

**Enhancing Integrated Coastal Management
decision making in KwaZulu-Natal, South
Africa through knowledge transfer and
information sharing**

by

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ABSTRACT

Coastal environments are complex systems being sought-after for a myriad of environmental, socio-economic and cultural activities, supporting an estimated 44% of the world's population. The demand for coastal space and resources has created extreme pressure in coastal areas, leading to reduced coastal functionality and amplified risk of natural hazards. These stresses and changes require proactive management, in particular through policies and legislation that ensure protection and long-term sustainability, thus the emergence of Integrated Coastal Management (ICM) as a 'holistic' approach. South Africa, being a country of high marine and coastal biodiversity, recognised the need for better coastal management in the 1970s; however, it was only in 2009 that an Integrated Coastal Management Act (ICM Act) was promulgated. The Act attempts to tackle the interlinked problems of coastal development and conservation; however to date implementation has been frustratingly slow, with capacity constraints and knowledge gaps being the primary limitations. If ICM is to be effective, coastal managers require a broad range of scientific and social information, modelled data and environmental indicators, meaning that the scope and complexity of coastal management is strongly dependent upon capacity. However, in South Africa, these functions do not rest with such experts, but are assigned to various government departments at the local municipality level. Thus ICM initiatives, that integrate natural and social sciences and empower managers with best available knowledge, are required.

This research focused on the KwaZulu-Natal (KZN) Province, one of four coastal provinces in South Africa grappling with ICM implementation. Consequently, the KZN provincial government committed financial resources to improving knowledge transfer, information sharing and capacity building. KZN-specific barriers to ICM implementation were identified through a series of interviews and surveys, from which requirements for an information support tool were determined. The tool, devised from a coastal management perspective, enables continued knowledge acquisition and retention, thereby acting as an 'institutional knowledge bank'. Development followed a participatory approach that ensured the needs of target users were met, however while such tools can improve understanding and lead to improved decision-making, their effectiveness depends on continued use by managers. Additionally, this research shows the value-add of such a tool in conjunction with traditional capacity building sessions and how these complementary approaches assisted ICM implementation. Lessons learned from KZN can be up-scaled to inform Government on the value of the information support tool by incorporating national data and information sharing for ICM capacity building.

DECLARATION

The research described in this dissertation was carried out in the Discipline of Geography, School of Agricultural, Earth and Environmental Sciences, University of KwaZulu-Natal, Pietermaritzburg, from January 2014 to February 2019, under the supervision of Prof T.R. Hill (University of KwaZulu-Natal) and Prof M.R. Phillips (University of Wales Trinity Saint David).

These studies represent original work by the author and have not otherwise been submitted in any form of degree or diploma to any University. Where use has been made of the work of others it is duly acknowledged in the text.

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Thesis contents

This doctoral thesis consists of an introductory chapter, a literature review, four journal papers, two of which are accepted and two are submitted and under the peer review process, and a synthesis chapter.

List of papers:

1. Goble, B.J., Lewis, M., Hill, T.R. and Phillips, M.R. (2014) Coastal management in South Africa: Historical perspectives and setting the stage of a new era. *Ocean and Coastal Management*, 91: 32-40.
2. Goble, B.J., Hill, T.R. and Phillips, M.R. (2017) An Assessment of Integrated Coastal Management Governance and Implementation Using the DPSIR Framework: KwaZulu-Natal, South Africa. *Coastal Management*, 45: 107-124.
3. Goble, B.J., MacKay, C.F. and Hill, T.R. (2019) Design, Development and Implementation of a Decision Support info-portal for Integrated Coastal Management, KwaZulu-Natal, South Africa. *Environmental Management*, 64 (1): 27–39.
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Co-authorship

Bronwyn J Goble led the writing, performed all analysis and interpretation for all four papers. The co-authors contributed with improvements of the text, arguments and scientific discussions.

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CHAPTER ONE: INTRODUCTION

1.1. Introduction

Coastal environments provide a diverse range of goods and services such as fisheries, water purification and coastal erosion protection, all of which are critical for sustaining populations living within close proximity to the sea (Sale et al., 2008). Martínez et al. (2007) determined the calculated value for Ecosystem Services Product (ESP) provided by global coastal ecosystems, including both natural (terrestrial and aquatic) and human-transformed ecosystems, added $25,782.53 \times 10^9$ \$US per year. In South Africa, coastal goods and services were valued at approximately R168 billion and indirect benefits contributing an additional R134 billion per annum (DEAT, 2000). As a consequence, the coast has become a global focus for a wide range of human activities (IGOS, 2006). As populations migrate to coastal areas due to increased tourism, recreation, residential and industrial development, the coastal environment is faced with increasing pressure from urban encroachment. In addition, the pollution of estuaries and coastal waters is increasing as a consequence of the discharge of raw or partially treated sewage, non-point discharges of pollution and industrial discharges (Fabbri, 1998). Concerns are exacerbated by the potential effects of climate change, with coastal environments being highlighted by the Intergovernmental Panel on Climate Change (IPCC) as an 'area of particular concern' (IPCC, 2007). It is anticipated that one of the most significant effects of climate change on the coastal environment is sea-level rise, which will increase the coast's exposure to other risks, such as increased coastal erosion, potential intensification of tropical and extra-tropical cyclones, and increased flooding and over-wash events (IPCC, 2007; Nicholls et al., 2007).

Worldwide, coastal authorities are faced with managing a highly complex environment that is subject to natural and anthropogenic pressure. These pressures have led to the recognition that this unique zone needs to be managed in a holistic, integrated manner, exemplified by Integrated Coastal Management (ICM) (Cummins et al., 2003). The ICM approach calls for the integration across government tiers and departments ensuring long-term sustainability. The notion of ICM was popularised in the 1970s with the United States developing an Integrated Coastal Management Act (ICM Act); fulfilling the need for a new, more integrated approach to coastal management (DEAT, 2000). Today a number of other countries, including South Africa, have developed similar legislation or coastal management programmes, all of which reflect the need to better manage the coastal environment to ensure its sustainability for future generations, particularly in light of increased anthropogenic pressures (Carter, 1999). South Africa's ICM Act is inherently dynamic, attempting to tackle the interlinked subjects of coastal development and conservation. However, decision-making

is a function of a manager's knowledge of the environment, the issues under consideration and the tools and techniques at their disposal to inform the decision-making process, which are often limited. Thus, decisions are often made under conditions of uncertainty, relating to the socio-economic, demographic, ecological, physical, climatic and technological conditions of the coast (Fabbri, 1998).

This research considers the challenges facing ICM at the provincial and local level in KwaZulu-Natal (South Africa) and investigates approaches that could aid in improving long-term ICM implementation and sustainability.

1.2. Research aim and objectives

Aim:

Directly support coastal management within the Province of KwaZulu-Natal through traditional training approaches and an information portal that stores a range of spatial and non-spatial information and data in support of ICM decision making.

Objectives:

1. To provide an overview of historical and current coastal management policies and initiatives in South Africa, with a focus on the Province of KwaZulu-Natal;
2. To review current ICM implementation and limitations in KwaZulu-Natal;
3. To develop an information support tool to assist in improving KwaZulu-Natal's coastal management; and
4. To assess the range of capacity building approaches and how the development of an information support tool for KwaZulu-Natal has aided coastal management decision making.

1.3. Study area

This research focuses on one of the four coastal provinces in South Africa, KwaZulu-Natal (KZN). This province was selected as it faces a number of coastal management challenges, has the highest population density of all the coastal provinces and a high degree of potential for future development as it boasts year-round warm climate, rich coastal biodiversity, availability of flat land and high aesthetic value. KwaZulu-Natal's coastal areas face increasing development pressure, particularly along the North Coast, from Durban through to Ballito (Figure 1.1), which is popular among investors and end-users alike (BusinessTech, 2017).

The KZN province is situated on the east coast of South Africa (Figure 1.1); its coastal zone stretches nearly 600 km from the Mozambique border in the north to the Eastern Cape Province in the South. The coastal climate is influenced by the warm Agulhas Current, which gives it its humid subtropical character. Daily temperature highs average between 16 to 25°C in winter and from 23 to 33°C in summer. These summer temperatures are often accompanied by high humidity levels which make for ‘uncomfortably high’ temperatures along the KZN coast (Kruger, 2014). A relatively high rainfall regime prevails during the summer months, approximately 845 mm annually. Additionally, the coast of KZN is subjected to a moderate wind regime; during autumn and winter months’ southwest winds are dominant, while north-easterly winds prevail during spring and summer.

The coast is generally linear with few bays and no islands or offshore barriers. Approximately 80% of this coast comprises stretches of sandy shores, with the rest being characterised by intermittent rocky outcrops (Palmer et al., 2011).

For the purpose of this research the coastal zone is defined in terms of the ICM Act, as a zone comprising coastal public property, the coastal protection zone, coastal access land and coastal protected areas, the seashore, coastal waters (including estuaries) and the exclusive economic zone and includes any aspect of the environment on, in, under and above such area (ICM Act, s 1(1)). By definition, the coastal protection zone includes any land 100 meters from the high-water mark in urban areas and land 1000 meters from the high watermark in undeveloped areas, resulting in a significant portion of land under coastal management. Census data show that the KZN’s coastal municipalities are home to 62% of the province’s total population (Statistics South Africa, 2011). This has resulted in the need for effective and proactive management of the KZN coast, to ensure natural functioning of the coast and protection of coastal properties and infrastructure.

People living in coastal areas and drawing on coastal resources, as well as those tasked with the management of these activities, have a limited understanding of the economic, cultural and aesthetic value of a sustainably managed coast. This contributes to a failure of coastal infrastructure and overexploitation of resources, in turn affecting the effectiveness of the management framework (Sale et al., 2008). Management authorities lack the resources to enforce compliance and there is a lack of scientific input into coastal management. Together these often led to management actions that are reactive as opposed to proactive. Furthermore, development along the coast is occurring at such a rapid rate that long-term management strategies are not relevant in the short term (Sale et al., 2008). In South Africa, coastal managers are attempting to address these challenges and at the same time,

meet the objectives of the ICM Act. Thus, coastal authorities require urgent support pertaining to scientific information or data to aid in, and to streamline, the decision-making processes.

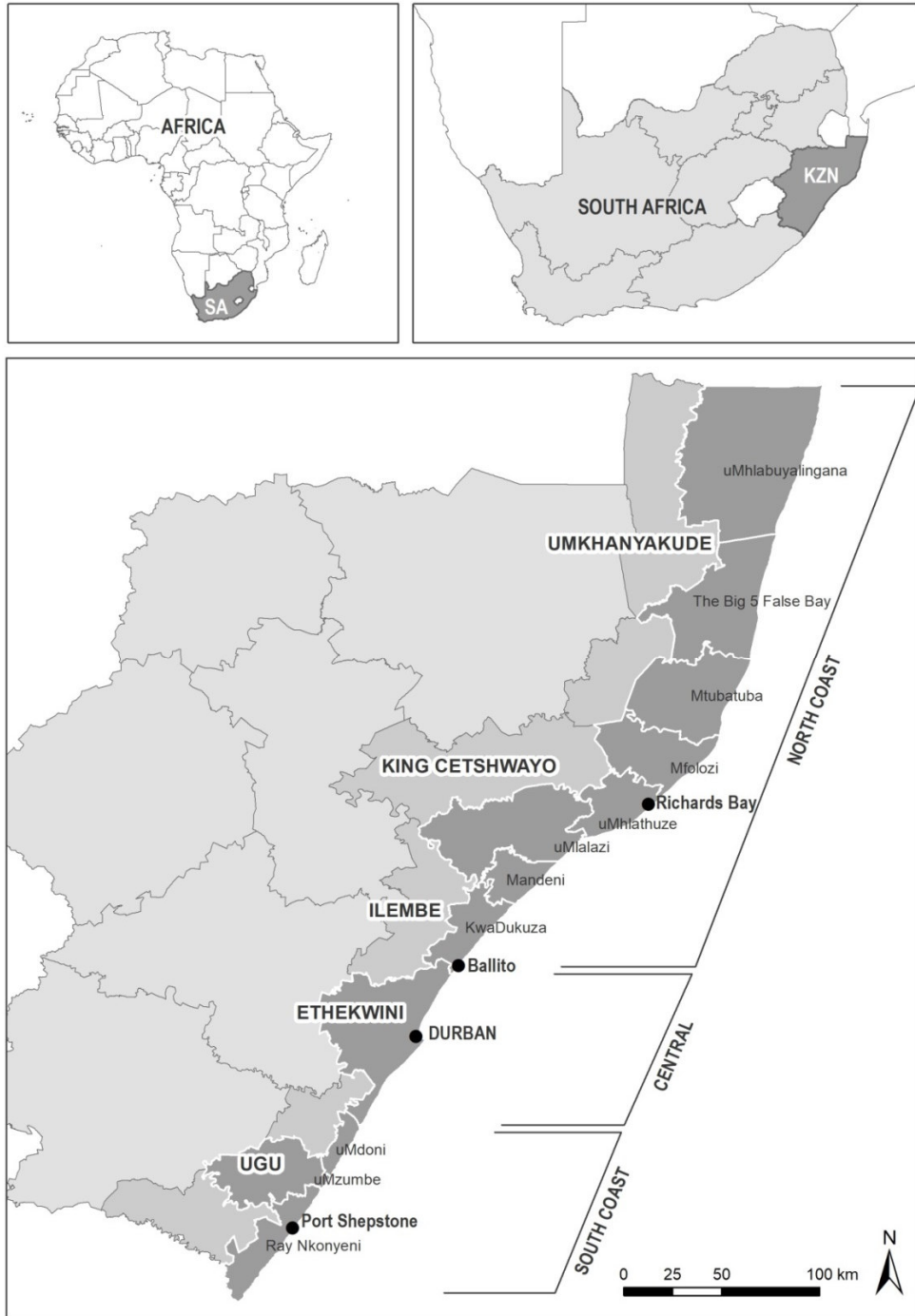


Figure 1.1: The KZN Province located along the east coast of South Africa

1.4. Methods

Capacity (both human and financial) constraints have been identified time and again in the context of coastal management within South Africa (Goble et al., 2017; Sowman and Malan, 2018; Rosendo et al., 2018). This has resulted in a number of guidelines and support documents for assisting in ICM. However, these documents are only as useful as the understanding and interpretation by managers and more interactive innovative tools are needed. For KZN, the need for such innovative support approaches was brought to the fore following a storm event in 2007, which caused extensive coastal erosion and severe damage (Smith et al., 2007; 2010; Mather, 2008) and left managers reacting to the aftermath in a vacuum. This reiterated that in emergencies guideline documents and reports add little value. Thus for KZN a rapid coastal vulnerability assessment was undertaken to determine future risk and aid in improved response going forward. The vulnerability assessment culminated in a coastal vulnerability index (CVI) and viewer to simplify the presentation to managers and decision makers. The tool was developed based on a desktop assessment of key physical parameters of natural coastal risk (Palmer et al., 2011). While the determination of the CVI was kept as simple as possible, working within the limits of available data and information, the output required some interpretation by users to be useful to management. This led to the realisation that technical information of this nature is valuable to decision makers, but in sharing this it should be presented in an interpreted, interactive, user-friendly format. In developing the CVI viewer (Figure 1.2) several factors needed to be considered including; internet access and speed, computer literacy, GIS knowledge and understanding of risk and vulnerability.

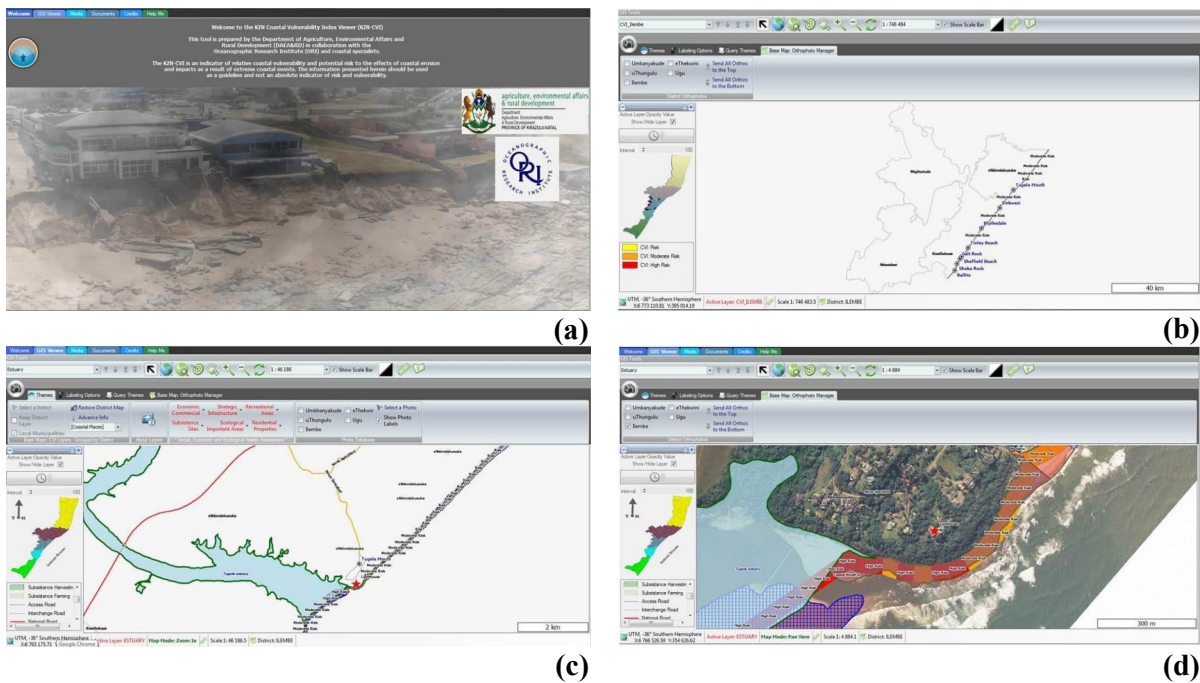


Figure 1.2: KZN coastal vulnerability index viewer. (a) The home or welcome page on opening the viewer, (b) an overview of the KZN coast, from where you can zoom to your preferred site, (c) an example of a site showing CVI scores, the estuary affected and major roads, (d) an example of a site showing CVI scores at a localised scale and social layers affected.

Given the lack of internet access of many local municipalities, the tool was developed as self-install standalone software, being primarily a spatial system that housed the risk information as determined by the vulnerability assessment. It housed several social information layers to inform users as to what is potentially at risk and supporting reports that summarised what users were viewing and how to interpret the information (Palmer and Parak, 2009).

The viewer achieved its objective of being simple and user-friendly, and at the time, the CVI viewer was a unique tool offered to KZN coastal managers with a focus of identifying properties and infrastructure potentially at risk (Palmer et al., 2011). The CVI tool was well utilised and supported a number of decisions pertaining to new development along the coast. A tool that provides information on risk and vulnerability is important as these pose major threats to people and properties. However, coastal managers require increasing assistance with shorter-term management challenges and improving knowledge for enforcement. Hence the need for a more encompassing approach that could better assist in facilitating all aspects of ICM (Figure 1.3). However, to effectively define and develop an ICM information support tool, a better understanding of current ICM objectives, requirements and challenges was needed. This research follows a step-wise approach, being made up

of three key parts (Figure 1.3), to ensure that these requirements and challenges were adequately understood and included in the proposed tool.

First, Figure 1.3 provides the background and motivation or need for this research, relating to the limitations of the CVI viewer and need for a broader management support tool, as emphasised above. Part One of the method focuses on ensuring a better understanding of the ICM arena in South Africa and particularly KZN (Figure 1.3). Surveys with provincial coastal managers and semi-structured interviews with selected managers and decision makers were used to determine this. From which KZN specific challenges were identified and framed coastal manager's requirements; this links to objectives one and two of this research and outlines the way for Parts Two and Three of the methodology (Figure 1.3). A conclusion of Part One is that it highlights the need for alternative ICM support for local and provincial managers in KZN. This leads to Part Two, which focuses on the development of a platform that assists coastal managers in decision making (Figure 1.3); the outcome of which aligns with the third objective, which focuses on the development of an information support tool for assisting in improved coastal management. Part Two considers how scientific information, data and technical skills can be better presented for informing effective ICM. Lastly, Part Three, which links to objective four (Figure 1.3), reflects on this process and if it has resulted in changes within the ICM arena for KZN. Again, this information is gathered via a number of surveys and interviews.

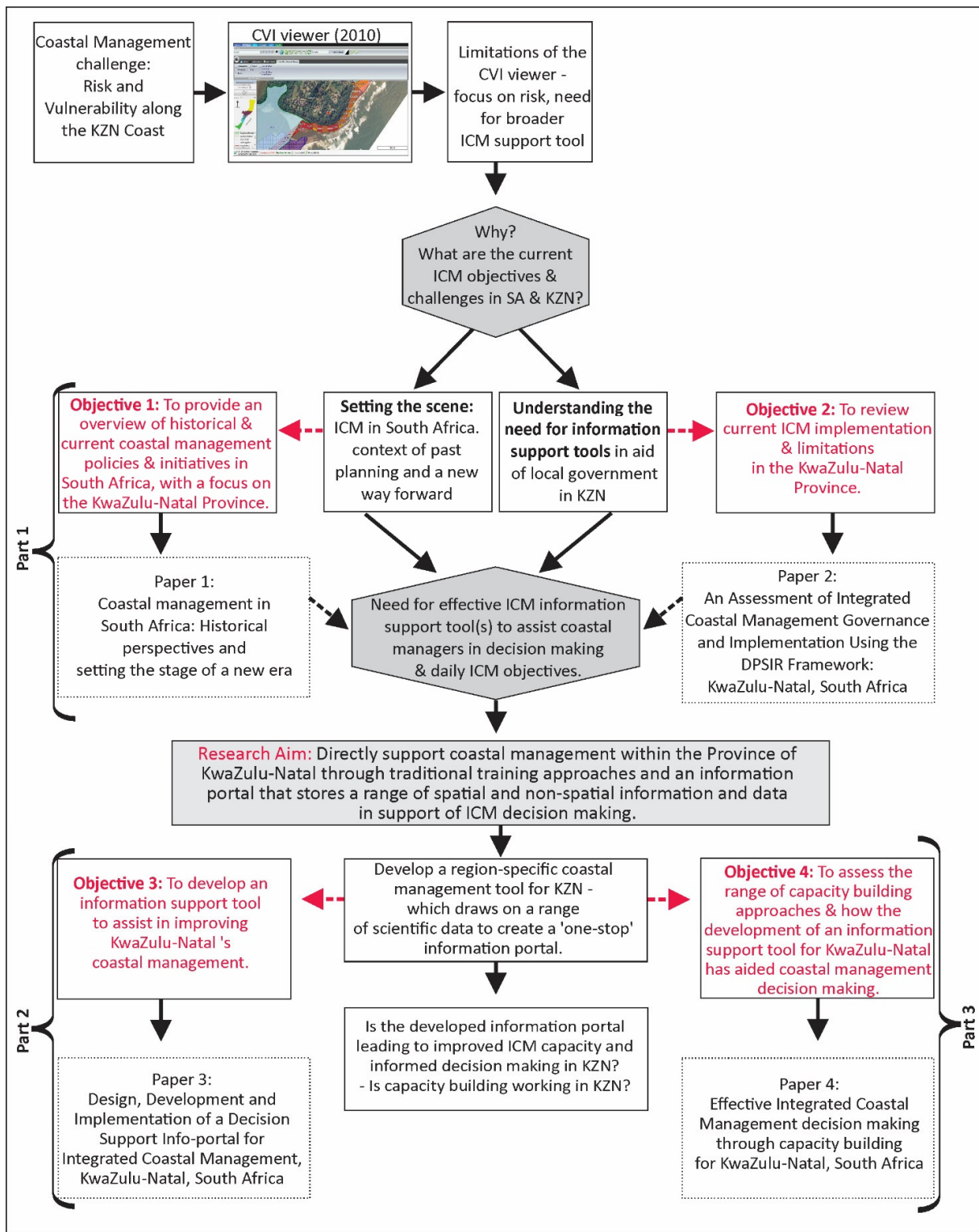


Figure 1.3: Thesis objectives, questions and outputs

1.4.1. Data collection

Much of the information used to inform this study was gathered 1) a series of surveys throughout the research and 2) one on one engagement with key stakeholders and decision makers. Each survey or survey set informs a different component and paper presented in this research. Further to this a test group was identified to inform the data gathering process and identification as to what is feasible for a tool such as the info-portal proposed. Engagement with key decision makers helped focus this research to allow for practical application.

