, Montserrat, St Vincent, Grenada, Martinique and Guadeloupe). For most islands there is often simplicity to their shape and relief which tends to restrict human settlement and physical development activity to a narrow coastal strip. From an oceanographic standpoint the Eastern Caribbean island chain defines the eastern limit of the Caribbean Sea and the Western limit of parts of the North Atlantic Ocean. The marine areas in-between the islands are typified by deep passages that allow the exchange of water across the larger water bodies. Research of large scale circulation patterns suggests that the region supports significant bio-physical activity and flow characteristics, for example currents, large scale circulation eddies and annual variations in salinity that are driven almost exclusively by river forcing for the larger river discharges from the South American Continent. In general the presence of the islands themselves offers little to the larger dynamics to these bio-physical and flow characteristics.

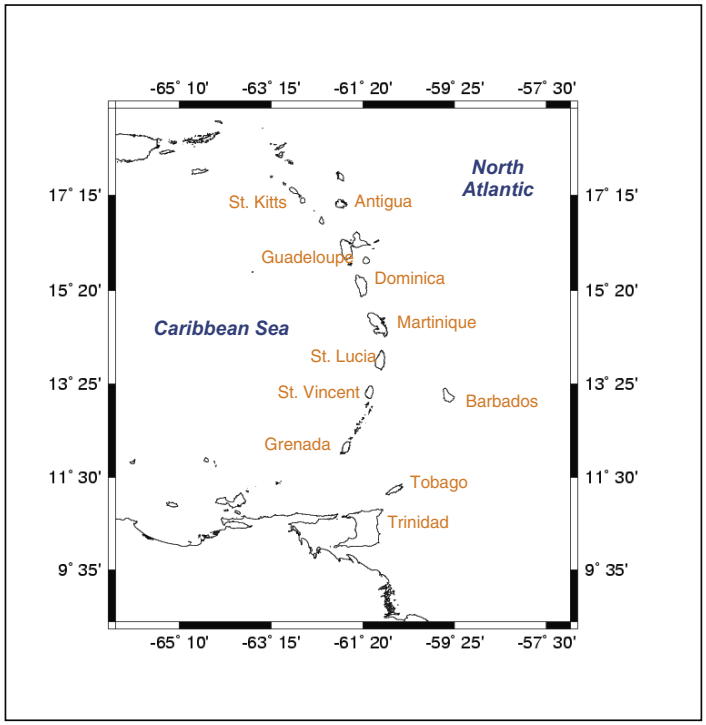

Figure 1: The Eastern Caribbean Islands

In a macro economic sense, size is easily reflected in the overall extent and reach of the national economy of a SIDS. Often the GDP in SIDS is often associated with economic structures that are heavily skewed towards only a single or a few economic sectors.

2.2 Vulnerability to Natural Resources

The vulnerability of small islands to natural disasters is best understood in terms of the record of post event disaster loss. The Eastern Caribbean islands are prone to extreme events including hurricanes and storms, flooding, earthquakes and volcanic eruptions. The estimates of return time for storms and hurricanes vary and the eruptions of earthquakes remain unpredictable but the need for investments of time, resources and standards in disaster preparedness is an important aspect of national planning.

The devastation caused by the passage of hurricanes, storms, heavy rainfall and the attendant flooding is often significant. Storm records indicate that in recent times more than fifteen named storms per year have crossed the region. A recent example is that of the passage of Hurricane Ivan over the island of Grenada in 2004. The storm was a Category 3 with sustained winds of 165 kph. Reports indicate that 80% of the island was severely affected, that 89% of the housing stock was destroyed and twenty-eight persons lost their lives. The scale of destruction is however not limited to infrastructure but also to still unquantified loss and or damage of coastal habitats including reefs, beaches and wetlands. Another example is that of the impact on the continuing volcanic eruptions on the island of

Montserrat. So severe are these eruptions that a significant part of that island, including the former capital is now delimited as an exclusion zone into which entry is strictly controlled.