A test group was identified for engagement on content and structure of the tool, this included representation from seven sectors, namely:

1. **Researchers related to the field of ICM:** Researcher working in fields associated with ICM, such as estuarine scientists.
2. **Researchers not related to the field of ICM:** Research working in unrelated fields, such as terrestrial scientists
3. **Local government officials:** Officials tasked with the implementation of ICM at the local level.
4. **Provincial government officials:** Officials tasked with the implementation of ICM at the provincial level.
5. **National government officials:** Officials tasked with the implementation of ICM at the national level.
6. **General or public user related to field of ICM:** Members of the public that have some understanding of coastal issues and management. E.g. people involved in coastal conservancies.
7. **General or public user not related to field of ICM:** Members of the public that have an interest in going to coast, extracting resources etc., but no knowledge of coastal management.

1.5. Thesis structure

The thesis comprises seven chapters and contains four papers, two of which have been published and two are submitted for publication in peer-reviewed journals. Chapter One (this chapter) provides an overview, defines the aim and objectives of, and rationale for, the research and presents a summary of the methods and study area. Chapter Two presents a literature review which details the ICM challenges being faced at the national, provincial and local levels; while considering the international ICM arena. In light of challenges identified, it considers and critiques the approaches to decision support type tools for improving decision making pertaining to the coast. This sets the framework for alternative support tools to improve ICM at the provincial and local level.

Chapter Three reviews the international ICM agenda, highlighting the global recognition for an alternative, holistic approach and the movement towards ICM. It deliberates upon the historical, fragmented nature of coastal management in South Africa and the development of the Integrated Coastal Management Act (ICM Act). It further discusses the requirements of the ICM Act and the mandates assigned to provincial and local governments, identifying some of the challenges these mandates bring about.

Chapter Four focuses on the KZN province and current ICM implementation and governance therein. Through a series of interviews and surveys the chapter outlines coastal managers' perceptions of the Act, the implementation hurdles and possible interventions that could assist. While Chapter Five assesses one such intervention in detail, taking cognisance of the design, development and implantation of an information portal (info-portal) for aiding in ICM decision making. The aim of the tool is to provide a 'one stop' information hub for aiding in the ICM decision making process, serving as an institutional knowledge bank in light of high staff turnover rates at the local level.

The success of such information support tools is only as good as their uptake and continued use. Chapter Six reflects on the success of the info-portal in the context of capacity challenges at the provincial and local level. It highlights that this is complementary to traditional training and knowledge transfer approaches go hand-in-hand.

In the final chapter (Chapter Seven), the outcomes of the research are synthesised and the opportunities for enhancing ICM are explored. This chapter critically assesses the process and determines to what extent the aim and objectives of this study were achieved.

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CHAPTER TWO: REVIEW OF ICM APPROACHES AND DECISION SUPPORT TOOLS

2.1. Introduction

Coastal environments are complex systems of significant biophysical, socio-economic and cultural value (Sowman and Malan, 2018), with approximately 44% of the world's population resident at or near the coast (UN Atlas of the Oceans, 2016). Population growth and migration continually add pressure to coastal areas (Creel, 2003). This, coupled with an increased understanding of the vulnerability of these systems to global environmental change, has led to the need for appropriate protection (Poh Wong et al., 2014; Sowman and Malan, 2018). As such, coastal managers are often required to have an understanding of issues beyond their own area of responsibility (Westmacott, 2001), resulting in the need for integrated, participatory and adaptive approaches to ensure that the management of coastal systems leads to protecting and enhancing the integrity and resilience of these complex socio-ecological systems and improving human well-being (Sowman and Malan, 2018).

A range of support type tools or programmes have been attempted globally, all with varied degrees of success. The emergence of coastal Decision Support Systems (DSS) has resulted in a fresh avenue for supporting coastal decision making. DSSs are developed with the aim of improving managers understanding of the inter-relationships between natural and socio-economic variables, leading to improved decision making (Westmacott, 2001).

The aim of this Chapter is to systematically consider the international ICM arena and more specifically ICM in South Africa. Outline current decision support systems or tools that can assist in ICM planning and decision making at the provincial and local level. It concludes with the value of technological based approaches to improving knowledge transfer and capacity building. This review focuses on past research pertinent to the coastal environment and its management as well as research focused on avenues to improve knowledge or decision making. Predominantly peer reviewed academic writings were used, government reports and other grey literature provided context and supporting information in framing the local situation

2.2. A global approach to Coastal Management and the emergence of ICM

The coastal zone faces some unique pressures exacerbated by global climate change, increasing human pressures and conflicts of interest for coastal space, the culmination of which has led to the emergence of Integrated Coastal Management (ICM) (Cummins et al., 2003). ICM as a concept has

been practised since the 1970s and for which there are numerous definitions and interpretations as to what ICM achieves. Burchi (2006, p3) defines ICM as an “*ongoing process of formulating, implementing and refining a comprehensive and holistic vision of how humans should interact in an ecologically sustainable manner with the coastal environment*”. Cicin-Sain and Knecht (1998, p39) take this further and highlight that it is a process “*designed to overcome fragmentation inherent in both the sectoral approach and the splits in jurisdiction among levels of government at the land-water interface*”. A common theme is the desire to achieve cooperation and a degree of integration on and the recognition that this is critical to ensuring success of ICM.

This integrated approach aids in supporting sustainable coastal development, the promotion of social equity, the protection of traditional resource use, and accrual of economic benefits (Cummins et al., 2003). The United States led the way in terms of developing a dedicated legislative framework for ICM through its landmark national coastal legislation, the Coastal Zone Management Act 1972 (Norman, 2014); since the 1970s a number of countries have followed with similar legislation and policies. South Africa being no exception, having undergone an extensive policy development process culminating, at the end of 2009, with an *Integrated Coastal Management Act* (Act No. 24 of 2008 and Amended Act No. 36 of 2014).

Importantly there are international programmes that drive unified objectives for improving sustainability. Key of which are the Sustainable Development Goals; Goal 14 speaks to the conservation and sustainable use of oceans, seas and marine resources for ensuring sustainable development. The focus of which is the development of effective strategies to combat adverse effects of overfishing, growing ocean acidification and worsening coastal eutrophication through the expansion of protected areas, increased research capacity and ocean science funding (United Nations, 2018). Target 14.2 encourages coastal countries to develop sustainable management approaches to their coasts and seas; with a target of 2020 for “*sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans*” (United Nations, 2018).

Coastal specific management and issues have more recently been highlighted by ongoing awareness around marine litter and plastic; formalised by the UN Environmental Assembly resolutions on marine litter and microplastics (United Nations, 2018). In addition, there is significant coverage relating to the loss of coral habitat through human impact and climate change (UNEP, 2019).

For eastern and southern Africa the notion of coastal management was predominantly brought into focus by the 1980s Regional Seas Programme (UNEP, 2012), an international management regime with over 120 countries participating (Needham and Jedyack-Coplef, 1989), through which a number of action plans for a variety of coastal and water resource issues and problems were developed (Needham and Jedyack-Coplef, 1989). The Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention) followed in 1985, which created a platform for the development of programmes aimed at strengthening the capacity of governments in the region (UNEP, 2018). In 1997, the Secretariat for Eastern African Coastal Area Management (SEACAM) was launched. The objective of this was to assist Eastern African coastal countries and the Western Indian Ocean Island States in implementing ICM; being active in Eritrea, Kenya, Mozambique, Tanzania, South Africa, Comoros, Madagascar, Mauritius, Seychelles and Reunion (Fr) (UNEP, 2018). Notably Angola, Namibia and South Africa have recently come together to sign the Benguela Current Convention which focuses on joint conservation and to manage the Benguela Current Large Marine Ecosystem (BCLME) (Benguela Current Commission, 2013).

ICM approaches vary worldwide, with countries developing specific legislation and policies for achieving ICM. Some efforts have been made to ensure consistency in application; the World Bank published guidelines in the late 1990s for effective ICM (Post and Lundin, 1996) and in 2002, the EU ratified the *Recommendations concerning the implementation of integrated coastal zone management in Europe* (2002/413/EC). This outlines eight core principles defining the essential characteristics of ICM to guide member states in ICM initiatives (Portman et al., 2015). However, these have been adopted with little critical review, and are presented with no prioritisation. This can result in a wide range of potentially conflicting strategies (McKenna et al., 2008). In order to be effective these principles require clarification and prioritisation of the strategic principles. Recognition that the principals are an indivisible integrated set that should not be used selectively for advancement of a particular agenda is needed (McKenna et al., 2008). However, as a guideline these principals are of value:

1. A broad overall perspective (thematic and geographic) taking into account the interdependence and disparity of natural systems and human activities;
2. A long-term perspective taking into account the precautionary principle and the needs of present and future generations;

3. Adaptive management, implying the need for a sound scientific basis concerning the evolution of the coastal zone;
4. Local specificity knowledge, which will make it possible to respond with specific solutions;
5. Working with natural processes and respecting the carrying capacity of ecosystems, thus making human activities more environmentally friendly, socially responsible and economically sound in the long run;
6. Involving all the stakeholders in the management process, based on shared responsibility;
7. Support and involvement of relevant administrative bodies at national, provincial and local level between which appropriate links should be established and maintained;
8. Use of a combination of instruments designed to facilitate coherence between sectoral policy objectives and coherence between planning and management.

(Source: 2002/413/EC)

The promise of ICM is that institutional mechanisms will be created to coordinate the activities of different coastal government; moving away from a sectoral, often fragmented management approach (Glavovic, 2006a). Has this really been effective? One success story is the management of the Great Barrier Reef World Heritage Area; which was declared a Marine Park in 1975. The success of management of this area rests on the successful public participation, with over 60 stakeholder groups being consulted in the development of the GBR World Heritage Strategic Plan. The management follows an integrated approach to scientific evaluation, with a strong issue-driven approach to required research ensuring that science informs decision making and problem solving (Cummins, 2003). Another important factor contributing to its successful management is the existence of a single coordinating authority which has clear, explicit functions aligned with achieving ICM. The success of the Great Barrier Reef World Heritage Area demonstrate how ICM can, and should, be approached, being completely inclusive of key role players and organisations that are needed for the process of defining issues, identifying solutions and ensuring effective implementation of these (Cummins, 2003).

That said, ICM has, for many areas, been less successful in practice, with conflicts over resource use still prevalent (Brugere, 2006). The US Coastal Management Act, while being the first of its kind, is described as being a good framework, however lacking a coherent coastal national strategy or plan with federal agencies still operating in isolation, and at times at cross purposes (Tibbets, 2002). Brugere (2006) proposes that the limitations of all ICM initiatives can be traced to two interlinked factors: people and the institutions they create, that the behaviour of people in coastal management roles are key to ensuring environmental sustainability.

2.3. Integrated Coastal Management in South Africa

2.3.1. The need for ICM in South Africa

The South African coast, being almost 3000 km in length, offers a diverse array of social and economic resources and benefits. These are utilised for both traditional reasons, such as subsistence harvesting of shellfish and religious ceremonies, and recreation, such as diving, swimming and sport fishing. However, it is important to note that South Africa's coastal space, as with the rest of the country, has been uniquely shaped by historical spatial-political planning through Apartheid¹, which is the policy whereby people were separated based on race during the 1940s (Clark and Worger, 2004). The government of South Africa set up 10 'homeland areas' to 'house' people of other ethnic groups; in KZN, the homeland of KwaZulu was established as the homeland for the Zulu people. This has led to uneven development and access along the coast, with historically demarcated homeland areas now offering the most natural, untransformed sections of coast. Not surprising though, this brings with it new development and access challenges in these areas, further enforcing the need for an integrated management approach.

In addition to the social and economic values of the coast, importantly the coastal environment of South Africa offers high biodiversity, as it is home to the Maputaland-Pondoland-Albany hotspot which supports a range of endemic, threatened fauna and flora (Conservation International, 2013). The value of this area is highlighted by the World Heritage Status it has been afforded, under the iSimangaliso Wetland Park (iSimangaliso Wetland Park Authority, 2009). For South Africa, the importance and value of the coastal environment has been underpinned by the declaration and management of a number of Marine Protected Areas (MPA) (Kidd, 2011). Importantly at the end of 2018 government approved the declaration of 20 MPAs as part of the Operation Phakisa²: Ocean Economy. This is achieved through both the expansion of existing MPAs and the establishment of new MPAs and brings the protection of the country's Exclusive Economic Zone (EEZ) up to 5%, from 0.4% (Government Communication and Information System, 2018). Operation Phakisa is a South African government initiative, designed to fast track the implementation of solutions on critical development issues highlighted in the National Development Plan (NDP) 2030 such as poverty, unemployment and inequality (DPME, 2018). The 'Ocean Economy Lab' focuses on unlocking the economic potential of South Africa's oceans, a key focus of which was the Marine Protection Service

¹ Meaning 'apartness' or separateness

² 'Phakisa' means 'hurry up' in Sesotho and the application of this methodology highlights government's urgency to deliver. Through Operation Phakisa, Government aims to implement priority programmes better, faster and more effectively.

and Ocean Governance component which aims to ensure the protection of marine and coastal areas (DPME, 2018).

2.3.2. Historical Coastal Management in South Africa

While a dedicated legislative framework is relatively new, the value of South Africa's coastal zone was formally highlighted in the 1970s; with early efforts focusing on policies and management of sensitive coastal systems (Sowman and Malan, 2018). Towards the end of the 1970s it was evident that ad hoc sector-based management needed to be replaced with a dedicated, more coordinated approach (Glavovic, 2006b). This led to an era of policy formulation and ultimately the enactment of an Integrated Coastal Management Act (Act 24 of 2008; Amendment Act 36 of 2014) (ICM Act). In spite of government and public support for the process, there were some that questioned the need for this dedicated approach to managing coastal areas, some arguing that dedicated functions for coastal management would extend the already stretched resources of management agencies (Glavovic, 2000). Nevertheless four key reasons in support of ICM were identified for South Africa, namely; the distinctive nature of the coast, the coast is as a national asset, it is a place of social value and provides a place for development opportunity (Glavovic, 2000).

Prior to the ICM Act, a range of legislations governed certain aspects of coastal management; these were enforced by different government departments as outlined in Figure 2.1. This resulted in coastal management being fragmented, with the terrestrial and aquatic components being governed independently of each other (Carter, 1999).

Legislation pertaining to the coast was often not aligned and management responsibilities were generally split across different departments and spheres of government, all of which have different, often conflicting mandates and management objectives (Wynberg, 2000; Sale et al., 2008). A key piece of legislation being the Sea-Shore Act (Act No. 21 of 1935); in terms of coastal management it prohibits the establishment of buildings or structures within the sea-shore, unless the land was leased from the state. It bans the dredging of, or deposition on the sea or seashore without consent, and only allows for the use of portions of the sea-shore for specified purposes or by resolution of Parliament. This legislation has subsequently been repealed under the Integrated Coastal Management Act. While the use of 'the sea' was governed by the Sea-Shore Act, the use of marine living resources is managed under the Marine Living Resources Act (Act No. 18 of 1998), which aims to ensure sustainable utilisation of, and equitable access to marine living resources.

The Sea-Shore Act and the Marine Living Resources Act fall short of offering a platform for ICM (Kidd, 1997). In the 1980s regulations recognising the coastal zone as an area requiring legislative attention were promulgated in terms of the now repealed Environmental Conservation Act (ECA) (Act No. 100 of 1982) (Glavovic and Cullinan, 2009). The regulations called for the demarcation of a strip of land 100 metres inland of the high-water mark as a limited development zone. Subsequently, this Act was replaced by the ECA (Act No. 73 of 1989) and the regulations pertaining to the 100 meter zone were no longer applied (Glavovic and Cullinan, 2009). In 1998 the ECA was repealed, in part, by the National Environmental Management Act (NEMA) (Act No. 107 of 1998), which ensures that environmental rights presented in the Constitution are protected and fulfilled (DEAT, 2000). NEMA, which is the overarching framework for all environmental legislation in South Africa, recognises that the coastal zone is a unique environment requiring dedicated management.

As is evident from Figure 2.1, various statutes and policies have shaped coastal management over the past 40 years. Importantly for South Africa, the protection of the coastal environment is underpinned by the Constitution; which sets out the basic framework for the management of the coast. It highlights the need for co-operative governance (Sections 40 and 41) and the need to develop the capacity of lower spheres of government, provincial government in terms of Section 125(3) and local government in terms of Sections 154(1) and 155(b). However, some argue that the Constitution does not provide adequate direction regarding the administration and management of the complex coastal environment (Smith and Cullinan, 2000).

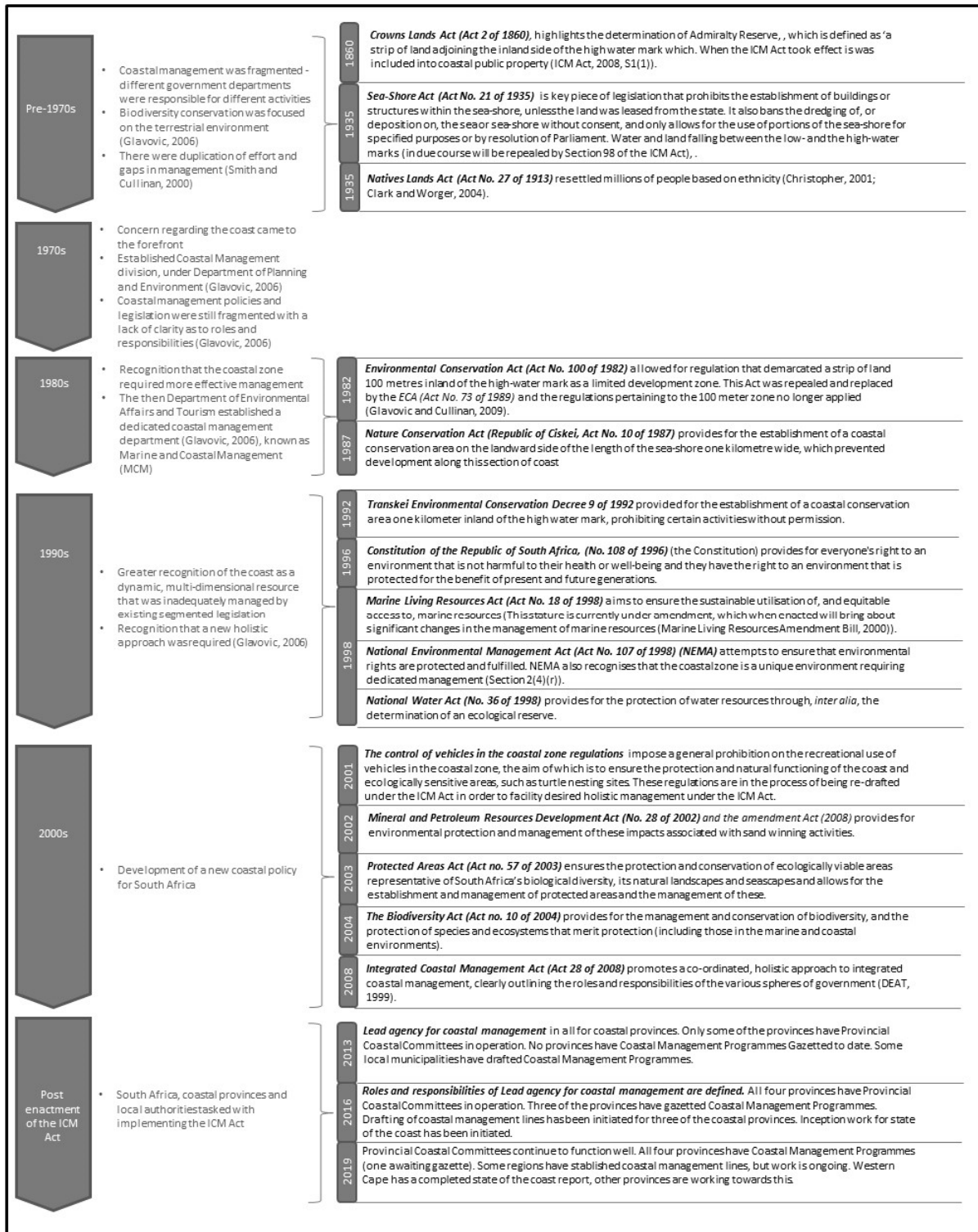


Figure 2.1: Evolution of coastal management in South Africa, as influenced by other environmental legislation, to the development of the ICM Act and progress since enactment (from Goble et al., 2014)

Development of the ICM Act went through a number of stages, starting with the release of a Green Paper in 1998, which was the policy document that led to the development of the White Paper (**The White Paper for Sustainable Coastal Development**) in 2000. The White Paper witnessed a fundamental shift in how the coastal zone was defined and managed. In terms of the White Paper, the *“boundaries of the coast are seen to extend as far landwards, and as far seawards, as is necessary for effective coastal management”* (DEAT, 2000, p13). The White Paper recognised that the coast needed to be managed as a system and not by sector if users were to benefit from the opportunities it provides (DEAT, 2000). Following on from the White Paper was the development of the **ICM Bill** and subsequently the **ICM Act**.

The Act, a landmark legislation being nominated for the 2012 World Future Policy Award³, that promotes a co-ordinated, holistic approach to integrated coastal management, clearly outlining the roles and responsibilities of the various spheres of government. The key objectives of the ICM Act include:

- The determination of the coastal zone – The ICM Act clearly defines the boundaries of different zones:
 - **Coastal Public Property (CPP):** coastal waters, land submerged by coastal waters, any island, the seashore, admiralty reserve owned and state own land along the coast.
 - **Coastal Protection Zone (CPZ):** agricultural or undetermined (rural) land situated within one kilometre of the high water mark and land part of a lawfully established township, urban area or other human settlement within 100 metres of the high water mark.
 - **Coastal access land:** Any land demarcated for the purpose of accessing CPP.
 - **Coastal protected areas:** recognised, formally protected areas managed by or on behalf of an organ of state.
 - **The seashore:** area between the low-water mark and the high-water mark.
 - **Coastal waters:** marine waters that form part of the internal waters or territorial waters and any estuary.
 - **The exclusive economic zone:** the exclusive economic zone of the Republic 30 referred to in section 7 of the Maritime Zones Act. 1994 (Act No. 15 of 1994).
- Provision for co-ordinated and integrated management of the coastal zone – the ICM act provides a framework following the principles of co-operative governance:

³ The aim of the award is to raise global awareness for these exemplary policies and speed up policy action towards just, sustainable and peaceful societies. In 2012, the award is dedicated to exemplary coastal and ocean policies.

- The established of Coastal Committees; which ensure that there are representatives from: applicable government departments, representation from local government, scientific organisations, NGOs and CBOs and persons with expertise in fields relevant to coastal management.
- The determination of Coastal Management Programmes which serve as a policy directive for ICM, they set out objectives, actions and responsibilities.
- Preservation, protection, extension and enhancement of CPP – In terms of the ICM Act this land is held in trust by the state for the benefit of all South Africans:
 - The ICM Act makes provision for the declaration of additional state land and CPP and if required the purchase of private land in order to meet the provision of providing CPP.
- Equitable access to coastal public property – The ICM Act ensures that all people of the Republic have the right to physical access to the coast:
 - Everyone has the right to reasonable coastal access, this is achieved through the provision of coastal access land and associated infrastructure (Parking lots, ablutions etc.). Importantly the ICM Act prevents the charging of access to the coast without permission from the MEC.
- Establishment of the CPZ – The ICM Act provides for the determination, use and management of a protection zone:
 - A zone of variable distance from the high water mark (ranging between 100 meters and 1 kilometre). The CPZ is established for enabling the use of land adjacent to CPP or that plays a significant role in a coastal ecosystem to be managed regulated or restricted in order to protect people, property, economic activities and ecological integrity.
- Giving effect to South Africa’s obligations under international coastal and marine law – The ICM Act provides for compliance with international laws:
 - The ICM Act highlights key areas of action in keeping with these obligations:
 - controlling or managing any activity on or in coastal waters
 - Amendment, revocation, suspension or cancellation of authorisations
 - Management of discharge of effluent into coastal waters
 - Management of dumping at sea

(Integrated Coastal Management Act, 24 of 2008)

Significantly the ICM Act places a strong emphasis on the public nature of the coast; the intention to extend and enhance equitable access to all coastal communities, while ensuring its protection and ecological integrity (Sowman and Malan, 2018; Glavovic, 2006a). However, authorities are now left with the daunting task of implementing this new, progressive legislation to create 'better management' of the South African coast.

2.3.3. Implementing the South African ICM Act

For the effective implementation of the ICM Act, all three spheres of government, national, provincial and local levels, are required to be co-ordinated and integrated across sectors and collaborate with other spheres of government (Sowman and Malan, 2018). However, existing government structures are pre-determined by the Constitution of South Africa; being divided into three government spheres; national, provincial and local government, all of which have legislative and executive authority in their own spheres (s40 of the Constitution) and are assigned roles and responsibilities in terms of the ICM Act.

National government is responsible for the implementation of laws and policies at a national level, dealing with country level issues (s85 of the Constitution). In South Africa, there are nine provincial government authorities, which are able to establish provincial legislation that ensures better management of individual provinces and their resources (s104 of the Constitution) (Figure 2.2). Provincial government is responsible for the coordination, monitoring and support of local authorities within each province. Local authorities are referred to as municipalities, which are categorised into either, 1) Metropolitans, which have a population of more than 500 000, 2) Local Municipalities, which fall outside of metropolitan areas and are significantly smaller and 3) District Municipalities, which are made up of a number of local municipalities. Municipalities are primarily responsible for daily management and enforcement of legislation, relating to natural resource management, land use planning, land development, catchment management, coastal and drainage engineering, local economic development, environmental assessment, strategic planning, housing and service delivery, environmental health and tourism promotion (s156 of the Constitution).

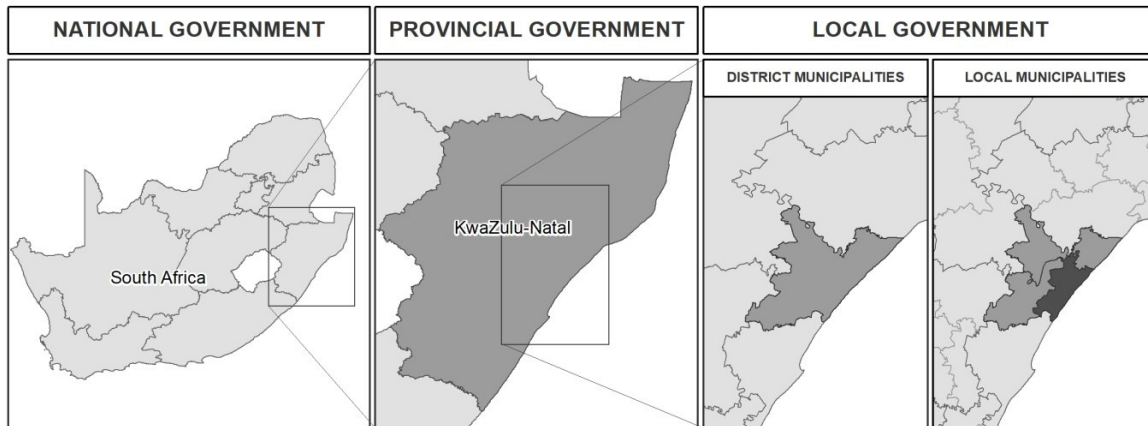


Figure 2.2: Spatial depiction of the spheres of governance in South Africa

As shown in Table 2.1, significant responsibility for implementation and enforcement are placed at the provincial and local level where there is a range of understanding and information regarding the coastal environment and the impact that the decisions they make have on long- and short-term coastal management.

Authorities are faced with a range of challenges to facilitate that the public can access the coast and benefit from its resources, while supporting ecological functioning of the coast. Thus, implementation of coastal legislation is not simple and there are a number of challenges that need to be overcome for the implementation of the ICM Act to be effective for South Africa. The ICM Act speaks to effective, integrated coastal management. However, achieving this requires substantial information and data about the current state of the coast and the pressures being addressed, information that is largely lacking. Secondly, long-term objectives and a direction for management is needed; unfortunately, these are influenced and changed as the political climate changes. Thirdly, the ICM Act clearly defines roles and responsibilities for all three spheres of government. National government is strategically focused, provincial government in management and coordination focused and local government is largely tasked with implementation and enforcement. The biggest challenge is that these functions are assigned with no additional financial or human resource provision. The role of ICM is assigned where there is perceived capacity; largely to planning departments, resulting in inconsistent ICM (Glavovic, 2014; Sowman and Malan, 2018). Knowledge on the interpretation of the ICM Act is lacking and thus timeframes lapse and deliverables are not met. At the implementation level, there is scope to support coastal managers and improve the transfer of knowledge and human capacity.

Table 2.1: Overview of the roles and responsibilities of the different spheres of government as outlined in the ICM Act (Adapted from: EDTEA, 2018)

Aspect	National	Provincial	Local
<i>Coastal Protection Zone (CPZ)</i>		Determination and management of the CPZ	
<i>Coastal Public Property (CPP) and access to the coast</i>	Management of CPP	Oversight for access to CPP	<ul style="list-style-type: none"> • Designation of coastal access land, for access to CPP • Impose fees within CPP • Determining and adjusting coastal boundaries of coastal access land
<i>Estuarine Management</i>	National Estuarine Management Protocol	Estuarine management plans	Estuarine management plans per agreement with provincial lead agency
<i>Coastal Committees</i>	National Coastal Committee	Establish and support a Provincial Coastal Committee	Establish and support a Municipal Coastal Committee
<i>Coastal Management Lines</i>		Establishment of coastal management lines	Coastal management lines demarcation on zoning maps
<i>Coastal boundaries</i>		Marking coastal boundaries on zoning maps	Marking coastal boundaries on zoning maps
<i>Provincial lead agency</i>	Monitor the appointment of provincial lead agencies	A Designation of provincial lead agency	
<i>Implementing ICM</i>	<ul style="list-style-type: none"> • Determination of national appeals powers • General provisions applicable to regulations • Prescribing regulations and fees 	<ul style="list-style-type: none"> • Regulations by the MEC • Monitoring coastal management at local level • Information and reporting on coastal matters • Coordination of actions between Province and municipalities 	Information and reporting on coastal matters
<i>Coastal Management Programmes (CMP)</i>	<ul style="list-style-type: none"> • Development and implementation of the National CMP • Consistency and alignment between the NCMP and other statutory plans 	<ul style="list-style-type: none"> • Development and implementation of a Provincial CMP • Consistency and alignment between PCMP and other statutory plans 	<ul style="list-style-type: none"> • Development and implementation Municipal CMPs • Consistency and alignment between MCMPs and other statutory plans
<i>Public participation</i>	Consult public and interested and affected parties	Consult public and interested and affected parties	Consult public and interested and affected parties
<i>Environmental authorisation</i>	Review and issue environmental authorisations for coastal activities	Review and issue environmental authorisations for coastal activities	Review and issue environmental authorisations for coastal activities
<i>Land use legislation</i>			Implementation of land use legislation in the CPZ
<i>Coastal Pollution</i>	<ul style="list-style-type: none"> • Discharge of effluent into coastal waters • Dumping of waste into coastal waters • Emergency dumping at sea 		

2.4. Supporting ICM decision making

As ICM has evolved, the last four decades have seen the development of frameworks and science-based approaches for informing ICM, resulting in a proliferation of implementation models (Taljaard, 2011; Bremer and Glavovic, 2013). However, given the complexity of coastal environments and their management this is understandable and the need for science-based approaches that inform coastal management is still very much evident (Bremer and Glavovic, 2013). Frameworks and implementation models include the cross-sectoral integrated coastal area planning (CICAP) process (Pernetta and Elder, 1993), the Joint Group of Experts on the Scientific Aspects of the Marine

Environmental Protection model (GESAMP, 2018), Olsen's ICM cycle (Olsen et al., 1997; 1999) and the European Union Integrated Coastal Zone Management Recommendations (European Commission, 2002). The success of such frameworks can be improved through collaboration between managers and scientists at all stages of the formulation of management policy and programmes.

In its uniqueness, the coastal environment comes with a range of complex issues, which results in decision makers needing to understand a wide range of issues that are often beyond their area of expertise but essential for understanding the potential impacts of decisions they make (Westmacott, 2001). As computers have become more user-friendly and accessible, computerised approaches in support of coastal issues is increasing as evident by the number of available Decision Support Systems or information support systems. A Decision Support Systems (DSS) is a focused 'system' that is interactive, flexible and adaptable; it is a computer based information system, that is specifically developed for supporting the recognition and solution of complex, strategic management problems to ensure improved decision making (Matthies et al., 2007). The concept of DSS has evolved from two main areas of research: the theoretical study of organizational decision making (during the late 1950s and early 1960s) and the technical aspects of decision making carried out in the 1960s (Shim et al., 2002). Development of these computerised decision-support tools or systems for ICM is increasing, and is being led by the major international organisations (Westmacott, 2001); examples include:

- **COAMES (COAstal Management Expert System)**, an object-orientated expert system bringing together specialist information and spatial data (Tyler, 2007). It uses the most suitable available technological innovations for addressing the coastal zone management challenges (Moore, 2001).
- **SIMCoast** is a fuzzy logic rule-based System, aiming to provide improved process understanding, new knowledge, new methods, new and improved numerical tools, through exchange of knowledge and experience of joint research (European Commission, 2014)
- **COSMO (Coastal Zone Simulation Model)**, which is a DSS that enables managers to evaluate strategies under different potential scenarios by allowing the user to specify scenarios or draw on pre-defined examples. COSMO aims to simulate the day-to-day management of the coast for the city government, public works department, the environmental department and the private sector (Taal, 1999).
- **DIVA-GIS**; a free mapping and geographic data analysis package that enables users to make maps at various scales using preloaded data. It is useful for applications pertaining to mapping and analysing biodiversity data, such as the distribution of species (DIVA-GIS, 2012).

- **CORAL** which assesses the impacts of alternative management strategies on the coastal zone. Uniquely it links socio-economic activities with reef health. It considers a cost-effectiveness analysis of the alternative interventions and combinations of interventions (Westmacott and Rijsberman, 1995).
- **Xplorah** is a multi-scale integrated land use model for the three major islands of Puerto Rico, considering different scenarios on the development of the island, working at different scales and incorporating knowledge from numerous disciplines (van Deldena et al., 2008).

The measurement of success for these tools is often a challenge, what makes one a success doesn't necessarily apply to another. For instance, SIMCoast was considered successful in ensuring a partner network that facilitated the exchange of information and knowledge in keeping with its main objective. It also provided early career researchers with an opportunity to gain practical experience within different scientific cultures (European Commission, 2014). Other tools followed active measures to ensure the successful use, such as Xplorah tool. The Puerto Rico Planning Board, RIKS and the Graduate School of Planning jointly organized a series of training workshops, in which about 40 planners from several departments were taught how to use the system and how it could fit in their workflow. (RIKS, 2009).

In addition, a number of technical tools have been developed for modelling different scenarios related to coastal processes, such as **SBEACH** (Storm-induced BEACH Change), which allows the user to calculate beach and dune erosion under storm water levels and wave action (Larson and Kraus, 1998). The US Geological Survey developed a **Digital Shoreline Analysis System** (DSAS) which allows users to calculate rate-of-change statistics from multiple historic shoreline positions using GIS (USGS, 2012). The **DESYCO** (DEcision support SYstem for Coastal climate change impact assessment) tool is a DSS focused on the assessment and management of multiple climate change impacts on coastal areas (Torresan et al., 2016). The **Delft3D Flexible Mesh** has a wide range of applications including the simulation of storm surges, hurricanes, tsunamis, and sediment transport, as well as interactions between these processes (Deltares, 2018). **Delft-FEWS** is an open data handling platform focused on flood forecasting and warning systems (Deltares, 2018). **Celeris**, is an open source interactive nearshore wave modelling software and supports simultaneous visualization with both photorealistic and color-mapped rendering capabilities (Celeris.org, 2017).

These technical spatial tools are useful in that they offer specific data or information required for effective ICM. However, spatial decision making is highly complex and many spatial decision problems are ill structured. Spatial support tools and expert systems are thus required for problem

solving, but these systems have their own limits and drawbacks (Tyler, 2007). Spatial tools require some expert knowledge of the software and the processes being modelled to be effective in supporting ICM. Furthermore, they are generally developed for a single section of the ICM decision-making environment, often the ecology or the economic system, but rarely for the combined economic-ecological system, being appropriate under different conditions and are often not universally applicable (Westmacott, 2001), making them limited in their potential application. This highlights the disconnect between scientific expertise and management activities, and if developed correctly these information support systems can assist in bridging the science management gap and aid decision making.

More recently, with computer and internet advances, there has been a shift to web-based information support systems; where data storage portals assist managers and decision makers by providing all the information required in a 'one-stop' portal. These offer more integrated information; which may overcome some of these limitations existing in each and provide the decision maker with an effective tool (Tyler, 2007). An important example of this is **OzCoasts**, which is a publicly available website providing a wide range of information about Australia's coasts for assisting natural resource managers, marine scientists, planners, policy makers and the general public (www.ozcoasts.org.au) One of the key aims of the information support system is to help improve understanding of Australia's coastal environments. What makes this such a unique and important example is that the content of OzCoasts represents the collaborative efforts of more than 100 coastal scientists from a wide range of government agencies and universities (Commonwealth Scientific and Industrial Research Organisation, 2017).

New Zealand offers a similar site; **NZ Coast**, which showcases a collection of information about the New Zealand coastal environment and related hazards. Linked to this is a 'coastal explorer' tool which delivers digital maps in a nationally consistent framework (NIWA, 2016). The Massachusetts State, USA has a Coastal Zone Management website that hosts a range of information to inform stakeholders about public access, emergency management and general public information (MOCZM 2012). Zanutigh et al. (2014) reviewed a range of existing ICM DSSs related to vulnerability, impacts and risks, and identification and evaluation of related management options. This led to the development of **THESEUS DSS** (www.theseusproject.eu), which is a comprehensive open-source GIS-based DSS developed to help decision makers in minimising coastal risks (Zanutigh et al., 2014). These more holistic information websites are adding value for coastal managers by making information and resources readily available to inform ICM decision making.

2.5. Improving ICM capacity in South Africa

Significant efforts have been made by the South African government to improve human capacity through the provision of a range of training or ‘capacity building’ sessions. Crawford et al. (1993) define capacity building as initiatives that aim to increase the capacity of those charged with management to make sound management and planning decisions. Simply put, some place capacity building as a process of ‘helping people to help themselves’ at a personal, local or national level (Eade, 1997). The capacity building process adds value to both individual decision makers and to institutional capacity (Crawford et al., 1993), and is considered to be a long-term investment into people and their organisations (Eade, 1997). Importantly, human capacity is focused on training and professional development and can include anything from written training material, videos, facilitated meetings or workshops to extensive long-term formal education programmes (Kay and Alder, 2005). South Africa has historically focused on workshops or training sessions and supported written material as the main mechanism to improve coastal human capacity. Between 2013 and 2018, the national government facilitated several training sessions ranging from an introduction to ICM, estuarine specific management, marine protected areas and compliance monitoring and enforcement. This is an important step in the ICM process for South Africa as capacity building is an important component of the ICM process, being linked to the effectiveness with which ICM can deliver sustainable development objectives (Barker, 2005).

However, South Africa has identified that a single approach, while invaluable in improving knowledge or capacity is not sufficient in isolation and a number of guideline documents have been developed, focusing on the critical ICM areas. These include; the User Friendly Guide to the ICM Act (Celliers et al., 2009; DEA and Royal HaskoningDHV, 2017), the ICM Act Enforcement Manual (DEA, 2011), a guide to the development of coastal management lines (DEA, 2017), and a guide to the development and implementation of Coastal Management Programmes (DEA, 2012). There are a host of other guidelines still in progress such as for the adjustment of coastal boundaries, the development of coastal planning schemes, stabilisation and rehabilitation in the coastal zone, and procedures to prevent/remove unlawful structures in the coastal zone (DEA, 2014a).

In keeping with changes of technology and access to information, a number of topic-specific spatial support tools have been developed, which focuses on specific ICM objectives. These include the *off-road vehicle (ORV) DSS* which assists decision makers in the ORV permitting process (DEA, 2014b). The *Coastal Viewer*, which is a spatial data repository aimed at providing data in support of ICM and the objectives as described in the National Coastal Management Programme of South Africa (DEA,

2014c), and more recently OCIMS (Ocean and Coastal Information Management System) is in development to provide decision support for the effective governance of South Africa's oceans and coasts through thematic tools; marine spatial planning, coastal flood hazards, marine domain awareness, harmful algal bloom, water quality and sea state (DEA, 2018). OCIMS hosts copies of relevant legislation, regulations, policies, programmes, plans and guidelines to assist in ICM decision making (DEA, 2018).

While useful at a national level, these tools are too general and strategic to assist managers at the provincial and local level. This highlights the need for a streamlined information support system, with a focus on ICM challenges and information for this level of government; a system whereby all relevant ICM data and information are hosted for ease of access by coastal managers.

2.6. Summary

The land–sea interface, where resources ‘overlap’ and where rules, access and use are complex, if not ill defined (Brugere, 2006), creates a complex arena for governance. This is particularly true for developing countries where human capacity and financial resources are limited as highlighted by Rosendo et al. (2018). The question remains, how can this gap be bridged, how do we improve ICM in light of these capacity gaps?

Tibbets (2002) states that for ICM to be effective, programmes that support it need to draw on shared knowledge from a wide range of stakeholders, both government and non-government. Importantly, this shared information needs to be interpreted and simplified if it is to actually inform and improve long-term coastal management. This has in more recent years been addressed through the use of technology-driven interventions, which have seen the development of a number of computerised decision-support-type tools. These have experienced mixed success, dependant on the scale at which they are utilised and the level of base knowledge the user requires. This highlights that a balance between the complexity of data and information and the ease of use of the support tool is critical.

If this principle is applied to South Africa, will such tools be successful in improving the knowledge of managers and assisting them in their ICM functions? It is evident that there are a range of support documents and basic tools available in South Africa, the success of which is not measured. So how will a dedicated ICM information support tool work in the South African coastal management arena? These questions frame the premises on which this research is founded, in order to develop a support

tool for coastal managers at the provincial and local level and test its effectiveness for improving ICM.

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CHAPTER THREE: COASTAL MANAGEMENT IN SOUTH AFRICA: HISTORICAL PERSPECTIVES AND SETTING THE STAGE OF A NEW ERA

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Abstract

The coastal environment represents a critical interface of human activity, socio-economic influence and ecological diversity. It is estimated that the coastal environment supports some 30% of the world's population and provides a range of social and economic benefits. Use of the coastal environment is ever increasing due to its attractiveness for recreation and leisure activities, holiday homes and retirement. As a result, the coastal environment is constantly under pressure and management actions, policies and legislation need to ensure the protection of this unique environment. South Africa is considered to be the third most biodiverse country in the world, largely linked to coastal and marine diversity with a number of Marine Protected Areas (MPA). This rich biodiversity needs to be carefully managed while also meeting the needs of South Africans with regards to access to coastal and marine resources. To date management of the South African coast has been governed by various statutes and access to the coast and its resources has been affected by historical spatial planning and socio-political conditions. To facilitate a more holistic management the newly promulgated Integrated Coastal Management Act (Act 24 of 2008) is an attempt to better manage coastal resources to protect coastal assets and functionality. The ICM Act is inherently dynamic, attempting to tackle the interlinked problems of coastal development and conservation. However, to ensure implementation, capacity challenges and historical fragmented governance structures need to be addressed.

3.1. Introduction

Coastlines represent some of the most important environments in which human activity, socio-economic influence, ecological and topographical diversity and geomorphological conditions interact (Fabbri, 1998). Small and Nicholls (2003) estimate that 30% of the global population are resident at or near the coast, with many coastal countries supporting a large percentage of their population (80–100%) within 100 km of the coast (Martínez et al., 2007). Coastal systems are important economic resources, with combined global value of goods and services being in the region of US \$10 trillion annually (Costanza et al., 1997), which accounts for approximately 77% of the world global value of ecosystem services (Martínez et al., 2007).

Due to the dynamic nature of the coast and demand for its resources, management of this zone is difficult to conceptualise and boundaries are often poorly defined with the coast referred to as a zone or area of transition (Kay and Alder, 2005). This coastal zone includes a broad array of habitats varying from rivers and estuaries, coastal forests, wetlands to coral reefs, sea grass beds, soft bottom or rocky benthic substrates (Carter, 1999; IGOS, 2006). These in turn provide a range of ecosystem goods and services such as fisheries, water purification and coastal erosion protection, all of which are critical for sustaining populations living within close proximity to the sea (Sale et al., 2008). Of concern, coastal habitats are being adversely affected by sewage and non-point discharges of pollution, development of artificial structures and the removal of naturally functioning areas (Martínez et al., 2007). It is estimated that coral reefs experience loss of 4% to 9% per year, salt marshes between 1% and 2% and mangroves between 1% and 3%, these losses are more rapid than the global loss of tropical forests, which is estimated at 0.5% per year (Duarte, 2009).

Coastal authorities are faced with managing a highly complex environment that is subjected to natural and anthropogenic pressure, driven by population increases and in-migration to coastal areas due to increased tourism, recreation, residential and industrial development, and urban encroachment. Concerns are exacerbated by the potential effects of climate change, with coastal environments being highlighted by the Intergovernmental Panel on Climate Change (IPCC) as an “area of particular concern” (Nicholls et al., 2007). It is anticipated that one of the most significant effects of climate change on the coastal environment will be sea-level rise, which will increase the coast’s exposure to other risks, such as coastal erosion, potential intensification of tropical and extra-tropical cyclones, and flooding and over-wash events (Nicholls et al., 2007).

While human impact and modification of natural coastal areas are not new concepts, with ancient civilisations having built ports and seawalls and deviated rivers, the engineering that supports this has increased significantly resulting in an intensification of these impacts on a global scale (Kay and Alder, 2005). This is evident, for example, from changes in coastal sediment supply where some interventions such as land clearance for agriculture, have led to increased sediment loads in rivers. In other instances, the trapping of sediment by dams results in a net loss of sediment from the system (Walling, 2006). The need to reconsider how coasts are managed has long been recognized, with policy makers defining policies and legislative instruments to address the problems of managing this complex zone (Nobre, 2011). The notion of coastal management is constantly evolving (Kay and Alder, 2005), with a long history of attempting to create a political setting in which coastal communities can partake in the decision-making process collaboratively (Bremer and Glavovic, 2013).

Integrated coastal management is a globally utilised approach for the management of the coast and its resources; emerging predominantly in response to the failures of sectorial management (Cicin-Sain and Knecht, 1998; Scottish Executive Central Research Unit, 2001). In spite of national and international instruments relating to coastal management, coastal management initiatives often fail as people living in the coastal area have a limited understanding of the economic, cultural and aesthetic value that a sustainably managed coast can provide. This is exacerbated by the fact that the rate at which development and impacts are occurring is increasing and long-term management strategies are not perceived to be relevant in the short-term (Sale et al., 2008). What are required are coastal management initiatives that are able to create and empower institutions to support decision making with the best quality knowledge available, traditionally through the integration of natural and social science with the political processes of decision-making (Bremer and Glavovic, 2013).