Records suggest that over the past two decades, natural disaster events in the eastern Caribbean include Hurricane Gilbert in 1988, Hurricane Hugo in 1989, Hurricanes Luis and Marilyn in 1995, Hurricanes Mitch and Georges in 1998 and Hurricane Lenny in 1999, all resulting in major losses. The impact of these hurricanes was also in the loss of agricultural output. Dominica, for example, saw banana production fall by 22.8% in 1995 because of an almost total destruction of the crop due to tropical storm Iris and Hurricanes Luis and Marilyn. Economic growth slowed that year to 1.6%, down from 2.2% the previous year.

Vulnerability to natural disasters also generates great concerns for the location of infrastructure including the location of ports and harbors and the attendant marine infrastructure as well as general marine and coastal access issues.

2.3 Dependence on marine resources

For centuries, island residents have exploited the marine resources around their islands, perhaps initially for fish, then later as access to markets and more recently for hydrocarbons and as tourism infrastructure. Recently, in the maritime boundary dispute between Trinidad and Tobago and Barbados (Award of Arbitral Tribunal 2006), the dependency of the local Barbados economy on access to pelagic fish, in particular the Flying Fish, was highlighted as part of a maritime claim. Also in Barbados, the economy's reliance on coastal tourism is evidenced by the large number of coastal hotels, beach and water sport facilities. Arguably sea and sand are critical parts of the Barbados tourism trust. The sustained quality of that resource is therefore of paramount importance to the national economy.

The twin island State of Trinidad and Tobago features a hydrocarbon led economy where significant aspects of its oil and gas reserves are located in the offshore marine environment. The presence of numerous offshore oil and gas installations on the eastern coast of Trinidad provides evidence for related issues of marine traffic and environmental pollution issues.

If anything this island dependence on coastal resources seems to warrant investment of marine administrations systems but remains unattended mainly because of the lack of political will.

2.4 Administrative constraints

In many cases the administrative structures within SIDS are inherited from a long colonial history. Some have argued that the form for those structures were often associated with single-minded short-term exploitation rather than long term sustainable development. Patterns of governance, the form of institutions and the shape of law and regulations were therefore primarily based on priorities driven by the hard economics of the day with little input from environmental or sustainability concerns. Often without update, such colonial or post-colonial forms have often proved weak or silent in tackling modern sustainability

problems. Administration without adequate regulation and law can be significant constraints to resource management.

In the former English colonies of the Eastern Caribbean the general model for land administration was centered on several Government Departments, including a traditional 'Lands and Surveys Department', and a regulatory framework designed for land spaces only. Of primary concern were the administration of tenure arrangements and the collection of taxes. The inherent weakness meant poor description of coastal matters such vertical datum, the high water mark as a jurisdictional limit and loose and overlapping jurisdictions amongst various Government agencies.

In the years that followed Independence, relatively little was done to change the basic form of land administration. The emergence of new technology such as GPS, Satellite Imagery and Geographic Information Systems greatly improved access to data collection but has had little impact on general land administration because of the inability of administrative structures within state agencies to use the increased resource information in the decision making processes.

Other less obvious administrative constraints became evident as the term land administration was stretched to include the administration of marine spaces – an area that in colonial times was generally the sole purvey of the Colonial Harbor Master. The primary concern of that functionary was the navigational safety and control of Customs rather than any larger resource management role. Traditionally, nearly all rights in marine spaces were owned by the State (previously the Crown), hence prior to the idea of a lease for marine resource exploitation, the documentation of rights in marine spaces were non-issues. This scenario is still reflected today in the general lack of training or other resources for measurement and indeed the administration of marine space in the region. Of the English speaking States of the Eastern Caribbean, today only Trinidad and Tobago and Barbados have some Government in-house hydrographic survey or marine area management capability.

3. MARINE ADMINISTRATION

The literature on marine administration identifies benefits to structured and well-managed marine administration that in the face of the close association of SIDS to the sea would recommend it. That notwithstanding, efforts at the adoption of marine administration with many SIDS are slow in coming. The States struggle with the lack of political will and constraints of size and lack of resources in pursuing implementation. Akin to the challenges of implementing environmental management, for many SIDS scarce resources must be prioritized on a long list of other social, economic and infrastructural demands. Only when economic or social pressure becomes unbearable, are better resource management structures considered.