South Africa, having almost 3000 km of coastline, is one such country grappling with sustainability of coastal resource use. The South African coastal environment offers a wide range of social and economic resources, which are exploited for traditional uses, such as subsistence harvesting of shellfish and religious ceremonies, and recreational activities, such as diving, swimming and fishing. Furthermore the coastal environment offers a range of ecological services, the estimated value of which is some \$6766 million for South Africa (Martínez et al., 2007). South Africa is considered to be the third most biodiverse country in the world, with its coast being home to the Maputaland-Pondoland-Albany hotspot which supports a range of endemic, threatened fauna and flora (Conservation International, 2013). The value of this area is further highlighted by the world heritage

status it has been afforded, as part of the iSimangaliso Wetland Park (iSimangaliso Wetland Park Authority, 2009). The importance of the coast and its resources is underpinned by the declaration and management of a number of Marine Protected Areas (MPA); namely the Pondoland MPA, Table Mountain National Park MPA, Bird Island MPA, and Stilbaai MPA (Kidd, 2011).

Unique to South Africa, coastal management and planning has been shaped by the historical spatial-political planning of Apartheid, which has resulted in current access and development being unevenly distributed along the coast. These factors highlight the need for careful management of the South African coast, and have led to the development and enactment of the Integrated Coastal Management Act (Act 28 of 2008) (ICM Act) in December 2009. This paper considers historical governance of the South African coast and how these have shaped the objectives of the ICM Act. It considers international instruments which are relevant to South Africa that impose legal obligations on South Africa or provide guidance on coastal management. We consider the obligations imposed by the Act on the various spheres of government and identify implementation limitations in view of developing decision support tools to facilitate and improve implementation.

3.2. International recognition of the need for Integrated Coastal Management

In the past thirty years there has been a notable increase in the number of international instruments directed at dealing with the problems that are threatening marine and coastal biodiversity (Wynberg, 2000). In the late 1980s to early '90s there was a realisation that ecosystems were being degraded by rapidly increasing populations and utilisation of resources (Kay and Alder, 2005). In terms of Article 61 United Nations Convention on the Law of the Sea (UNCLOS), the most important international instrument concerning oceans, recognizes an Exclusive Economic Zone (EEZ) of 200 nautical miles, and provides that coastal states are responsible for the conservation and management of living resources within their EEZ (UNCLOS, 1982). In 1992, through Agenda 21, the international community recognised the need for environmental action. Chapter 17 of Agenda 21 identifies a number of activities for achieving integrated management and sustainable development of coastal areas, through integrated coastal zone management (United Nations, 1992a). However, it was acknowledged that established management approaches were not effective in achieving sustainable development (UNEP, 2012). Which led to the realisation that economic maximisation could not be applied if the goal of ensuring sustainable use of resources was to be achieved, and ecosystem approaches were established and applied to coastal areas (Kay and Alder, 2005). However, ecosystem management along the coast is difficult as there is a lack of information on its biodiversity, functioning, dynamics and interactions with other ecosystems (Christensen et al., 1996). In 1996, the

World Bank published guidelines for effective ICM to assist countries with setting up ICM legislation and putting programmes in place. The guidelines outlined roles and responsibilities across government structures, the general public and other coastal stakeholders, and highlighted how ICZM plans should be implemented, monitored, evaluated and enforced (Post and Lundin, 1996).

In 1999 the Hangzhou Declaration on Sustainable Solutions for Resolving Problems Associated with Urbanization of Coastal Areas, the Intergovernmental Oceanographic Commission (IOC) identified human migration to coastal areas and the emergence of coastal megacities, as an area of concern, a concern now realised by many countries including South Africa. The Declaration identifies that education, training and public awareness need to be increased as a way of ensuring that the interactions between coastal and urban environments are appreciated and understood (UNESCO, 2000).

The United Nations Convention on Biological Diversity (1992) highlights the need for conservation of biological diversity and sustainable use of these resources (United Nations, 1992b, Article 1). In terms of Article 7 of the Convention, parties should, where possible, identify ecosystems and habitats of high diversity, large numbers of endemic or threatened species, areas of wilderness, or areas required by migratory species for conservation and sustainable use. Parties should consider the social, economic, cultural or scientific importance of areas that should be conserved and monitored (United Nations, 1992b). While Article 8 allows for the declaration of protected areas (Article 8), in order to ensure the conservation of identified biological diversity. An outcome of the 2010 Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) was the updating of the Strategic Plan for Biodiversity and the identification of targets for the period 2011-2020. Key to the coastal environment is Target 11, which sets the goal that by 2020 at least 10% of coastal and marine areas are conserved, especially areas of particular importance for biodiversity and ecosystem services (Decision XI/11). Under the CBD, Marine and Coastal Biodiversity has been highlighted as a thematic programme, for which the COP has adopted a number of key decisions and has recognised the importance of Integrated Marine and Coastal Area Management (Decision VIII/22). In 1995 a number of countries adopted the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). The GPA is designed as a source of conceptual and practical guidance for the development of national and regional plans and actions to prevent, reduce and control marine degradation as a result of land-based activities (UNEP, 1995). South Africa, subsequently (in 2008) developed a National Action Plan for the Protection of the Marine Environment from Land Based Activities, which is aimed at ensuring that all South Africans have the

opportunity to benefit from the resources that the coast offers and in so doing take shared responsibility for the health and maintenance of the coastal environment.

In eastern and southern Africa, coastal management initiatives were brought into focus in 1980 through the regional seas programme initiated by UNEP in 1974 after the UNEP governing council designated 'oceans' as a priority area for which activities were to be developed (UNEP, 2012). The Council endorsed a regional approach to the control of marine pollution and the management of marine and coastal resources, aimed at long-term monitoring and management of coastal environments. However, these programmes considered broad changes and the effects of change at the international level (UNEP, 2012) and the governments of Somalia, Kenya, Tanzania, Mozambique, Comoros, Madagascar, Mauritius, Seychelles and Reunion came together and requested UNEP to create a regional seas programme for the region, as had been done in other areas. In 1980 the Eastern African Regional Seas Programme was established, however countries in the region required additional assistance in terms of formulation and implementation of programmes. Thus, in 1985 the Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region (Nairobi Convention) was adopted and created a platform for the development of programmes aimed at strengthening the capacity of governments in the region. This resulted in the East African Coastal Resources Database and Atlas Project, which mapped a corridor of land 100 km wide, inland of the high water mark, to provide synthesised information on the coastal environment that would inform future planning and development in this zone (UNEP, 2001).

The Nairobi Convention is now an important platform for dialogue between Governments and civil society (UNEP, 2013), with a number of protocols under the Nairobi Convention, such as the Protocol for the Protection of the Marine and Coastal Environment of the Western Indian Ocean from Land-Based Sources and Activities, the Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region and the Protocol Concerning Co-operation in Combating Marine Pollution in Cases of Emergency in the Eastern African Region (UNEP, 2013). Following the adoption of the Nairobi Convention, as well as the Arusha Resolution on Integrated Coastal Zone Management in Eastern Africa Including Island States (1993) and the Seychelles Statement on Integrated Coastal Zone Management (1996), the Secretariat for Eastern African Coastal Area Management (SEACAM) was launched in Maputo, Mozambique (1997). The SEACAM's objective is to assist Eastern African coastal countries and the Western Indian Ocean Island States to implement ICM, and it is currently active in Eritrea, Kenya, Mozambique, Tanzania, South Africa, Comoros,

Madagascar, Mauritius, Seychelles and Reunion (Fr) (UNEP, 2001). There are a number of other global and regional instruments and agreements that have bearing on marine and coastal management in the region and globally, as outlined in Table 3.1, with a number of countries, including South Africa being party or signatories to a number of these. Most recently, Angola, Namibia and South Africa came together to sign the Benguela Current Convention which captures the countries' intention to conserve and manage the Benguela Current Large Marine Ecosystem (BCLME) jointly, for the benefit of present and future generations. The BCLME is considered to be one of the richest ecosystems, with ecosystems services being estimated at approximately US\$ 54 billion per year (GEF, 2013).

Table 3.1: Selection of international agreements to which South Africa is party to

Agreement	Year	Number party to agreement
Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter (London Convention)	1972	77 Parties
International Convention for the Prevention of Pollution from Ships (MARPOL)	1978	96 Parties
United Nations Convention on the Law of the Sea: General provisions	1982	110 Parties (60 countries signed but not yet ratified)
World Summit on Sustainable Development (WSSD): Plan of Implementation	1992	189 Countries
The Jakarta Mandate (under the Convention on Biological Diversity)	1995	145 Countries
Protocol to the London Dumping Convention	1996	43 Countries

(The Millennium Project, 2011; Hoyt, 2011)

As is evident there are a plethora of international instruments pertaining to global coastal management and collaboration. However, in spite of significant progress in the formulation and adoption of these instruments, implementation in coastal developing countries at the local level has been hindered, primarily by inadequate human resource capacity and financial constraints (Hewawasam, 2002), where countries are dealing with national legislation as a priority of international obligations.

3.3. Coastal Management in South Africa

As is evident from Figure 3.1, various statutes and policies have shaped or changed how the coast has been managed over the past 40 years. The protection of the coastal environment is underpinned by the Constitution of the Republic of South Africa, (No. 108 of 1996), although not expressly referring to coastal management; the Constitution provides a framework for the management of the coast. It highlights the need for co-operative governance (Sections 40 and 41) and the need to develop the capacity of lower spheres of government, provincial government in terms of Section 125(3) and local government in terms of Sections 154(1) and 155(b). However, some argue that the Constitution does

not provide adequate direction regarding the administration and management of the complex coastal environment (Smith and Cullinan, 2000).

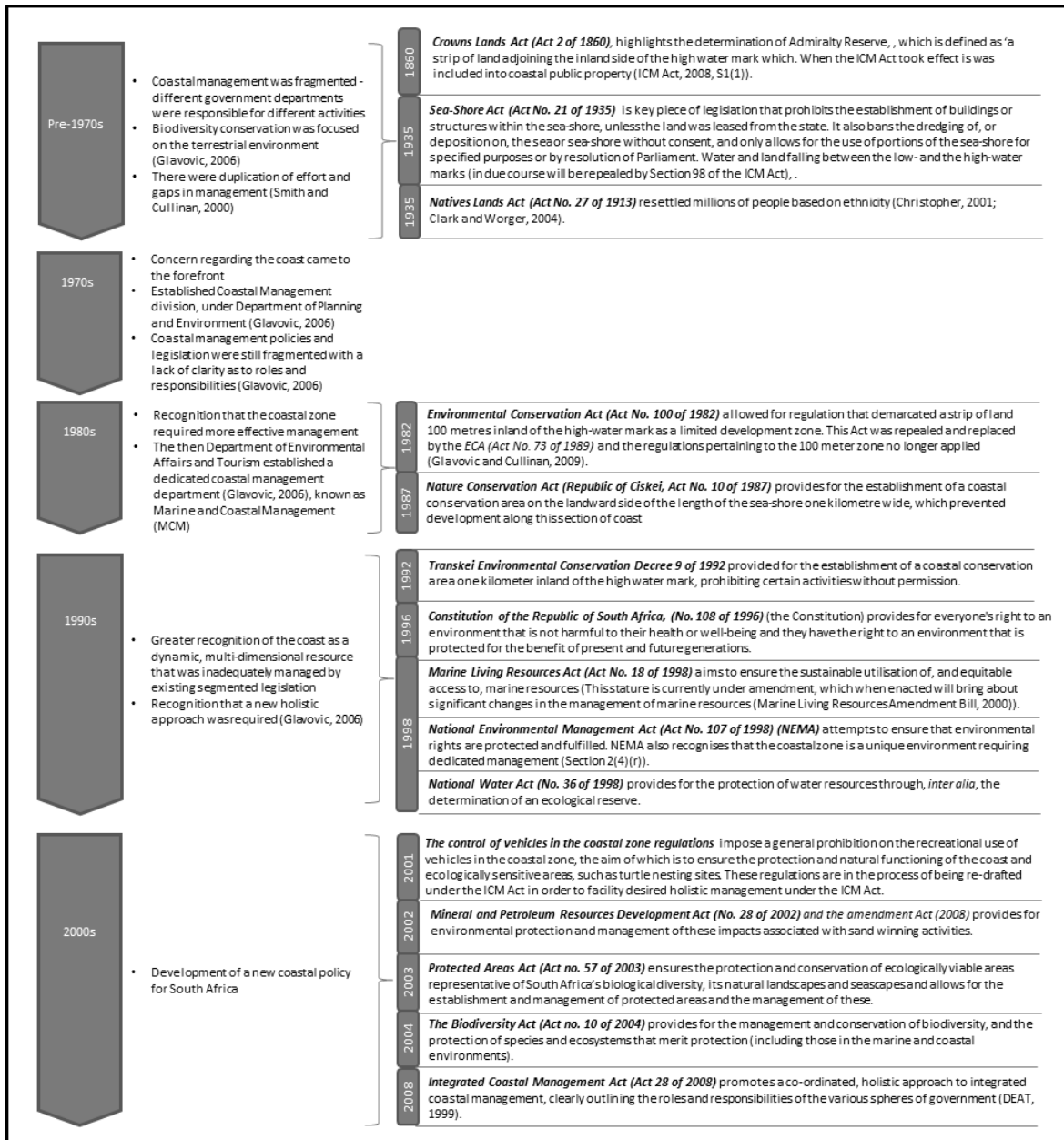


Figure 3.1: Evolution of coastal management in South Africa, as influenced by other environmental legislation, to the development of the ICM Act

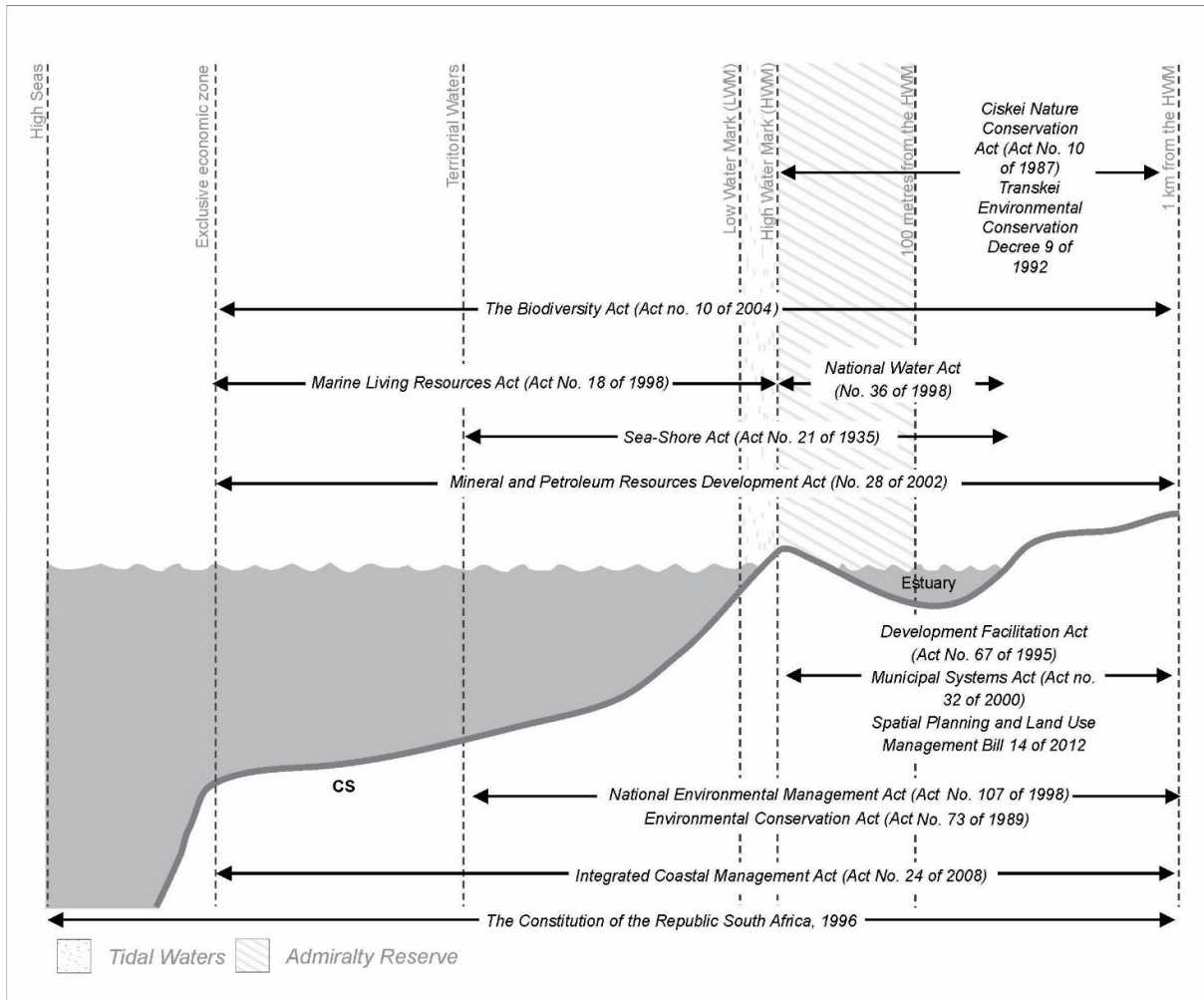
While a range of environmental specific statutes and policies are in effect, there are various other planning statutes that have bearing on the management of the coastal zone, specifically in terms of land management, planning and utilisation, notably, the historical Apartheid planning legacy. Apartheid, meaning “apartness” or separateness, refers to the policy of separating people based on

race and came into effect in 1948 (Clark and Worger, 2004). During this time, the government set up 10 homelands (in accordance with the Natives Lands Act (Act No. 27 of 1913)). The effects of Apartheid planning are still evident today, with specified race or ethnicity groups predominantly occupying certain areas. The homelands were nominally self-governing tribal homelands, with most having their own nature conservation laws, several of which are still in force (Figures 1 and 2). This has impacted the coastal landscape of South Africa significantly, with former 'white' areas being densely populated and developed and former 'black' or homeland areas remaining underdeveloped, with limited access to economic resources or social services and inadequate infrastructure (Matthews, 2001).

The Post-Apartheid South African government has implemented land reform policies, aimed at restitution, redistribution and tenure reform of land to secure land rights (Lahiff, 2003; Adams et al., 1999). However, land reform is challenged by limited budget, lack of policy direction, inadequate co-operation between government spheres and constraints imposed by the national land reform policy (Lahiff, 2003), resulting in low levels of land reform, and a high degree of uncertainty pertaining to ownership and developmental rights of land which in turn has resulted in lack of development. With much of this land being along the coast, future management of these areas needs to balance access and land rights against coastal conservation needs.

In South Africa management and legislative objectives are achieved through the division of government structures into three spheres: national, provincial and local government, in order to streamline and divide management roles and responsibilities. All three spheres of government have legislative and executive authority in their own spheres (s40 of the Constitution). National government is responsible for the implementation of laws and policies at a national level, dealing with issues that are of concern to the whole country (s85 of the Constitution). In South Africa there are nine provincial legislatures, which are authorised to enact provincial legislation on issues included in specified 'functional areas', so as to ensure better management of individual provinces and their resources (s104 of the Constitution). Provincial government is responsible for the co-ordination, monitoring and support of local municipalities within each province (s155 of the Constitution). Local authorities are largely responsible for daily management relating to natural resource management, land use planning, land development, catchment management, coastal and drainage engineering, local economic development, environmental assessment, strategic planning, housing and service delivery, environmental health and tourism promotion (s156 of the Constitution).

Coastal management in South Africa has been fragmented across different departments and spheres of government, all of which have different, often conflicting, mandates and management objectives (Figure 3.2) (Wynberg, 2000; Sale et al., 2008), hence the need for dedicated coastal management legislation and the development of the ICM Act. While the ICM Act aims to achieve holistic management of the coast, it is important to note that this does not repeal existing statutes discussed, with the exception of the Dumping at Sea Control Amendment Act (Act No. 73 of 1995) and sections of the Sea-shore Act. However, it does supersede these in the event of conflicts between the statutes.



Where: LWM – low water mark, HWM – high water mark, TW&R – tidal waters and rivers and CS – continental shelf

Figure 3.2: Summary of legislative jurisdiction in South Africa (Adapted from Glavovic, 2000)

3.4. The Integrated Coastal Management Act

The development of the ICM Act went through a number of phases, starting with a Green Paper (Towards Sustainable Coastal Development in South Africa) in 1998, which identified the need for a coastal policy and laid the foundation for the development of a White Paper (The White Paper for

Sustainable Coastal Development) in 2000. The White Paper saw a paradigm shift in how the coastal zone was defined and managed, moving from a “conservation discourse” to a “sustainable development” discourse (Glavovic, 2006), with the coastal zone being defined as a zone extending as far seaward and landward as necessary for effective management. The White Paper recognised that the coast needed to be managed as a system and not by the sectors of users who benefit from the opportunities it provides (DEAT, 1999). Following on from the White Paper was the development of the ICM Bill and subsequently the ICM Act, which commenced in December 2009. The ICM Act promotes a more holistic or ecosystem-based approach whereby the coast is managed as a unit, encompassing all elements that have historically been fragmented and addressed by the various statutes (Table 3.2). This principal of the Act aligns with international Ecosystem-Based Management (EBM), with management considering ecological systems and promoting inter-sectorial coordination without focusing on single issues, species, or ecosystem functions in isolation (UNEP, 2011).

Table 3.2: Aspects of coastal management addressed by other statutes

	Ecological & biodiversity conservation	Coastal buffer/ protection zone	Social rights of access to & use of resources	Cooperative governance
Crowns Lands Act (Act 2 of 1860)		X		
Sea-Shore Act (Act No. 21 of 1935)	X			
Natives Lands Act (Act No. 27 of 1913)		X		
Environmental Conservation Act (Act No. 100 of 1982)		X		
Nature Conservation Act (Republic of Ciskei, Act No. 10 of 1987)		X		
Transkei Environmental Conservation Decree 9 of 1992		X		
Constitution of the Republic of South Africa, (No. 108 of 1996)	X		X	
Marine Living Resources Act (Act No. 18 of 1998)			X	
National Environmental Management Act (Act No. 107 of 1998) (NEMA)	X		X	
National Water Act (No. 36 of 1998)	X		X	
The control of vehicles in the coastal zone regulations	X		X	
Mineral and Petroleum Resources Development Act (No. 28 of 2002)			X	
Protected Areas Act (Act no. 57 of 2003)	X			
The Biodiversity Act (Act no. 10 of 2004)	X			
<i>Integrated Coastal Management Act (Act 28 of 2008)</i>	X	X	X	X

Importantly, in terms of the ICM Act, the state must act as the trustee of the coastal zone, holding coastal public property in trust on behalf of the citizens of the Republic, it is inalienable and cannot be sold, attached or acquired (ICM Act, S11). It must ensure that coastal public property is used, managed, protected and enhanced in the interests of the whole community, and must take reasonable measures to protect it, ensuring that no person causes adverse effect on the coastal environment (ICM Act, S12). All organs of state have a responsibility to manage activities on or in coastal waters, and must do so in the interests of the whole community, to ensure and maintain fair and equitable access to and use of resources (ICM Act, S21).

3.5. Discussion

As with many third world countries, South Africa is reliant on natural resources to support livelihoods, the management of these resources and their utilisation is critical for ensuring long-term sustainability. As a result, environmental legislation in South Africa is people-centred or anthropocentric, where the environment is managed for the benefit of people (Kidd, 2011). Section 2(4)(o) of NEMA states that the environment is held in public trust for the people. The beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage. *"This principle follows the United Nations Convention on Biological Diversities objective for "the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources⁴..."* (United Nations, 1992a, Article 1).

The ICM Act follows the objective of NEMA and adopts a people-centred, pro-poor approach to coastal management (Glavovic, 2006), with its objectives focused on 2(e) preserving, protecting, extending and enhancing the status of coastal public property as being held in trust by the State on behalf of all South 1 means genetic material of actual or potential value Africans, including future generations; in order 2(d) to secure equitable access to the opportunities and benefits of coastal public property. The notion of people-centred management for the coast was fostered in the original policy document for coastal management, with the White Paper setting out a people-centred approach that highlights that maintaining healthy and productive coastal ecosystems is central to facilitating sustainable coastal development and contributing to the reconstruction and development in South Africa (DEAT, 1999). The premise being that this will afford the coastal environment greater security, as sustainability for human use incentivises conservation (Glavovic, 2006). However, Wynberg (2005) cautions that 'benefit-sharing' management is a buzzword, creating visions of community

⁴ Means genetic material of actual or potential value

empowerment, enrichment and partnerships that offer equitable access and use of resources. Very seldom is this case, with governments left to develop policies in support of people-centred ICM, and a number of challenges associated with this (Taljaard, 2011), resulting from “*knowledge gaps and government incapacities to deal with issues*” (House and Phillips, 2012, p495), such as the implementation of new legislation. Over the past 40 years, there has been a debate among integrated coastal management scholars and practitioners on the best way to mobilize knowledge, with some experts defending a science based interface, while others advocate a more participatory interface that admits all coastal stakeholders and their knowledge systems (Bremer and Glavovic, 2013).

In South Africa, the ICM Act goes beyond the scope of previous statutes and aims to align with global issues, such as climate change, and advocates adaptation and management of the effects of climate change through the determination of coastal set-back lines, which should protect coastal public property, private property, the coastal protection zone and public safety (S25 (1) (i) and (ii)) from the effects of sea-level rise, storm surge and coastal erosion (Goble and MacKay, 2013). Furthermore it advocates for the protection of the marine and coastal environment through the determination of protected areas as heightened by the Convention on Biological Diversity. While the determination of Marine Protected Areas (MPA) is achieved in terms of the Marine Living Resources Act (MLRA) (S43), the ICM Act provides mechanisms for better management of these areas. In South Africa there are 23 MPAs, some of which are classed as no-take MPAs in which some activities are permitted and closed areas, in which no activities are allowed (Sink et al., 2012). Recently, South Africa declared the Prince Edward Islands (PEI) MPA, one of the largest of its kind and the first South African offshore MPA. It will contribute significantly to global protection of offshore and deep ocean areas (DEA, 2013a). Notably the establishment of this MPA contributes significantly towards South Africa’s national and international commitments to biodiversity protection (DEA, 2013a).

Implementation of the ICM is complicated by the territorial overlap with other existing legislation (Figure 3.1), which has not been repealed and can result in conflicts of jurisdiction and inadvertently prevent participatory resource management and sustainable utilisation of resources (Castro and Nielsen, 2003). That said, the ICM Act attempts to address this through holistic management of all components of coastal biodiversity and social management, a component identified as a gap by previous statutes (Table 3.2). For the Act to be effective there needs to be strict articulation and balancing of management roles (Alves et al., 2013). The Act decentralises management with greater provincial and local authority roles and responsibilities. While an improvement over historical centralised, top-down management, concern has been raised as to the onerous nature of the Act and

the high degree of cooperative governance required in order to achieve the targets (Palmer et al., 2011). Decentralization of roles has led to local authorities being left with the daunting task of implementing the new statute and ensuring „better management“ of the South African coast. The obligations imposed by the ICM Act, while aimed at enhancing coastal management, place pressure on authorities that often do not have the human and financial capacity to address them (Palmer et al., 2011). Decision makers need knowledge on a diversity of topics, some of which are beyond their expertise but essential for informed decision making (Westmacott, 2001).

Current implementation of the ICM Act has been met with mixed success; the ICM Act outlines a number of obligations and timeframes within which these should be achieved. Table 3.3 highlights those requirements that should have been achieved since enforcement, a period of four years. The aim of the table is to provide an overview of the current state of progress without singling out local governments that have not undertaken any action. There are different socio-economic aspects that influence implementation and would be politically insensitive. Progress on meeting these targets has been mixed, driven by varied human and financial capacity to achieve these targets. Ability to meet these targets is linked to capacity to understand the requirements and resources to achieve those (Palmer et al., 2011). A 2008 study highlighted capacity issues in the Eastern Cape Province (one of four coastal provinces in South Africa), interviewed respondents expressed concern as to the capacity of local government to meet the requirements of the Act as they already lacked capacity to deal with service delivery and increasing development pressure. Furthermore, it was further noted that in some instances local authorities had no person responsible for environmental management due to financial constraints (Palmer, 2008), thus the implementation of an additional unfunded mandate has been met with mixed success.

Table 3.3: The requirements of the ICM Act and progress achieved for the four year period from enactment to date

Requirement	Section of the ICM Act and time frame	Progress (2013)
Designation and functions of provincial lead agency	38. (1) The Premier of each coastal province must, <i>within two months</i> of the commencement of this Act, designate a provincial organ of state to function as the lead agency for coastal management in the province and must ensure that there is at all times a lead agency for coastal management in the province which is responsible to the MEC.	All four coastal provinces now have a designated lead agent; however, this took three and a half years for some provinces.
Establishment and functions of Provincial Coastal Committees	39. (1) Each MEC must within 12 months of the commencement of this Act establish a Provincial Coastal Committee for the province.	There is mixed progress, some provinces have functioning PCC's in place, while others are yet to get this up and running.
Establishment and functions of National Coastal Committee	35. (1) The Minister must by notice in the Gazette establish a National Coastal Committee and determine its powers (<i>no specified timeframe – but should align with the Provincial Coastal Committees</i>)	To date there is no National Coastal Committee – this section of the Act is under amendment, thereafter a National Coastal Committee may be established.
Designation of coastal access land	18. (1) Each municipality whose area includes coastal public property <i>must within four years</i> of the commencement of this Act, make a by-law that designates strips of land as coastal access land in order to secure public access to that coastal public property.	There is mixed progress, with better capacitated local authorities having identified coastal access and have mechanisms in place to manage this.
National estuarine management protocol	33. (1) The Minister, with the concurrence of the Minister responsible for water affairs, <i>must within four years</i> of the commencement of this Act prescribe a national estuarine management protocol.	A draft protocol was developed and released for comment in 2012.
Preparation and adoption of national coastal management programme	44. (1) The Minister <i>must within four years</i> after this Act takes effect, prepare and adopt a national coastal management programme for managing the coastal zone.	A national coastal management programme has been drafted with public consultation being undertaken in 2013.
Preparation and adoption of provincial coastal management programmes	46. (1) The MEC of each coastal province <i>must within four years</i> of the commencement of this Act, prepare and adopt a Provincial coastal management programme for managing the coastal zone in the province.	There is mixed progress. While provinces do not have CMP in accordance with the ICM Act, that have historical management strategies. National government is in the process of developing a guideline for the development of coastal management programmes.
Preparation and adoption of municipal coastal management programmes	A coastal municipality <i>must, within four years</i> of the commencement of this Act, prepare and adopt a municipal coastal management programme for managing the coastal zone or specific parts of the coastal zone in the municipality.	There is mixed progress, with better capacitated local authorities having drafted coastal management programmes. National government is in the process of developing a guideline for the development of coastal management programmes.
Information and reporting on coastal matters	93. (2) The MEC must prepare a report on the state of the coastal environment in the province every <i>four years</i> , which must contain any information prescribed by the Minister.	To date none of the coastal provinces have completed this reporting.

It is important to note that provincial authorities have identified other priority sections for auctioning, which do not have timeframes attached, such as the determination of coastal set-back lines.

A criticism of the ICM Act has been the lack of guidance for implementation, with much being left to interpretation (Palmer, 2008). As a result, there are a range of guidelines available to streamline and assist authorities to meet the objectives of the ICM Act: The User Friendly Guide to the ICM Act (Celliers et al., 2009), the ICM Act Enforcement Manual (DEA, 2011), and the National Estuaries Protocol (DEA, 2012). Others in development include a guideline for developing a Coastal Management Programme, guidelines for the establishment of coastal committees, and a guideline for

the determination of coastal management lines, with a range of others on the table for future development (DEA, 2013b). Thus, it is evident that there is a need to facilitate or assist authorities with the implementation and objectives of the ICM Act. A globally recognised approach, albeit with mixed success, is the use of decision support tools, with different tools are appropriate under different conditions with no single tool being universally applicable for a region or application. For South Africa to benefit from such tools, unique tools need to be developed that support coastal authorities with the implementation of the ICM Act and decision making.

3.6. Conclusion

South Africa's coastal management has evolved and resulted in the development of the ICM Act. The ICM Act is inherently dynamic, attempting to tackle the interlinked problems of coastal development and conservation. Just as natural and man-made changes have become integrated, so too should the management structures and legislation that govern these. That said, a greater paradigm shift is required to allow for these overlaps. In turn this will ensure that historical fragmented governance structures are overcome and implementation is improved. Effective implementation will facilitate appropriate and sustainable use of coastal resources, responsible coastal development and the protection of ecologically sensitive areas, which ensures natural coastal functioning and protection.

As identified in this paper, the ICM Act has a range of legislated requirements that require capacity and financial resources to achieve. Only four years into the implementation of its new Act, some lessons have emerged that highlight the current capacity constraints and speak to the complexity of legislation that is to be implemented. As a result, the implementation of this statute has been met with mixed success, with a number of challenges that need to be overcome if holistic coastal management is to be achieved.

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**CHAPTER FOUR: AN ASSESSMENT OF INTEGRATED
COASTAL MANAGEMENT GOVERNANCE AND
IMPLEMENTATION USING THE DPSIR FRAMEWORK:
KWAZULU-NATAL, SOUTH AFRICA**

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Abstract

Coastal areas are under increasing pressure from population growth and coastal space demands for recreation and other socio-economic activities. The pressures and associated changes to the coastal environment need to be managed to ensure long-term sustainability. South Africa has enacted an Integrated Coastal Management Act (ICM Act) to facilitate dedicated management of its coastal environment. Implementation has been met with a number of challenges, primarily relating to financial and human capacity constraints, particularly at the local government level. Given that the ICM Act devolves powers to local government, it is imperative that implementation challenges be addressed. This paper focuses on KwaZulu-Natal, one of four South African coastal regions, which is a renowned tourist destination and home to 11.1 million people (Statistics South Africa, 2015). This paper considers the state of coastal management, as well as implementation challenges being experienced at a local governance level, and highlights ways to address these. Data were acquired through surveys and semi-structured interviews. The Drivers-Pressures-State-Impact-Response (DPSIR) framework was used to identify relevant ICM issues and concerns and develop potential actions for improving the implementation of coastal management activities and the ICM Act. In the assessment of the ICM governance and implementation to date a key concern identified was a general lack of coastal management knowledge amongst officials. It was specifically identified that knowledgeable management and capacity building required championing from the provincial government in order to more efficiently and effectively implement the objectives of the ICM Act through an improved understanding of the coastal environment, its functioning and management.

Key words: DPSIR, Coastal management, government capacity, constraints to implementation, Integrated Coastal Management

4.1. Introduction

Coastal areas are hotspots for recreation, leisure and subsistence activities. An estimated 44% of the global population reside within 150 km of the coastline (UN Atlas of the Oceans, 2016) and an estimated three billion people depend on marine and coastal biodiversity for their livelihoods (United Nations Development Programme (UNDP), 2016). Consequently, coastal areas are an important economic resource with a global combined annual value of goods and services in the region of US \$22 trillion (Costanza et al., 2014). Since the 1992 UNCED Conference, the high importance of coastal areas was placed on the agenda of many donor communities, national governments, non-government organisations and universities (Olsen, 1996). Chapter 17 of Agenda 21 highlighted the importance of oceans and coastal areas for their contribution to global life-supporting systems, thereby providing positive opportunities for sustainable coastal development (Cicin-Sain et al., 1995). Furthermore, the 2030 Agenda for Sustainable Development, goal 14 states: *Life below water (conserve and sustainably use the oceans, seas and marine resources)*. This goal aims to ensure sustainably managed and protected marine and coastal ecosystems, while enhancing the conservation and sustainable use of oceans and their resources (United Nations Development Programme (UNDP), 2016).

Numerous conflicts exist within coastal areas due to divergent interests, concerns, ecological limitations and resource constraints (Ahmed et al., 2014). This highlights the need for holistic, integrated management to ensure long-term sustainability. Managing this highly complex environment requires dedicated management interventions (Goble et al., 2014). This has led to a new approach to the management of coastal areas through the emergence of Integrated Coastal Management (ICM), which is defined as an “ongoing process of formulating, implementing and refining a comprehensive and holistic vision of how humans should interact in an ecologically sustainable manner with the coastal environment” (Burchi, 2006, p3). ICM is a globally utilised approach focusing on a balance between coastal demands from socio-economic activities and environmental needs (Beeharry et al., 2014), through the integration of, and a focus on key principles (Portman et al., 2015). The various definitions of ICM emphasize the need for a balance between development and conservation through multi-sectoral planning; balanced against participation and conflict mediation (Christie, 2005). The World Bank published guidelines for effective ICM aimed at assisting countries develop ICM legislation and programmes (Post and Lundin, 1996). In 2002, the EU ratified the *Recommendations concerning the implementation of integrated coastal zone management in Europe* (2002/413/EC), which outlines eight principles defining the essential characteristics of ICM to guide member states in ICM initiatives (European Commission, 2016;

Portman et al., 2015). As such, many coastal countries have undergone a process of establishing ICM programmes and policies to improve coastal management, and have facilitated a multi-sectoral governance approach.

In line with international trends, South Africa is no exception, having undergone an extensive policy development phase, culminating, at the end of 2009, in the enactment of an Integrated Coastal Management Act (Act No. 24 of 2008 and Amended Act No. 36 of 2014; hereafter referred to as the ICM Act). The ICM Act is an integrated, holistic and encompassing approach to coastal management, aimed at ensuring the long-term sustainability of the South African coast. In South Africa, coastal management, as with environmental management in general, is complex due partly to the historically fragmented nature of coastal governance, as different sectors have been historically responsible for different aspects of management under a variety of legislation. This fragmentation resulted in a lack of clear governance and clarity as to specific roles and responsibilities across government sectors and spheres (Middleton et al., 2011). The ICM Act aims, in part, to address this historically disjointed nature of coastal management, through the incorporation of all coastal management actions under one Act. The ICM Act outlines an approach for integrated coastal and estuarine management, through the development of norms, standards and policies to promote conservation of the coastal environment while at the same time ensuring holistic management and equitable access to the coast and the resources it offers (Republic of South Africa, 2008). To complete the legislative space for ocean and coastal management, South Africa is now also in the process of developing a National Environmental Management of the Ocean Act (white paper). This complicates the coastal management policy framework as it creates uncertainty around the spatial jurisdiction of management. The boundary between oceans and coast is unclear; however this paper cannot unpack the complexity of this disjunct.

In South Africa, the ICM Act provides for a nested governance system across three spheres; national, provincial and local. It assigns specific roles and responsibilities to each sphere of government and specifies timeframes within which government departments should achieve these objectives. There is growing concern that implementation has been too slow and that the prescribed timeframes have lapsed (Goble et al., 2014). As such, it is highlighted that ICM implementers are key to the success of ICM initiatives and legislation. Notwithstanding the range of external factors that can affect effective ICM, such as limited data or information availability, high coastal pressures and competing political priorities, capacity (human and financial) is identified as key to effective ICM. Kiambo et al. (2001) described an 'ideal' coastal manager or management unit, as needing competency in project

management; ICM practice; professional skills and a broad range of technical skills pertaining to ICM. For ICM to be effective, government capacity and technical understanding is required. The United Nations Development Programme defines capacity development as *“the process through which individuals, organizations and societies obtain, strengthen and maintain the capabilities to set and achieve their own development objectives over time”* (United Nations Development Programme (UNDP), 2008, p4). Government capacity is considered essential for the establishment of a regulatory climate that is conducive to economic and social development within the coastal environment (Organisation for Economic Co-operation and Development (OECD), 2009). On an international level, the achievement of targets such as the Millennium Development Goals hinge on the capacity of individuals, organizations and societies to understand, buy-in and strive towards targets (UNDP, 2008). The same principles apply at a local government level, whereby capacity of those in coastal management positions is fundamental to successful governance.

Human Capacity, as well as the need for capacity building programmes are essential requirements for successful implementation of ICM principles, and South Africa is not unique in struggling with these challenges. These challenges highlight the need for ICM training and capacity building worldwide. In the Philippines, Courtney et al. (2002) found that capacity building was essential for local government to achieve their objectives. While in Kenya and Zanzibar, site-based projects partially aimed at building capacity and commitment to sustain and expand ICM initiatives were undertaken (Hale et al., 2000). Integrated Coastal Management in the Southern Cone (C-MCISur) aimed to improve capacity in coastal management in Uruguay, Mexico, Chile, Brazil and Argentina (Echevarría et al., 2013) and the PEMSEA initiative (Partnerships in Environmental Management for the Seas of East Asia) is assisting local government in China in building its capacity to develop and implement ICM strategies (Chen and Uitto, 2003). In Alves et al.'s (2013) review of Portugal's progress in implementing ICM, they found there was a need to strengthen governance, improve decision-making and most importantly, secure financial sustainability. When assessing Mediterranean and Black Sea coastal governance, House and Phillips (2012) identified a need for further manipulation, translation, coordination, communication and adaptation between policy portfolios, while Calado et al. (2010) recommended that new goals based on horizontal planning tools should cut across sectoral policies and support joined up policy making. Capacity has for some time been identified as an obstacle to successful ICM at an international scale, with the Global Environmental Facility specifically highlighting the need for human resource development and capacity building (Crawford et al., 1993). Reis and Lowe (2012) further argue that there is a lack of

capacity to successfully implement coastal and marine management programmes, given the proliferation of coastal and marine legislation and policy.

This paper focuses specifically on the coastal province of KwaZulu-Natal (KZN), highlighting local government management issues in terms of implementation of coastal management and the ICM Act. It considered the DPSIR (Drivers-Pressure-State-Impact-Response) framework to assess the ‘drivers’ of the legislative framework, the ‘state’ of implementation, the ‘impact’ of driver and proposed ‘responses’ to improve local level ICM. Local government, as with higher levels of government are assigned mandates, responsibilities, functions and powers for implementation, enforcement and compliance, pollution management, biodiversity management and planning and land use management. The KZN coast is one of four coastal provinces in South Africa and was selected due to its economic importance, being the second largest economy in South Africa (Fin24, 2014). It assesses expert opinion and identifies what progress has been made, as well as constraints to implementation and management. It concludes by making recommendations to improve implementation of ICM and the ICM Act within KZN.

4.2. Study area

The KZN coast, on the east coast of South Africa, stretches approximately 580 km from the Mozambique border in the North to the Mtamvuna Estuary in the South, where it borders the Eastern Cape Province (Figure 4.1; Goble and Mackay, 2013).

The KZN coast is a renowned international and domestic tourist destination, offering attractive beaches, a variety of recreational activities, year-round warm climate and comfortable seawater temperatures. It is easily accessible via a well-connected road and air network. In addition to seasonal demands from holiday makers, KZN is home to 11.1 million people, 50% of which are based in the province’s coastal municipalities and as such directly benefit from the coast, be it through recreation, leisure or subsistence activities (Statistics South Africa, 2015). The KZN coast offers direct economic benefits to the province and South Africa, through two nationally important commercial ports; Durban and Richards Bay. There are many smaller marine and coastal commercial activities that contribute to the KZN coastal economy, such as commercial fisheries, shellfish harvesting, recreational angling, and scuba-diving. Further value of the KZN coast is evident through its contribution to the long-term conservation of coastal and marine ecosystems. It is home to the iSimangaliso Wetland Park, a world heritage site in the far north of the province, which accounts for 30% of the coastal zone (Goble and van der Elst, 2013). This ensures the long-term protection of a

range of the province’s marine and coastal ecosystems (United Nations Educational Scientific and Cultural Organisation (UNESCO), 2014). However, the remainder of the KZN coast is afforded little or no formal protection and is under increasing pressure for development and transformation to accommodate socio-economic demands. Therefore, it is imperative that there is effective management of the coastal environment, its resources and access to and use of these resources.

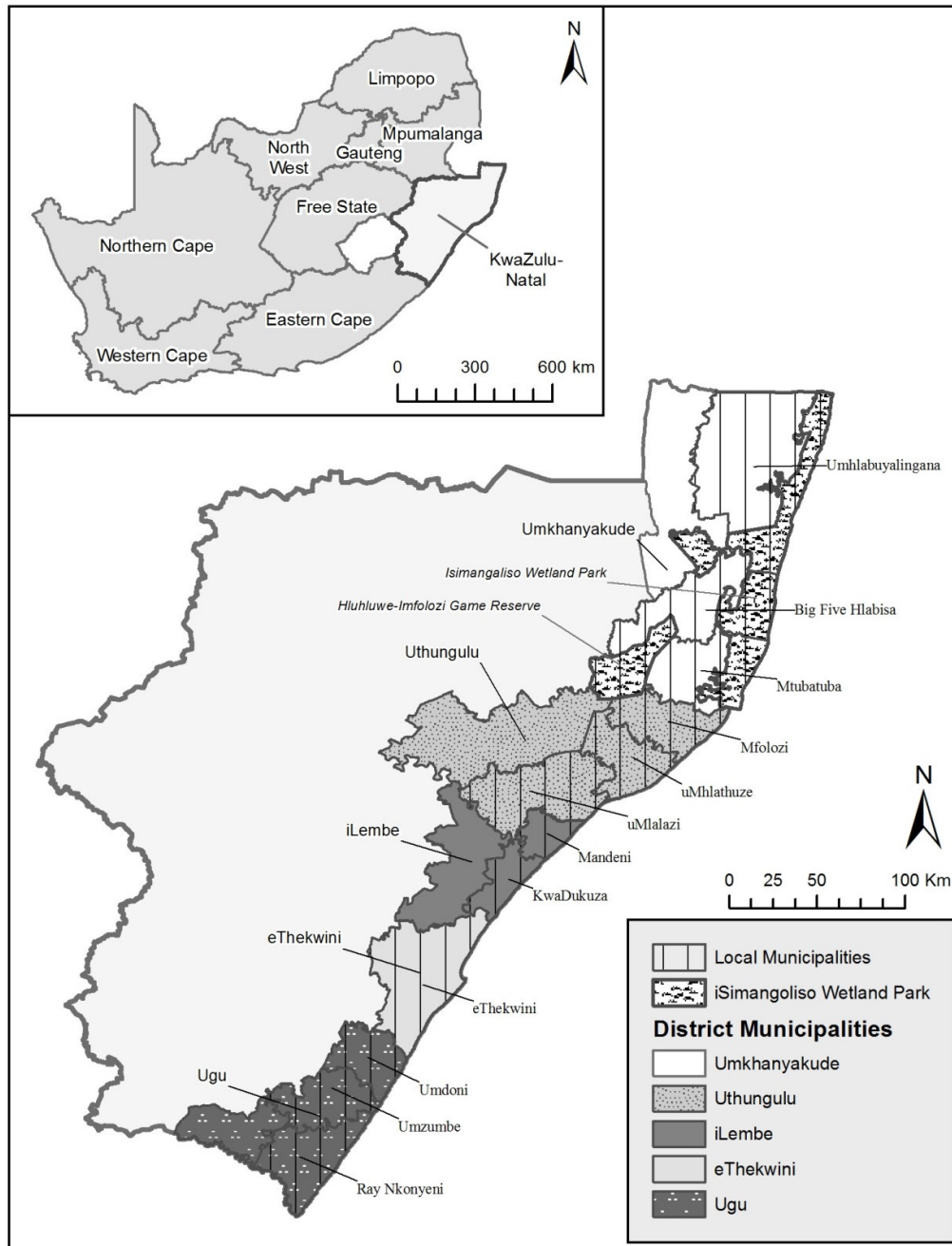


Figure 4.1: Location of coastal district and local municipalities, showing their jurisdiction along the KZN coast

In terms of governance, the KZN coast is divided into four district municipalities, one metropolitan and eight local municipalities which fall within these district municipalities (Figure 4.1). All these districts are required to meet coastal management objectives in terms of the ICM Act. The metropolitan is considerably better capacitated than the district and local municipalities, both in terms of staff numbers and financial allocation. This is evident from the fact that the metropolitan has been able to achieve targets such as determination of coastal access land. An important feature of the KZN coastal landscape is the iSimangaliso Wetland Park, which is primarily managed in terms of the World Heritage Convention Act (Act 49 of 1999). The requirements of the ICM Act are nested below the World Heritage Convention Act and the National Environmental Management: Protected Areas Act (Act 57 of 2003) (iSimangaliso Wetland Park Authority, 2016), making the managing agency of the iSimangaliso Wetland Park the lead agency for ICM within its jurisdictional boundaries. As such, the provincial and local authorities have little jurisdiction within the park boundaries; therefore, this section was not directly included in this assessment. This highlights concerns pertaining to fragmentation of ICM, the ICM Act clearly outlines the need for integration and holistic ICM. However, the legislative hierarchy for this region has largely prevented this from occurring.