As in many SIDS, the idea of adopting marine administration systems is still not a priority and still not recognized as a management tool. In the Eastern Caribbean, the following features can be identified.

- In general, land administration is still relatively weak and complicated by the lack of political willingness to engineer change. Significant updating of the laws governing physical planning and land development are required.
- There is now increased effort to incorporate the use of satellite imagery, GIS and other modern data gathering and data analysis systems (particularly in response to disaster management) but little co-ordination amongst stakeholder groups at data sharing and data management.
- Research efforts remain limited and poorly funded.
- Many fundamental coastal issues remain unattended, for example coastline monitoring, marine habitat and resource mapping and the implementation of management methods for coastal development.
- There is little effort on the standardization of marine data reporting and exchange formats. Such exchange of data is an integral part of marine administration systems since they eliminate duplication and improve cooperation.
- Nautical charting efforts are generally restricted to surveys of ports and harbors or other areas of commercial importance.
- The idea of the adoption of a marine cadastre has not yet been fully considered.
- Attempts at capacity building in the area of marine administration are scattered, slow and without focus.

Perhaps one notable exception to the above is the efforts on the Government of Barbados in funding research and the implementation of coastal management at a national level through statutory planning and the introduction of legislation to support that planning. Barbados has established a well-defined coastal zone and the necessary administrative resources to monitor and manage its coastal resources. It is possible that with time the current marine administration systems in Barbados will evolve to include larger marine administration issues.

Several developments with the Eastern threaten to hasten interest in marine administration; these include continued efforts at regional integration at economic level, attempts at improving disaster preparedness and the emergence of new technologies that support marine resource exploitation. The growing fear is that as the land based resources become more and more restricted, development and interest in the marine resource will grow.

4. CONCLUSION

The future of formal marine administration systems into SIDS is heavily dependent on the ability of the SIDS themselves to lobby for its adoption. The special circumstances of SIDS present challenges but ones that if resolved can bring rich reward. While still some time away, SIDS will eventually be compelled to pursue management and administration of its marine area if success at sustainable development is to be achieved.

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Issues in the Governance of Marine Spaces

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Marine Administration Research Activities within Asia and the Pacific Region – Towards a Seamless Land-Sea Interface

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Resolving Spatial Uncertainty in the Tidal Interface

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A National Geocentric Datum and the Administration of Marine Spaces in Malaysia

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Governing the North Sea in the Netherlands

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Using Canadian MPAs to Highlight the Need for Improved Tenure Information Management

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Institutional Frameworks in the Administration of Coastal and Marine Space in Africa

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Impacts and Management of Oil Spill Pollution along the Nigerian Coastal Areas

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The Douala Coastal Lagoon Complex, Cameroon: Environmental Issues

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The Protection, Management and Development of the Marine and Coastal Environment of Ghana

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A Note on Marine Administration in Small Island Developing States (SIDS)

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The coastal zone is a complex and finely balanced ecosystem contained within a relatively narrow band of land and sea. Many coastal marine ecosystems are among the most productive in the world. They provide food and livelihood for millions of people. Coral reefs are home to more than a million species. Coastal zones are economically, politically and socially critical to many nations. Coasts are used by millions of people for recreation. Major transport hubs are situated in or near the coastal zone where ports and harbours are vital to commerce and trade.

This narrow band of land and sea occupies only 20 per cent of the world's land area. Half the world's population, some 3,000 million people, live within 200 km of the coast and it is estimated that by 2025 this figure may double. Our cities use some 75 per cent of the world's resources and discharge similar amounts of waste.

It is hardly surprising then that this marine space is under serious threat from a myriad of overlapping and conflicting interests. FIG, through the work of a joint Commissions 4 and 7 workgroup, has been active in the areas of Coastal Zone Management, Marine Cadastre and Marine Governance since 2002. This has included an international workshop, published papers, presentations and attendance at FIG and other International fora. This publication comprises a number of papers that focus on issues related to the administration of marine spaces from regional perspectives. Its purpose is to stimulate further discussion and research in this most important subject area. Whilst it is not possible to deal with all issues, it does underscore the international importance of administering marine spaces.

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