A second influencing factor on the coastal landscape of KZN, as with the rest of South Africa, is historical Apartheid planning. Apartheid meaning ‘apartness’ or separateness, and refers to the policy of separating people based on race and ethnicity. This policy was introduced in South Africa in 1948 (Clark and Worger, 2004). During this time a number of homeland areas were established to ‘separate’ people. Within KZN, the homeland of KwaZulu being the largest of the homelands, was established as the home of the Zulu people (Figure 4.1; Palmer et al., 2011). As a self-governing state, the KwaZulu Legislative Assembly established the Ingonyama Trust, in terms of the KwaZulu Ingonyama Trust Act, (No. 9 of 1997), which provided for land owned or belonging to the KwaZulu Government to be held in trust for “the benefit, material welfare and social well-being of the members of the tribes and communities” living on the land (Ingonyama Trust Board, 2016). Whilst national legislation such as the ICM Act is applicable in these areas, land management is governed by the Ingonyama Trust Board, making the institutional setting in these areas different and often more challenging than in the remainder of the province.

This historical planning has shaped the coastal landscape of KZN, with former ‘white’ areas being densely populated and developed with upmarket residential and holiday accommodation. In contrast the former ‘black’ or homeland areas have remained underdeveloped with limited access to economic resources, social services and infrastructure (Goble et al., 2014; Matthews, 2001). The southern coast

of KZN, where limited homeland area abuts the coast is characterised by ribbon-type development. In comparison the northern sections of the coast show pockets of development, linked to former ‘white’ towns (Figure 4.1; Goble and van der Elst, 2013).

4.3. Methods

The ICM Act in South Africa aims to improve coastal management through an integrated, holistic approach. Successful implementation of the ICM Act requires appropriate tools to assist managers with various components of the Act. To inform the design, development, testing and use of tools, there is a need for the use of a conceptual framework, which provides a basis to assure that appropriate tools will be available going forward (Rekolainen et al., 2003). The DPSIR framework has been adapted and applied to outline the implementation of the ICM Act at the local level, through which responses to challenges can be identified.

To ascertain the ‘pressures’ posed by the ICM Act, the current ‘state’ of implementation, the ‘impact’ this has on the coastal environment; as well as to identify the possible ‘responses’ that can be applied to facilitate better ICM at the local level, two stages of data acquisition were adopted. 1) A survey was circulated to obtain a broad overview regarding current perceptions of coastal management, coastal management issues and requirements to build capacity; 2) based on the stakeholder feedback through the surveys, one-on-one interviews with selected persons within the case study area were undertaken. The focus of the interviews was to determine critical gaps at local level regarding ICM and discuss issues identified through the survey process. As this work forms part of an ongoing project, all survey questions were considered and approved by an ethics committee, while anonymity of survey and interview respondents was guaranteed.

A survey was distributed to a targeted audience of personnel involved with implementation of the ICM Act at local, district, provincial and national government levels (n=120). The survey focused on the following two themes:

- 1) *The respondent’s opinion of ICM:* perceived value of the coast and responsibilities for its management;
- 2) *The respondent’s opinion in terms of implementation of the ICM Act:* perceived opportunities and constraints of the ICM Act and ways to improve ICM implementation.

The surveys assessed perceived current capacity for achieving ICM and meeting targets associated with implementation of the ICM Act. The second phase of the study focused on one-on-one interviews

representatives from each of the eight local, one metropolitan and four district offices along the KZN coast were interviewed. Interviewees have diverse backgrounds; from planning and engineering to environmental management. Interviews considered opportunities and constraints, and tools and interventions that could potentially help progress future implementation in general. This was achieved following the “interview guided approach” which has limited structure, and allows for a range of topics and issues to be covered (Kitchin and Tate, 2000). This approach is commonly used as it allows the researcher to produce rich, varied data in the context of an informal setting (Kitchin and Tate, 2000; Cloke et al., 2004). It is considered effective in dealing with complex human systems and emphasises the importance of the social context, in this case, better management (Cloke et al., 2004). Interviews focused on: understanding of the coastal zone and management; roles and responsibilities in terms of coastal management; coastal issues and challenges at the local level; capacity to address coastal management; and possible alternative approaches for improved coastal management capacity in KZN.

The results from the surveys and interviews were consolidated and assessed within the DPSIR framework. Analytical frameworks have been adapted for coastal environments and aid in the determination of the extent of coastal areas and provided detailed understanding as to the function and value of coastal areas (Agardy et al., 2005), primarily through reporting on the state of the coast. In the legislative context, the DPSIR Framework allows for changes in coastal governance and legislation to be related to the management ‘state’ pressures posed by the governance framework (Figure 4.2).

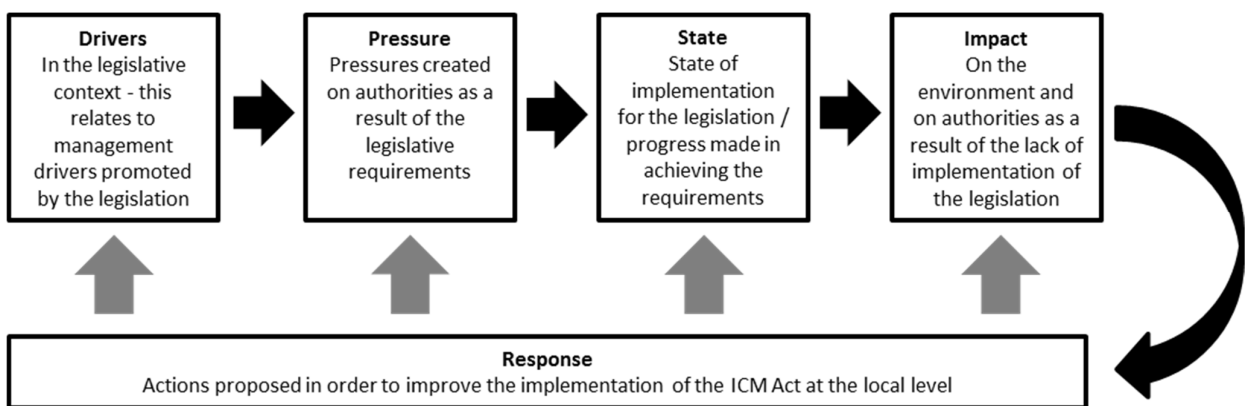


Figure 4.2: DPSIR Framework applied in the context of legislative implementation

4.4. Results

4.4.1. Survey

A total of 65 surveys were returned from the target audience of 120, but seven were incomplete and therefore 58 responses were analysed. Respondents were asked to provide their view of coastal management, the ICM Act and its implementation. Most respondents (91%) were of the opinion that the management of the coast is a shared responsibility amongst government departments and a range of stakeholders (Figure 4.3). There was mixed feedback about the implementation of the ICM Act, with 60% of the opinion that implementation is a major challenge and 59% feeling that the biggest obstacle was buy-in from stakeholders, followed by political buy-in, 24% (Figure 4.3).

Comments were invited on the current implementation ‘state’ and possible alternative or ‘responses’ to improve implementation of the ICM Act, these are assessed by means of the DPSIR framework in conjunction with interview responses, in order to provide a coherent picture of the implementation framework. A summary of these comments (Figure 4.4) shows that 36% of survey respondents believe the ICM Act would result in better management of the coastal environment. However, there are ‘many pressures’ that affect the ‘state’ of implementation that need to be considered and addressed. Major obstacles identified were human (61%) and financial capacity (30%; Figure 4.4) and co-operative governance requirements (7%), although 12% felt this was a positive ‘driver’ of the ICM Act as it enforces an integrated and coordinated approach (Figure 4.4).

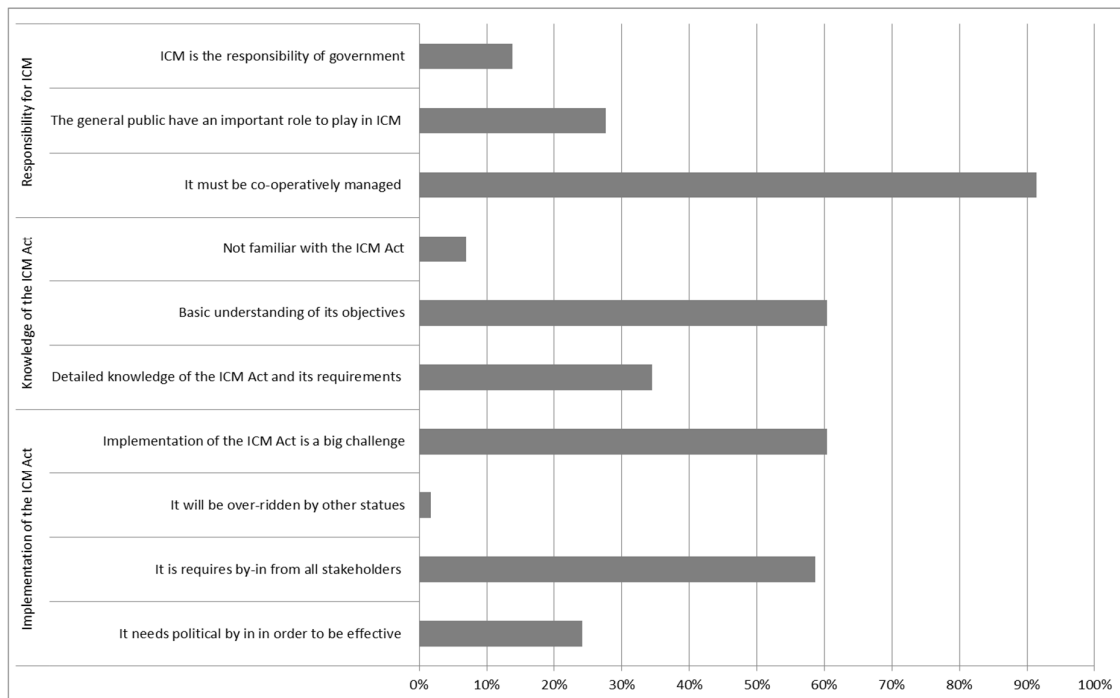


Figure 4.3: Interview respondent’s opinions on ICM and the ICM Act

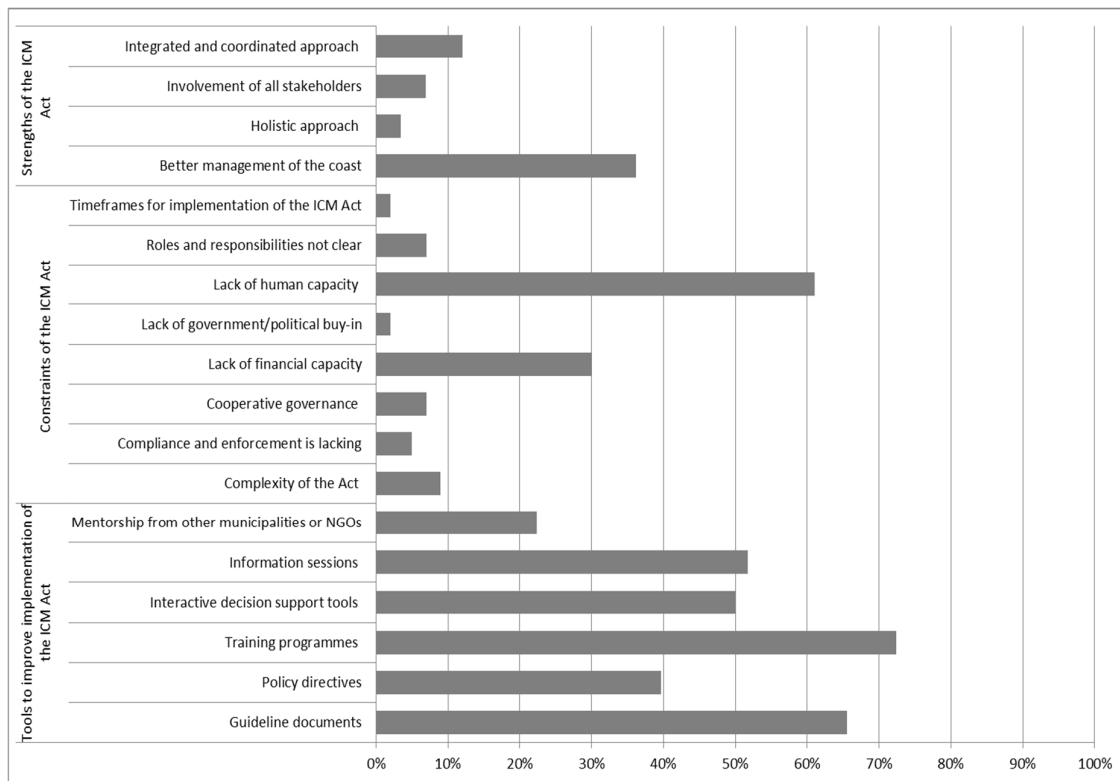


Figure 4.4: Strengths and constraints presented by the ICM Act, and tools to improve implementation as identified by survey respondents

4.4.2. Interview results

Follow-up interviews were held with representatives from each of KZN’s district and local government spheres involved in implementing the ICM Act, represent a diverse range of responses from local and district municipalities with perceived differences in capacity, knowledge and ability to implement ICM and the ICM Act.

Information generated through the interview process was informed by the survey results and is summarised within the DPSIR in conjunction with the survey results (Figure 4.5), with the key points raised being listed in Table 4.1. There was general acceptance by interviewees of the importance of the ICM Act for South Africa and KZN, because it ensures appropriate management of the coast and provides direction or context as to how this can be achieved (Interview respondent, 2014, pers. comm.; Table 4.1). Key governance issues within KZN range from a lack of Provincial government support for local government to human and financial capacity, particularly at the local level (Table 4.1).

Table 4.1: Summary of key comments from interview respondents

ISSUE	COMMENT
Value of the ICM Act	“If we did not have a Coastal Management Act, where would our legal mandate be coming from” (Interview respondent, 2014, pers. comm.).
Implementation	“Implementation of the Act has actually been really slow... (have advocated about certain authorities actually taking some sort of lead, because it’s such a new act there are a lot of municipalities that aren’t really sure what they are supposed to do, even if they know what they supposed to do they not sure they should do it” (Interview respondent, 2014, pers. comm.).
Roles and responsibilities	“...in terms of roles and responsibilities and so on it becomes a ball tossing exercise” (Interview respondent, 2014, pers. comm.).
Human capacity	“... adequate leadership, some of the guys don’t have the right skills set” (Interview respondent pers. comm., 2014).
Financial constraints	“...in government budget is always a problem” (Interview respondent, 2014, pers. comm.).
Provincial support	KZN province has an element of diplomacy...they are saying we won’t dictate to municipalities...they kind of take a back seat in the name of we don’t want to dictate to you” (Interview respondent, 2014, pers. comm.). I’m not sure where province priorities are at the moment” (Interview respondent, 2014, pers. comm.). Province must outline what is required from municipalities and see that it is being done... “Province needs to push, make me say to council ‘province is pushing me’, if province is asking ‘how far are you’ if they don’t do that them I’m unable to (go to council)” (Interview respondent, 2014, pers. comm.). “Nobody at national saying four years have expired where are your plans? Why aren’t you doing this? Why aren’t you doing that? Province why isn’t this thing sorted?” (Interview respondent, 2014, pers. comm.). “Lack of championing from the province” (Interview respondent, 2014, pers. comm.).

4.4.3. DPSIR framework

The ICM Act sets out a framework for the management of the coast and outlines what governments are required to do at the provincial and local levels. The feedback generated through the survey and subsequent interviews inform this study and help develop a cause and effect framework to inform responses and approaches to follow going forward. Figure 4.5 presents this framework and highlights key ‘drivers’ promoted by the ICM Act, such as cooperative governance. It shows the ‘pressures’ that this creates on local government, such as the lack of human and financial capacity to meet this new mandate. This results in a ‘state’ whereby there is a general lack of understanding and coordination which ‘impacts’ the local level implementation; examples include lack of provincial support, timeframes not achieved and a general lack of compliance and enforcement. This ultimately leads to the identification by implementers of ‘responses’ that can aid in meeting the objectives and requirements of the ICM Act, such as the development of decision support tools, training and capacity building and the establishment of coordinating committees.

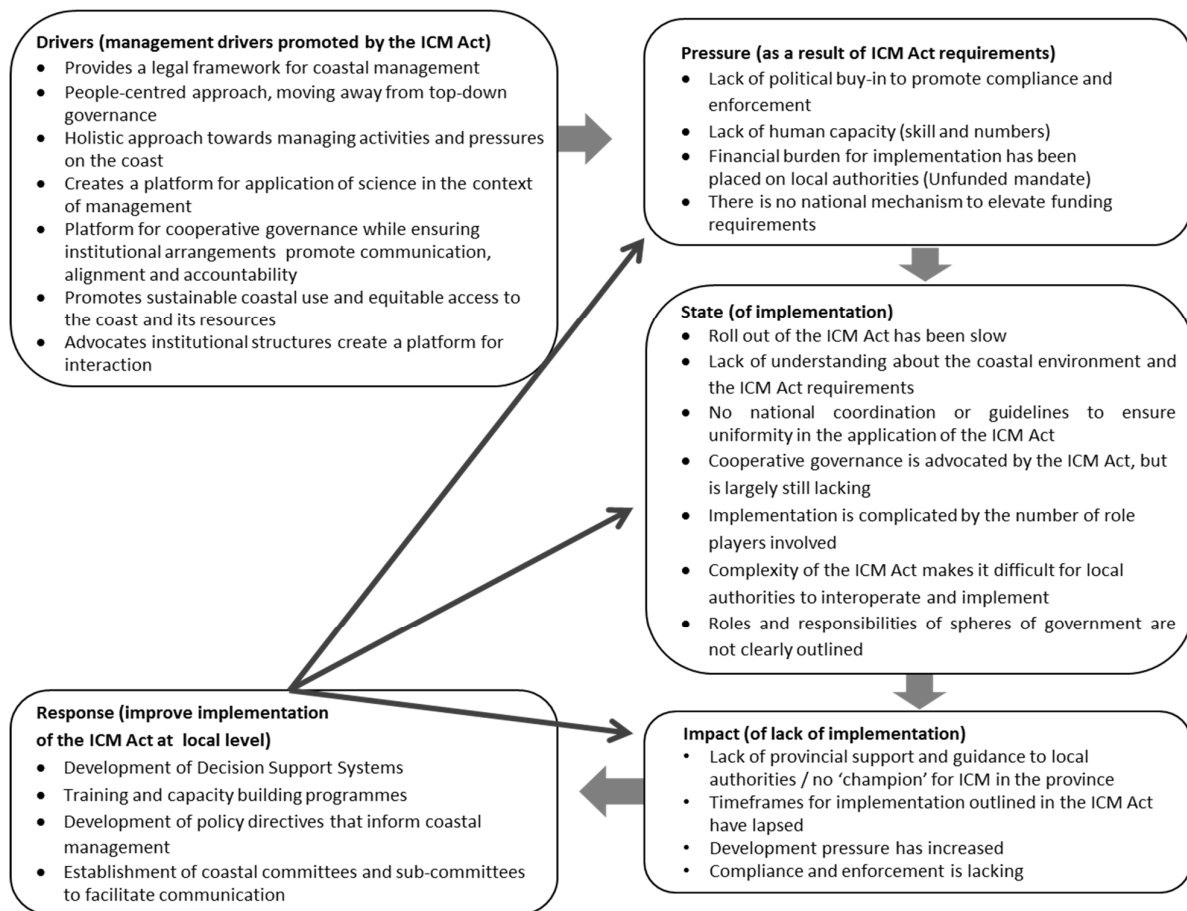


Figure 4.5: DPSIR framework showing respondents' feedback

In terms of responses to address the challenges raised, the effectiveness of these is questionable; as such possible outcomes of the proposed 'response' options are outlined in Figure 4.6. This shows how positive feedback into the management framework can ultimately result in improved ICM implementation.

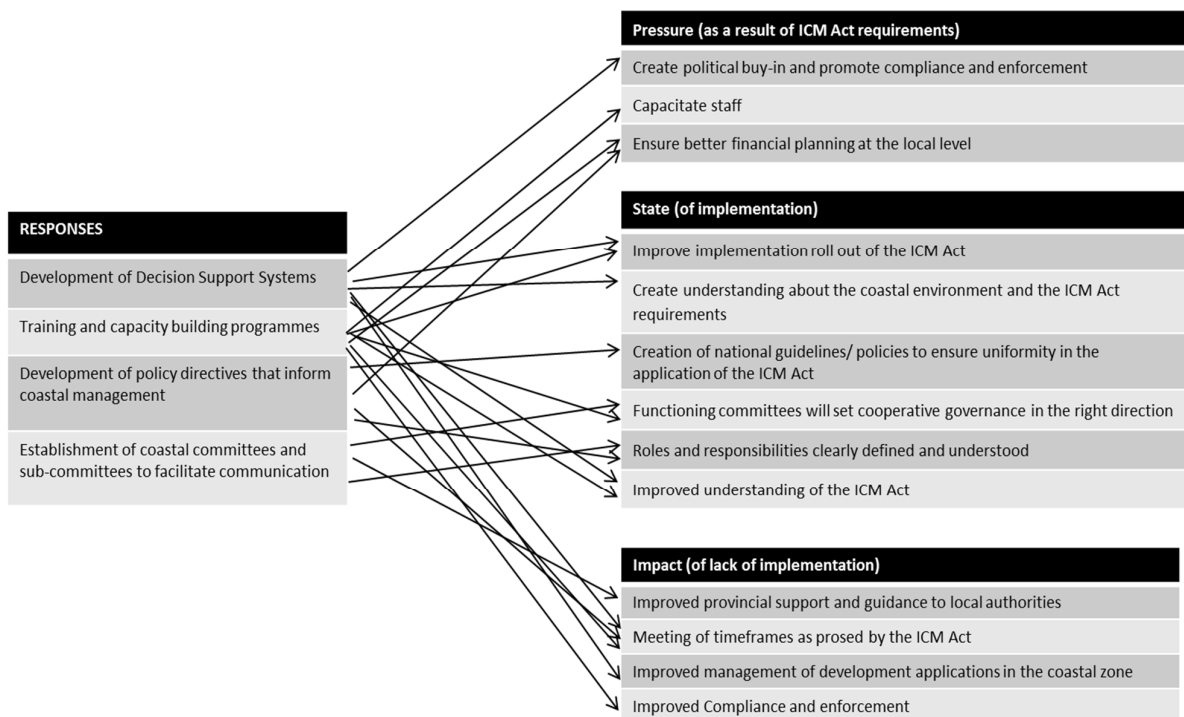


Figure 4.6: How response posed feed back into the DPSIR framework and improves implementation of the ICM Act

4.5. Discussion

One of the main concerns regarding implementation of the ICM Act is local government’s capacity and ability, particularly given that the Act places greater levels of responsibility and powers on local government to achieve ICM. Implementation of the ICM Act has been relatively slow and several milestones required by the ICM Act have not been achieved highlighting that the essence of ICM is known but difficult to translate into efficient, strategically sound action (Olsen, 1996). Lack of tangible achievements for ICM can be attributed to authorities not taking a lead to ensure implementation; particularly at the local level; Celliers et al. (2015) point out that it is unlikely that they (local government) will take a pro-active approach to coastal governance. This, in part, is because “local government is unsure as to what is required of them and how best to meet the objectives of the ICM Act” (Interview respondent, 2014, pers. comm.; Table 4.2). The National Coastal Management Programme for South Africa also identifies capacity concerns as a major threat to sustainable coastal management in the country (Department of Environmental Affairs, 2014). Burning issues identified by interview respondents focus on the value of the ICM Act, its implementation, defining of roles and responsibilities, the lack of human and financial capacity and the lack of governance support from Provincial government (Table 4.2). However these issues are not new, with a lack of funding and institutional capacity and a lack of accountability and administrative responsibility having been

identified as key issues in a 1997 assessment of ICM in KZN (Environmental Advisory Services, 1997). In 1999 the development of a coastal management policy, improvement of the coastal zone information base and capacity building, education and awareness were identified as key actions (Local Government and Housing, 1999); some of which are still the focus of interventions to improve ICM. This raises the question as to what is actually required for successful ICM at the local government level? Are the knowledge requirements and technical skills needed an elusive, unattainable concept? (Celliers et al., 2015).

Table 4.2: The requirements of the ICM Act and progress achieved

Requirement	Progress (2013)	Progress (2016)
Establishment of coastal management lines - An MEC must in regulations published in the Gazette: establish or change coastal set-back lines (25. (1))	None of the provinces have set-back lines in place.	Sections of coast in the Western Cape and Eastern Cape have coastal set-back lines. KZN is working on the determination of coastal set-back lines.
Designation and functions of provincial lead agency - The Premier of each coastal province must, <i>within two months</i> of the commencement of this Act, designate a provincial organ of state to function as the lead agency for coastal management (38. (1))	All four coastal provinces now have a designated lead agent; however this took three and a half years for some provinces.	All provinces except KZN have this in place. KZN environmental affairs changed parent departments and lead designation is no longer valid they are still in the process of trying to obtain re-designation.
Establishment and functions of Provincial Coastal Committees (PCC) - The MEC must within 12 months of the commencement of this Act establish a PCC (39. (1))	There is mixed progress, some provinces have functioning PCC's in place, while others are yet to get this up and running.	All provinces have functioning PCC's in place.
Designation of coastal access land - Each municipality <i>must within four years</i> of the commencement of this Act, make a by-law that designates strips of land as coastal access land in order to secure public access (18. (1))	There is mixed progress, with better capacitated local authorities having identified coastal access and have mechanisms in place to manage this.	There is mixed progress, with the larger Metropolitan areas having made progress on coastal access. KZN Province has made some progress in assessing access as a means of assisting local governments. The metro has determined coastal access, but needs to finalise this.
Preparation and adoption of provincial coastal management programmes (PCMP) - The MEC of each coastal province <i>must within four years</i> of the commencement of this Act, prepare and adopt PCMP (46. (1))	There is mixed progress. While provinces do not have PCMPs in accordance with the ICM Act, that have historical management strategies. National government is in the process of developing a guideline for the development of coastal management programmes.	The Northern, Western and Eastern Cape have PCMPs in place. KZN has a draft PCMP in place, which is still subject to public comment and gazetting (2016).
Preparation and adoption of municipal coastal management programmes (MCMP) - A coastal municipality <i>must, within four years</i> of the commencement of this Act, prepare and adopt a MCMP for managing the coastal zone (48. (1)).	There is mixed progress, with better capacitated local authorities having drafted coastal management programmes. National government is in the process of developing a guideline for the development of coastal management programmes.	Some municipalities have MCMPs in place. In KZN the metropolitan, 2 District and 2 local municipalities have completed MCMPs.
Information and reporting on coastal matters - The MEC must prepare a report on the state of the coastal environment in the province every <i>four years</i> , which must contain any information prescribed by the Minister (93. (2)).	To date none of the coastal provinces have completed this reporting.	National has undertaken to facilitate some coordination amongst provinces. KZN and Western Cape have developed a draft list of indicators that need to be reviewed by National.

KZN, as with the rest of South Africa, has seen a number of governance changes and organisational restructuring which has resulted in alterations to respective mandates. In 1999, the then Department of Local Government and Housing (responsible for environmental management) recognised that to improve management of the KZN coast there needed to be a high degree of information sharing and awareness regarding the coastal environment (Department of Local Government and Housing, 1999). To assist with capacity issues, the South African government has invested significantly in capacity building programmes across sectors and spheres of government (Peters and Van Nieuwenhuyzen, 2012). One of the current initiatives is the shared services programme, which is present in the Uthungulu and iLembe Districts (Figure 4.1), “*whereby support is provided to local municipalities with no in-house capacity for environmental management within their jurisdiction*” (Interview respondent, 2014, pers. comm.). The shared services programme was initiated by the Department of Local Government and Traditional Affairs to provide district-wide development planning shared services support for local municipalities. The programme aims to overcome capacity gaps in the planning function in municipalities and to ensure sufficient capacity in municipalities given the delegation of planning functions to municipalities (Department of Local Government and Traditional Affairs, 2009). This initiative helps at the strategic and broad management levels, but does not deal with daily management issues facing local government personal. Thus, there is a need for capacity building at the local government level and better support from provincial governments to assist them with meeting the requirements of the ICM Act and general coastal management (Interview respondent, 2014, pers. comm.). However the current state of implementation is that the “*provincial support appears to follow a precautionary approach, portraying an element of diplomacy and not dictating to local municipalities what they should be addressing in order to meet objectives of the ICM Act*” (Interview respondent, 2014, pers. comm.; Table 4.2). Local municipalities feel that provincial government should be “*championing coastal management; for example, while all districts have coastal working groups in place that meet to discuss coastal management issues, these are poorly supported and often cancelled or postponed*”. It is evident that there is a “*lack of championing from the province*”, “*If province applied some pressure on local municipalities more action would be evident*” (Interview respondent, 2014, pers. comm.; Table 4.2).

According to the National Planning Commission (2014) problems of uneven capacity and varied performance are acute at local government level. These problems can be expected with the current local government system having only been in place for just over a decade, and inevitably challenges remain to be addressed (National Planning Commission, 2014). It is clear, from municipal performance reviews, that greater attention needs to be given to local municipalities to assist with the

fulfilment of their core functions (National Planning Commission, 2014), “*with clarity on roles and responsibilities being required*” (Interview respondent, 2014, pers. comm.; Table 4.2). The question is how is this to be achieved, given funding constraints (identified by 30% of respondents) and the interpretation that at local government level this is an unfunded mandate (Figure 4.5), which makes implementation difficult? Limited human capacity and support from provincial government has resulted in reliance “*on external consultants to deliver on coastal projects*” and mandates (Interview respondent’s pers. comm., 2014). This raises other questions around financial capacity, as “*...government budget is always a problem*” (Interview respondent, 2014, pers. comm.), and it can be argued that the use of consultants is not a cost-effective approach to meeting deliverables and mandate. Instead it is suggested that governments should be exploring opportunities to improve internal capacity, or develop partnerships with CBOs and NGOs, both from a human capacity aspect and in terms of possible funding. Christie (2005) identifies that external funding of projects is one of the main means of implementation of ICM within developing countries. Furthermore, they have the ability to focus attention on ICM issues, generating awareness and support as the shift in legislation itself cannot ensure effective governance; it can only set the platform for cooperative governance and partnerships.

The question is raised as to whether we should be looking beyond government structures for solutions and call on the conservation agencies, CBOs and NGOs, the general public etc. to play their part in facilitating better, holistic ICM? In so doing, this advocates a bottom up approach to ICM, whereby coastal communities are integral to the management of ‘their’ environment, through a people- centred, pro-poor ICM approach (Glavovic, 2006). Cooperative governance is in part legislated through the ICM Act whereby the establishment of a Provincial Coastal Committee (PCC) is mandated and should be made up of both government and non-government representatives; experts in the field of ICM, community based and non-government organizations and scientific or coastal research institutes. The PCCs function it is to promote a co-ordinated, inclusive and integrated approach to coastal management within the province by providing a forum for, and promoting, dialogue, co-operation and co-ordination between the key organs of state and other persons involved in coastal management in the province. However, determination of a new Act in itself will not ensure good governance, nor will it mobilize communities and facilitate bottom-up, integrated management. Leadership is needed from the ‘top’ that can focus on the problems that need to be addressed at all levels of government. It is only through this process that alternative approaches can start to take shape and management will shift to a community-government partnership approach (Lowry et al., 2005). Nordstrom et al. (2009) show the effectiveness a local authority can have being the driver of changes

in management. The Avalon Island example shows how a local authority can take the lead and go beyond the minimum state requirements for reducing coastal hazards and protecting resources. They have educated residents and obtained buy-in which ensures long term sustainability and an integrated management approach.

While training programmes were identified as a significant tool to improve knowledge, capacity for government officials (Figure 4.5), focus on training should be cautioned due to the relatively high staff turnover (Interview respondent, 2014, pers. comm.; Deloitte and Touche, 2013). A further concern is that there is increasing difficulty in attracting skilled personal such as engineers and spatial planners (Deloitte and Touche, 2013). More recently there is a notable trend towards qualifications in earth and environmental science, focused on geography, environmental science or environmental management. These fields are more general and move away from the applied life sciences or specialist fields; a trend identified by Deloitte and Touche (2013). Alternative capacity building approaches such as short courses, mentorships and development of decision support systems should also be considered. It is important to note that there is “*varied capacity amongst the district and local municipalities*” (Interview respondent’s pers. comm., 2014), and encouragingly, many local municipalities are making progress despite financial and human resource issues (National Planning Commission, 2014; Interview respondent, 2014, pers. comm.). Evidence of this is the highly capacitated metropolitan, which has met most of the deadlines imposed by the ICM Act, only being constrained in areas that required input from other spheres of government (Interview respondent, 2014, pers. comm.). This further highlights concerns which see provincial support as a hindrance to effective implementation of the ICM Act. Most local municipalities are struggling to meet the requirements of the Act and are overwhelmed by the requirements placed on them to achieve certain targets within certain timeframes. For example, the development of a Municipal Coastal Management Programme and provision of coastal access land within four years of the commencement of the Act was required. The reality is that no local municipalities have met these deadlines.

There are a number of challenges that have been identified, the main challenge being implementation of legislation. The ‘responses’ highlighted in this paper can lead to improved implementation should they be undertaken in the correct manner (Figure 8). The most achievable actions are to implement training and capacity building programmes and to develop support tools that can assist in decision making.

4.6. Conclusion

Government capacity determines the effectiveness and efficiency of ICM implementation. While access to resources to increase staffing and budgets are difficult to obtain, there are alternative approaches that can aid in bridging the knowledge and understanding gap. Some alternative approaches identified by this study include: training programmes, guideline documents, information sessions and decision support systems that can inform and streamline the decision-making process.

The ICM Act advocates an integrated, holistic approach to management of the coast, however implementation and the delegation of authority to local and district municipalities is where the greatest challenges are being identified. From the KZN experience there have been a number of challenges and missed milestones to date. There needs to be consideration of various alternatives, such as partnerships with conservation agencies, CBOs, and NGOs and local communities to play their part in facilitating better, integrated coastal management. This in itself poses challenges over the short term. However legislation, in itself, cannot ensure cooperative governance. Thus, in terms of governments' current implementation standing, provincial government must take a lead to shape the implementation of ICM in KZN. It is anticipated that should provincial government champion these campaigns it will ensure buy-in and participation from district and local governments and ultimately communities, leading to effective community-government partnerships. In turn this can ensure a better understanding of the coast and ICM in general, creating efficient and effective management of KZN's coastal environment.

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CHAPTER FIVE: DESIGN, DEVELOPMENT AND IMPLEMENTATION OF A DECISION SUPPORT INFO-PORTAL FOR INTEGRATED COASTAL MANAGEMENT, KWAZULU- NATAL, SOUTH AFRICA

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Abstract

Coastal environments face mounting pressures from development and resource use, and appropriate coastal management supports long-term ecosystem functionality, viability and delivery of goods and services. Integrated Coastal Management (ICM) is advocated as a best practice approach to achieving this, but comes with its own challenges. Given the diverse nature of the coastal environment and the goods and services it offers; its management is complex. In South Africa, this is exacerbated by the legislative framework which delegates numerous responsibilities to local government without providing financial or human capacity to meet these requirements. These challenges have resulted in the development of a number of guidelines in support of achieving ICM objectives. This paper focuses on one coastal region in South Africa, KwaZulu-Natal, which is grappling with coastal management issues, including the implementation thereof for a 580 km coast with 76 estuaries. It considers the progressive, iterative development of an innovative Decision Support info-portal to assist local coastal managers in the absence of human capacity support and tools. Stakeholders were asked to complete a survey to provide feedback on their impression of the tool, its functions and usability. This facilitated stakeholder input into the info-portal development, which was essential in ensuring that the end product is useable, relevant and supportive of coastal management and decision making. Since its public release, the Decision Support info-portal has been implemented and utilised by government officials for both ongoing management and emergency response within the KZN province.

Key Words: Integrated Coastal Management, Governance, Web-based DSS, Information portal

5.1. Introduction

The coastal environment and the resources it offers are in demand for multiple and often competing users and activities; including industrial development, subsistence livelihoods, recreation, tourism, residential space, waste disposal, water extraction, conservation and protection. These conflicting activities can result in incompatible land and coastal space utilisation (Kay and Alder, 2002). These pressures bring with them socio-economic and political concerns and environmental stress leading to land degradation, pollution and ecosystem destruction (Leatherman, 2001). These are exacerbated by the long-term threats posed by climate change including sea-level rise which could cause damage or loss of coastal infrastructure, ultimately affecting the economy of these areas, ultimately affecting local-level water and food security. In spite of these known risks and hazards, in many developing countries there continues enormous pressure to develop remaining coastal open spaces (Ugu District Municipality, 2011). These challenges have, in part, led to coasts being identified by the Sustainable Development Goals (SDG) (Goal 14) as an area of focus, which highlights conservation and sustainable use of oceans, seas and marine resources. This SDG focus aims to develop effective strategies to combat adverse effects of overfishing, growing ocean acidification and worsening coastal eutrophication through the expansion of protected areas, increased research capacity and ocean science funding (United Nations, 2018).

Key to achieving this is the capacity or ability of coastal nations to support these international goals. However government, particularly local government, has the unenviable task of balancing the delicate tightrope of appeasing all user groups while at the same time ensuring the long-term productivity and sustainability of the natural coastal environment. Over time, to address multiple players and issues, Integrated Coastal Management (ICM) emerged and with it, the development of coast-specific policies and legislation to facilitate robust coastal management (Beeharry et al., 2014). Integrated Coastal Management is aimed at ensuring a balance between coastal demands from socio-economic activities and a supportable ecosystem functionality level (Beeharry et al., 2014). This has been

achieved by creating institutions that support decision-making with the best knowledge available, traditionally through the integration of natural and social science within the political decision-making process (Bremer and Glavovic, 2013). Many coastal countries now have dedicated coastal management legislation but are faced with the ongoing challenge of implementing and enforcing this legislation in a vacuum of limited human and financial capacity. South Africa is one such country, grappling with the sustainability of coastal resource and natural service benefit and the implementation of a specific coastal management Act (ICM Act). The South African Integrated Coastal Management Act (Act 24 of 2008) took ten years to develop and is considered internationally to be an exemplary policy, being shortlisted for the prestigious 2012 World Future Policy Award (DEA, 2012a). However, the implementation of this legislation has been described as an ‘elusive pursuit at best’, with destruction and degradation of coastal ecosystems continuing unabated (Glavovic, 2006).

Given the diverse aspects of socio-ecological systems to be accommodated in coastal management, the application thereof has historically been fragmented in South Africa, with different government departments and governance spheres playing various, often overlapping, roles (Goble et al., 2014a). This has led to conflict and provoking lack of action as departments have different mandates and management objectives (Wynberg, 2000; Sale et al., 2008) with no individual or unit willing to take the lead for coordination of coastal management issues, given concerns or acknowledgement of other departments mandates. This is exacerbated by coastal management being often undertaken in the context of lack of personnel and financial capacity (Cicin-Sain and Knecht, 1998; Goble et al., 2017; Jameson et al., 1995). In many cases, decision makers are required to consider various issues that require a basic understanding of the topic, such as pollution and its environmental impacts, climate change projections and predicted impacts, and social and human behaviour dynamics, some of which are beyond the mandate or skills level of the decision makers (Westmacott, 2001). While scientific data or studies often exist in support of ICM, they are not presented in a manner that can be digested

by decision makers. Thus there is the need to explore innovative ways to share this information and assist decision makers in the coastal decision-making process. One approach is the use of Decision Support Systems (DSS) or Decision Support Tools (DST) to support ICM, the aim of which is to assist individuals or groups in their decision-making process by supporting the individual's judgement and improving understanding of inter-relationships between natural and socio-economic variables (Janssen, 1992; Westmacott, 2001). While several coastal DSSs have been developed, few are simple and easy to use for decision makers to evaluate and manage local systems (Torresan et al., 2016). Furthermore, a number of these focus on one aspect of ICM, and there is a growing need to provide a platform that supports the spectrum of ICM needs, uses, users and activities.

This paper focuses on one of four coastal regions in South Africa, KwaZulu-Natal (KZN), and the development of a region-specific coastal management tool. The tool draws on a range of scientific data to create a 'one-stop' information portal for KZN coastal decision makers, managers and users to bridge the science-management gap, where scientific data and information exists but is not conveyed appropriately to managers. KwaZulu-Natal supports a population of approximately 11 million permanent residents (Statistics South Africa, 2015), many of whom live within the coastal zone and depend on its resources for their livelihoods and subsistence. Furthermore, the region experiences significant seasonal tourist population increases, significantly more than the three other coastal regions in South Africa, predominantly driven by the year-round warm weather and coastal water temperatures. These pressures result in the coast being exposed to a number of anthropogenic pressures, impacts and risks that require sound ICM underpinned by robust scientific information. Goble et al. (2017) undertook a needs assessment of current ICM capacity at the local government level and found human and financial capacity lacking, with the exception of the largest Metropolitan – eThekweni, which has a number of ICM staff and sufficient budget allocation. This raises concerns about the level of achievable management implementation, exacerbated by the fact that the ICM Act places greater responsibility on local government to achieve ICM. To date, implementation has been

slow with many milestones not being achieved. This lack of achievement is attributed to capacity limitations and authorities not taking a lead in facilitating implementation at the local level (Goble et al., 2017). Local government is unlikely to take a pro-active approach to coastal governance (Celliers et al., 2015), as they have limited capacity for implementing ICM (Goble et al., 2017). This has led to innovative solutions to support coastal decision makers in KZN, to improve capacity and understanding of socio-ecological coastal aspects and to provide spatial tools to support the decision-making and management process.

This paper considers the current ICM challenges in KZN, the steps required and followed to develop a support tool for improved information sharing and decision-making. It considers the best approach to follow and the steps utilised. A series of surveys were used by this study as a means of gaining feedback from authorities, decision makers and general coastal users throughout the development process.

5.2. Review of existing tools in support of ICM

The complexity of the coastal environment and the management thereof has led to science-based approaches that inform coastal management (Bremer and Glavovic, 2013). In turn, coast specific DSSs or DSTs have been developed to aid in the interpretation and usability of these science-based solutions and assist in broadening people's perceptions and understanding of the wider issues (Westmacott, 2001). Traditionally DSS models are developed for a single component of the ICM decision-making environment, such as ecology or economics, focusing on spatial or non-spatial aspects. Seldom are these combined to consider economic-ecological systems that involve multiple decision makers and multiple issues and disciplines (Westmacott, 2001). Van Kouwen et al. (2008) define ICZM-DSSs as "computer-based systems containing information on ICM issues, designed to perform analysis that supports coastal managers". Given the complexity of the coastal zone, the application of DSSs for coastal management has been limited (Wiggins, 2004), and in this context

have declined since the 1990s (Van Kouwen et al., 2008). This is likely a result of un-usability, with a mismatch between the complexity of the information generated by the tools and the users' ability to interpret the information (Uran and Janssen, 2003). Westmacott (2001) points out that a number of coastal DSSs are not used because the users were not involved in their development or the outputs that they deliver.

Decision Support Systems range in application and complexity, depending on the associated information and features being addressed by the system and the context within which it is being applied. As determined by the needs of the target audience, the intended use and the data being conveyed. There are a number of examples that illustrate the diversity of applications in the context of environmental decision making. 1) The UK Environment Agency offers a range of interactive maps to inform users about the availability of environmental data for England at the local level, including risk of flooding from rivers and the sea, coastal erosion and live flood warnings (Environment Agency, 2013). 2) The United States Environmental Protection Agency (EPA) offers an EnviroMapper which provides relevant environmental information and associated data (United States Environmental Protection Agency, 2016). 3) The US National Oceanic and Atmospheric Administration (NOAA) Centre for Environmental Information offers interactive map information on climate indicators such as drought and precipitation, surface maps and time-related maps, which present monthly, daily and hourly information on climate (NOAA, 2015). 4) The Canadian Government hosts an interactive indicator maps portal that shows environmental data relating to air and water quality (Government of Canada, 2015).

There are less specific coastal DSSs including COSMO (COastal zone Simulation MOdel) and RamCo (Rapid Assessment Module for Coastal Zones) (Misdorp, 2011). However, they do not cover the entire ICM spectrum; COSMO is a computer GIS-based model that assists coastal zone managers to become more familiar with methods for evaluating potential management strategies under different

scenarios, including long-term climate change (Misdorp, 2011). RamCo aims to provide a rapid, integrated assessment tool for ensuring sustainable solutions for coastal zone management, providing information on natural and anthropogenic processes in a coastal zone under the influence of the dynamic behaviour and interaction of agents (Misdorp, 2011). Area-specific DSSs offer a range of data and information, but predominantly focus on the natural coastal environment. For example, OzCoasts (ozcoasts.org.au), is an online information repository that provides a wide range of comprehensive information about the Australian coast (Geoscience Australia, 2015). It includes conceptual models of pressures and ecosystem function, information on coastal indicators, habitat mapping, natural resource management and landform and stability information, and informs natural resource managers, marine scientists, planners, policy makers and the general public (Geoscience Australia, 2015). The North Carolina Coastal Atlas is a collaborative effort that enables access to coastal data and informs coastal managers, scientists, students and the interested public about the coast of North Carolina. It includes a wide range of information from geospatial data to visualisation tools and thematic maps focused on coastal resources and hazards (North Carolina Coastal Atlas, 2016). Zanuttigh et al. (2014) reviewed a range of existing ICM DSSs related to vulnerability, impacts and risks, and identification and evaluation of related management options. This led to the development of THESEUS DSS (www.theseusproject.eu), which is a comprehensive open-source GIS-based DSS developed to help decision makers in minimising coastal risks (Zanuttigh et al., 2014). The DESYCO (DEcision support SYstem for Coastal climate change impact assessment) tool is a DSS focused on the assessment and management of multiple climate change impacts on coastal areas (Torresan et al., 2016).

These DSSs focus on specific ICM issues and offer useable solutions, but do not address the ongoing daily ICM challenges experienced at the local level, such as managing coastal access, reviewing coastal development applications and enforcement of the ICM Act. In the South African context, efforts to address these challenges have focussed on developing various guideline documents at a

national level with the aim of directing or supporting local level implementation and enforcement. These include; the User Friendly Guide to the ICM Act (Celliers et al., 2009; DEA and Royal Haskoning DHV, 2017), the ICM Act Enforcement Manual (DEA, 2011), a guide to the development of coastal management lines (DEA, 2017), and a guide to the development and implementation of Coastal Management Programmes (DEA, 2012b). Furthermore, there is a National Estuarine Management Protocol (DEA, 2013) which outlines the minimum requirements and procedures for developing an estuary management plan. The national government has tabled the development of a number of other guidelines such as for the adjustment of coastal boundaries, the development of coastal planning schemes, stabilisation and rehabilitation in the coastal zone, and procedures to prevent/remove unlawful structures in the coastal zone (DEA, 2014a). In addition, there have been some specific topic-driven spatial tools, or basic DSSs developed. Each focuses on a single aspect of ICM, notably the off-road vehicle (ORV) DSS, a Coastal Viewer and an Ocean and Coastal Information Management System (OCIMS) under development. The ORV DSS assists the permitting authority in the ORV permitting process (DEA, 2014b), and the Coastal Viewer is a spatial data repository aimed at providing data in support of ICM and the objectives as described in the National Coastal Management Programme of South Africa (DEA, 2014c). These guidelines document and DSS-type tools form the basis for of current DSS framework in South Africa.

However, KZN is in itself different to other coastal provinces in south Africa, given its subtropical climate, number of estuaries, high coastal population and development intensity. Resultantly these generic documents don't support the situation within KZN. For KZN specifically, an 'understanding our coast' guide was developed (2010), 'Ugu Lwethu – Our Coast, a profile of coastal KZN' (2014) (Goble et al., 2014b) and an annual coastal newsletter is produced, all of which focus on awareness and education for government and non-government. In 2010, an interactive coastal vulnerability DSS was developed to aid decision makers with issues relating to development with respect to risk and vulnerability (CVI viewer). The tool was developed based on a desktop assessment of key physical

parameters of natural coastal risk namely; beach width, dune width, distance to the 20m isobath, distance to vegetation behind the back beach and percentage rocky outcrop (Palmer et al., 2011). At the time, the CVI viewer was a unique tool offered to KZN coastal decision makers. It was well utilised and has informed decision-making along the KZN coast (Palmer et al., 2011). However, the CVI viewer was limited in that it focused on only risk and vulnerability in relation to storm surge and extreme erosion, ignoring other ICM challenges. Decision makers expressed the need for a more integrated platform that could better facilitate all aspects of ICM.

Notwithstanding its large population, The KZN coast experiences significantly more anthropogenic pressures than the other three South African coastal provinces. These pressures result in a range of management challenges that current limited human resource capacity cannot adequately address (Goble et al., 2017). This is where the need for a streamlined information support system became evident; whereby all relevant ICM data and information is housed for ease of access to inform decision making.

5.3. Methods

Having considered the limitation of topic-specific DSS tools in meeting general ICM management challenges and the needs of local managers, the development of a more general ICM Decision Support info-portal (hereafter referred to as info-portal) was identified as being more relevant for KZN, in light of the capacity shortage at the provincial and local levels identified by Goble et al. (2017). Additionally, Glavovic et al. (2018) note that failures of provincial government adversely impact coastal sustainability at the local level. The aims of the proposed info-portal are to bridge the capacity gap and support the translation of ICM into efficient, strategically sound action (Olsen 1996). A second challenge is that ICM decision-making in KZN occurs within a framework of limited available, accessible data; primarily due to limited financial resources to access or acquire these. Nevertheless, the proposed info-portal offers a ‘one-stop’ information hub that houses reports,

legislation, distilled information and visual data in the form of spatial layers that can inform the ICM decision-making, distil this and present it to users in a simple user-friendly format that is understandable and useful to decision makers.

The development of the info-portal followed an adapted version of the DSS lifecycle development as outlined by Turban et al. (2005), whereby six steps were followed; 1) need, 2) planning, 3) analysis, 4) development and design, 5) implementation and 6) evaluation. The lifecycle was refined for the info-portal to engage with key stakeholders and the target audience at strategic steps of the info-portal development. This process is iterative with any of the six steps being revisited through the development lifecycle of the DSS (Figure 5.1) (Turban et al., 2005). A critical step being the evaluation phase as this allows for the engagement of the target audience and informs refinement of the info-portal. As such, our refinement resulted in two key phases in which consultation with various stakeholders resulted in re-development and re-design of aspects of the info-portal. This phased approach ensured that relevant, available information was considered in the decision-making process (Turban et al., 2005).

Evaluation was undertaken by means of user-feedback from targeted users. The feedback informed changes and refinements to the tool, insuring an improved info-portal. For a DSS or DST to be useful and successfully implemented, it must consider the needs of the end user and involve them in the development process (Courbon, 1996). Feedback from users was received by means of a survey, following a structured approach.

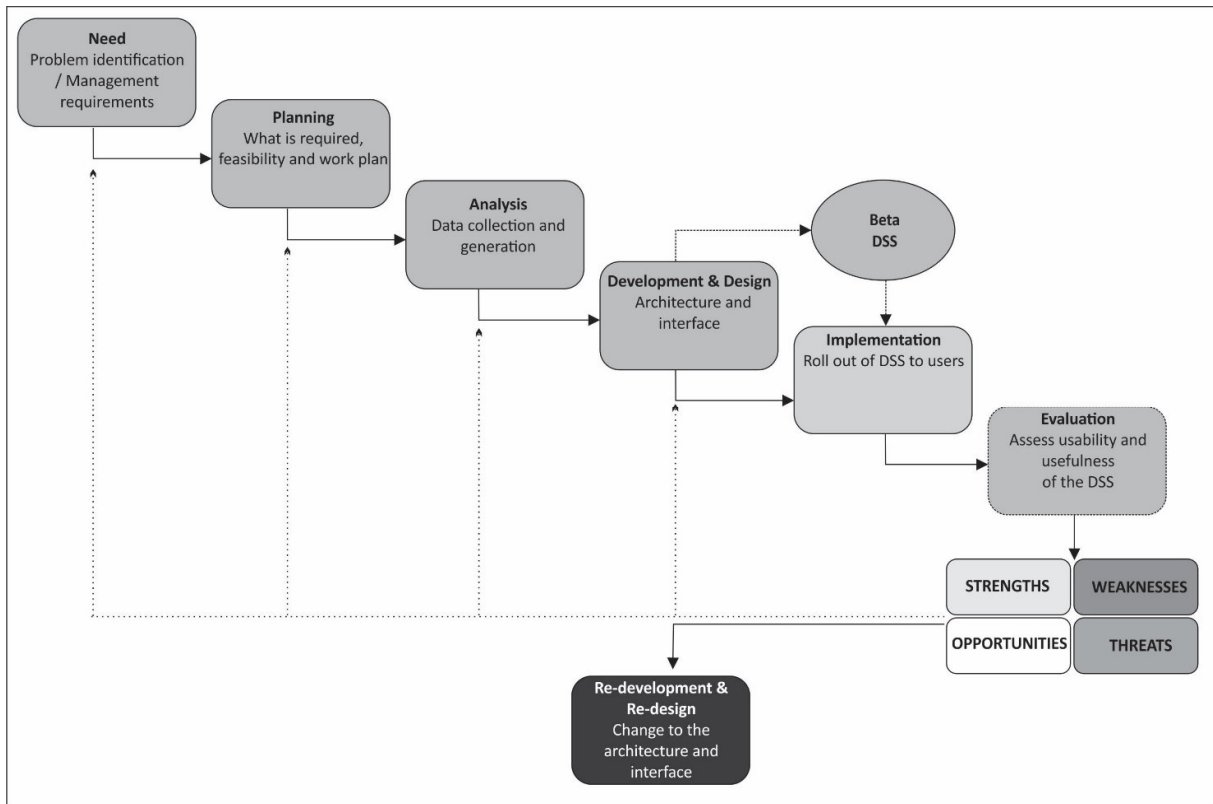


Figure 5.1: Framework for developing an ICM Decision Support info-portal (Adapted from Turban et al., 2005).

For Beta testing of the info-portal, a selected test group (n=50) were chosen to represent a diverse range of users. Representation from seven sectors, namely; researchers related to the field of ICM, researchers not related to the field of ICM, local government officials, provincial government officials, national government officials, general or public user related to field of ICM⁵ and general or public user not related to field of ICM⁶. Selection for each of the sectors was based on individuals' knowledge of support tools and ICM and willingness to participate in the test phase. Literature suggests that for pilot testing a test group should represent 10% of the projected user group (Connelly, 2008), while Hill (1998) suggested 10 to 30 participants for a test groups is adequate, thus the test group of n=50 was considered sufficient. Engagement with the study test group, representing key

⁵ Members of the public that have some understanding of coastal issues and management. E.g. people involved in coastal conservancies

⁶ Member of the public that has an interest in going to cost, extracting resources etc., but no knowledge of coastal management.

stakeholder groups of ICM in KZN, assisted targeted feedback on the DSS to refine and improve the system prior to release to all users. These refinements are discussed further.

The test group were requested to use the tool for a minimum of two hours, accessing various pages, themes, topics and tools. They were then requested to provide honest comment and feedback on their overall impression, the aesthetic impact, the information presented, and functionality of the tool by completing a survey which outlined a set of guided questions. As this work forms part of an ongoing project, all survey questions were considered and approved by an ethics committee, while anonymity of survey and interview respondents was guaranteed. Feedback was required within a specified timeframe so that changes and tool refinement could proceed. Feedback from the test group was captured and assessed to undertake refinement of the tool before releasing the info-portal version 1 to all users. Feedback was synthesised and assessed within a SWOT (Strengths, Weaknesses, Opportunities and Threats) matrix to inform changes and refinements. The matrix helps reveal weakness and potential threats to the successful implementation, while at the same time highlighting strengths and potential opportunities through refinement of the tool.

5.4. Results & Discussion

The initial need for a KZN DSS for ICM became evident through engagement and consultation with government officials and decision makers relating to their daily management requirements for ICM (Goble et al., 2017). Goble et al. (2017) found that managers need access to a wide range of information to inform the decision-making process. A key problem is that materials ranged across electronic and printed media and were spread across government departments, independent studies, universities and accessing data and information can be problematic and could require significant processing and require expert familiarity with data subject matter. Following a participatory approach with stakeholders, officials and decision makers, the identified needs included the type and format of data, the platform for presentation and the look and feel required. 1) Spatial data, including vector layers

such as place names, coastal risk lines, cadastral boundaries and coastal access routes, and aerial photography, current and historical presented in an understandable interactive format was important to users. This information is important to users as it shows visible integration of data and information that can be better used to underpin locational issues; this is particularly important in making decisions regarding new developments. 2) Non-spatial data, such as legislation, technical reports and contact information, related to daily management objectives. 3) Processing and presenting information and data in an easily accessible platform. In summary, a ‘one-stop’ tool or information portal for ICM in the province was conceptualised that could, in a unique approach, bring together a range of spatial and non-spatial data and information.

Planning focussed on what steps would be required to address the implemented the aforementioned needs and for the province (Figure 5.2). It was determined that the knowledge required by decision makers could be ascertained by including the following:

1) Legislation and policy documents: copies of relevant national legislation, regulations, policies, planning documents, guideline documents, bylaws and management plans are housed on the info-portal for ease of access for users. For each document, a summary overview is provided to outline the value and use of the specific document (www.coastkzn.co.za/Governance).

2) Thematic areas for ICM: Key ‘hot topics’ identified through engagement with stakeholders, officials and decision makers were identified and presented in a simplistic user-friendly format. Topics include, but are not limited to; coastal vulnerability, coastal access, coastal erosion, estuaries, pollution and pressures on the coastal environment (www.coastkzn.co.za/Themes).

3) Spatially relevant data: A unique dedicated spatially referenced interactive map was established through the development of this hybrid tool offering non-spatial and spatial information. Included are spatial layers that aid the decision-making process such as estuary location, type, name, estuary limit, water surface area through time, coastal management (set-back) lines, areas of high, moderate or

decision makers to coastal events, cadastral boundaries, conservation areas and the location of key recreational activities (maps.coastkzn.co.za/viewer/).

4) A section on help or hot topics: how to apply for permits, who to contact in the event of oil spills or fish kills, what to do if you see an illegal activity and contact details for coastal authorities.

All data and information included has been generated through short to long-term research or monitoring projects, some in partnership with government, ensuring that each component presented has a scientific, data-validated foundation and has undergone authentication prior to inclusion. The task team reviewed possible platforms through which the tool would be made available to end-users. It was determined that a website was the most effective delivery and consumption method as the majority of users have internet access. This would allow for the tool to be constantly updated and for users to access the most up-to-date data and information.

The analysis step (Figure 5.2) focused on sourcing data, reports and other relevant information for the tool that would be useful in decision-making; including legislation, policy documents, a help guide for ICM, definitions and terminology, spatial data and a number of easy to use resources. The development and design phase focused on two web-based platforms for presenting the data and information; one being a user interface allowing access to documents, reports and other ICM information, the other focused on a spatial component that allows users to see sections of coast and integrate and interpolate spatial data (Figure 5.2). For the architecture of the info-portal, expert programmers were consulted to develop the platform. The data and information presented were assessed, assimilated and adapted to create simple, easy to understand products for inclusion rather than number-heavy outputs which are difficult for decision makers to interpret.

The info-portal was developed through a participatory, consultation process with those that will use and benefit from the tool. However, the manner in which it is structured and hosted allows for the

info-portal to be independently maintained and managed by an NGO, thus ensuring information and data presented remains unbiased and unaffected by the political climate. Additionally, it is facilitated by a government-NGO partnership, where government offers financial support for the maintenance of the site and the NGO the expertise and capacity to development and maintains it. The risk is that the functioning of the info-portal relies on this relationship and if funding is discontinued so with the info-portal. The expectation being that this will result in the long-term sustainability of the info-portal for all users. Nevertheless, given the independent nature of the tool, there is no legal requirement for government officials to utilise it or the data it presents. To encourage its adoption as part of the information-gathering and decision-making processing, a large focus was placed on participation to allow stakeholders input into what should be presented by the info-portal, making it more likely that they will utilise it and its functions.

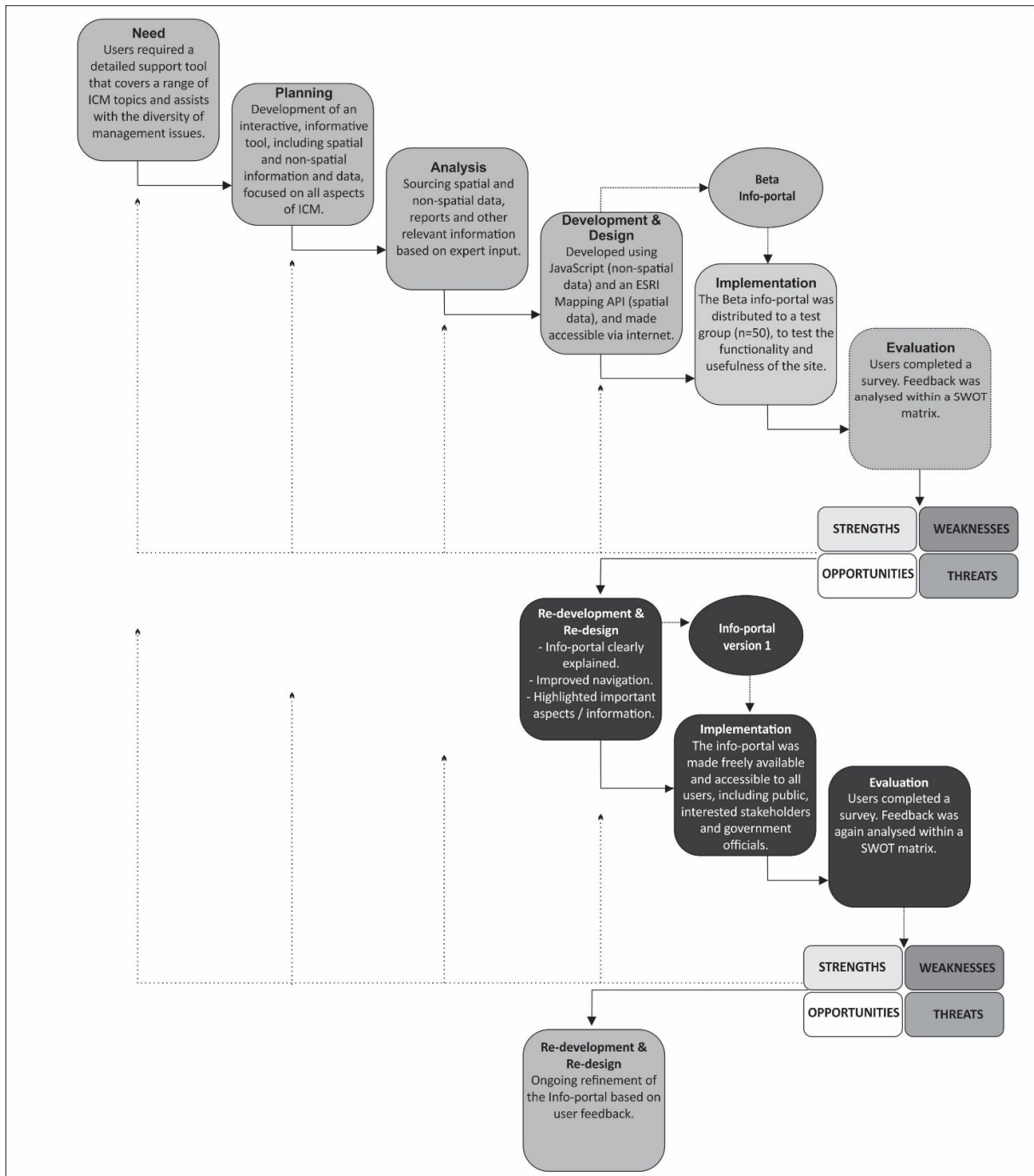


Figure 5.2: Resultant iterations of development of the ICM info-portal for KZN, South Africa

During Implementation (Figure 5.2), the Beta info-portal release to the test group (n=50) for use and interrogation yielded 21 responses (42% return), with representatives from each group (Table 5.1). The highest response was received from general users related to field of ICM (86%). There was no response from national government, and only one response from a general user not related to the ICM

field (25%), this is likely as a result of these tool having limited relevance to these user groups. In spite on numerous efforts to gain feedback from government officials, the response from local government officials remained low (30%), this is of concern given that the tool is development predominantly for these officials. In spite of repetitive attempts to gain these users’ feedback, none were received. Importantly this does not mean that they have not looked at or utilised the tool, but only that they have selected to not fill out the survey. This is validated by the number of registered users, whereby half of 132 registered users are government officials.

Despite the disappointing response from government, the overall response rate is considered within the average for online surveys. Nulty (2008) determined an average response rate of 33% for online administered surveys; which is lower than traditional paper-based surveys. This feedback received was used to consider design and functional changes to the info-portal (Figure 5.2) prior to the release of the info-portal version 1 tool.

Table 5.1: Beta info-portal survey responses

Respondent categories	Number represented per original categories in test group (% of test group)	Survey Return numbers (% of original test group categories)	Proportion of total responses (relative to original group n=50)
Researchers related to the field of ICM	9 (18%)	6 (67%)	29%
Researchers not related to the field of ICM	5 (10%)	3 (60%)	14%
Local government officials	10 (20%)	2 (20%)	10%
Provincial government officials	10 (20%)	3 (30%)	14%
National government officials	5 (10%)	0 (00%)	0%
General or public user related to field of ICM	7 (14%)	6 (86%)	29%
General or public user not related to field of ICM	4 (08%)	1 (25%)	5%
TOTAL	n = 50 test group	n = 21 response group	

The Evaluation stage allowed for feedback from the test group via surveys. Feedback was received from the test users by means of a survey and assessed via a SWOT matrix which resulted in the refinement of the info-portal (Figure 5.2). Feedback from the test group assessed in identifying

improvements for the info-portal these suggestions were reviewed by means of a SWOT matrix (Figure 5.3). The main weaknesses related to the limited amount of information presented in the beta version, the layout of the tool and the ease of navigation, all of which were refined in the info-portal version 1. The target group identified a number of opportunities that would lead to a significantly improved tool, including refined navigation such as by using drop down-menus and sub-headings, more explanatory text, emergency contact details and a map-making facility.

	Helpful	Harmful
Internal origin	<p>Strengths</p> <ul style="list-style-type: none"> • It will assist in improving understanding for those involved in marine & coastal issues. • It is a professional looking site. • Great way of making lots of data available. • Simple, user-friendly, and relatively easy to navigate. • Clear, crisp appearance - pages are clear and uncluttered. • Selection of pictures are appealing and well illustrate the themes. • The look and feel was inviting; good colour choices and layout. • The links are clear and it appears to be a user-friendly site. • The site is quite intuitive and easy to navigate through. • 'One stop shop' for information on the KZN coast. • Potentially a useful resource. • This is an excellent first attempt at a product that will aid coastal management in KZN. • What seemed to be available was easily accessed. 	<p>Weaknesses</p> <ul style="list-style-type: none"> • The layout of the "Themes" section could be improved. • Could be a bit more colourful. It is quite pale with few strong colours. • Perhaps a little too minimalistic for a first time user - one needs to explore a bit to find your way around. • Some of the terms are not completely familiar. • The tool lacks visual appeal.
External origin	<p>Opportunities</p> <ul style="list-style-type: none"> • Map needs a little 'tidying' – it could identify some sites along the coast in more detail. • Homepage needs to have 'about us'/what the website is for. • Welcome section needs to be higher, so that it is the first thing a user see. • Some areas could use additional information. • The "Themes" section is confusing, some brief explanatory text would be useful to guide the user. • A section explaining how and why to register would useful to highlight the different access to content. • Additional facts, figures and data sources should be included. • Lists of emergency numbers (pollution, NSRI, navigation hazards, whale stranding's, poaching) would be useful. • Need to clarify what the different sections are. • Needs to be made much simpler and clearer. 	<p>Threats</p> <ul style="list-style-type: none"> • The pictures load slowly. • The map page loads too slowly. • Spatial data layers in the interactive map don't load correctly. • Sections are not clear. • Search function does not work well.

Figure 5.3: SWOT assessment of the Beta info-portal, based on user feedback

Feedback was received for four focus areas as outlined in the survey; 1) first impression when using the info-portal (look and feel), 2) user-friendliness of the info-portal, 3) info-portal functionality and 4) info-portal content.

5.4.1. Impression of the info-portal

A user's first impression of a website, tool, DSS or info-portal is critical; people make snap judgements and form an impression within a matter of seconds (Yamamoto, 2013). A user's first impression informs their likelihood of utilizing the tool going forward. A first impression is generally informed by the look and feel followed by how readily available is the information? Seventy-five percent of the test group felt that the info-portal was visually appealing, clean and clear with a good selection of photographs, images and colours. The remainder found that the info-portal's light colour palette to be a problem.

The test group (95%) had a positive first impression of the info-portal, stating it was a useful tool, offering a consolidation of coastal management-related information for KZN, providing a wide range of information and offering a useful resource for coastal decision makers and the general public alike (Figure 5.3). However, there were some issues identified relating to the display and interface responsiveness on different screen sizes. Only 1 user (5% of users) stated a somewhat negative impression of the info-portal, the user felt that there was insufficient information on the info-portal for it to be of use to members of the public (User feedback - Beta version, 2016). The test group provided feedback on the type of information or data they believed would add value to the info-portal, this was considered and as far as possible included in the info-portal version 1.

5.4.2. User-friendly nature of the info-portal

How intuitive or simple the info-portal is to use, will inform whether users will revisit and use the system again in the future. Fifty percent of the test group felt that the info-portal was very user-friendly and easy to navigate with only a few steps needed to find what was required and a person with few computer skills will easily navigate around the info-portal (User feedback, 2016). A further 40% felt it was moderately user-friendly, with some navigation issues being highlighted; users need to spend time looking to find what they need. Sections of the info-portal were identified as being

confusing for users that are not familiar with the terminology; explanatory text would be useful to inform about these sections and their intended purpose (User feedback, 2016).

5.4.3. The functionality of the info-portal

The test group was asked to provide feedback on functionality of the info-portal; the ease of understanding what is presented and how well this information meets their individual needs. Of the test group, 30% felt the data and information presented were extremely easy to understand, and a further 25% felt it was very easy to understand, which is considered to be the strength of this tool (Figure 5.3). However, 40% said it was only somewhat easy to understand and 5% said it was not at all easy to follow or understand data and information presented, which provided an opportunity for refinement. The test group assessed the usefulness of the data and information presented in their daily management and application. Fifty percent of the target group believed that the info-portal would meet their needs very well; only 10% felt it would not meet their needs well.

5.4.4. Content of the info-portal

In terms of the data presented, the target group was asked to rate on a scale of 1 to 5 how much they trusted the data and information presented in the info-portal. Feedback showed that 35% of the target group said they completely (rating of 5) trusted the data and information presented on the info-portal and a further 30% rated their level of trust as four. A further 35% rated it as a 3, stating some aspects of the info-portal were sourced from third party information and the sources of some data were unclear. The target group was asked if they would be willing to share some of their own data and information on the info-portal to make it available to other users, to which 60% said they would definitely share data and information via the info-portal. Only 10% said they were not likely or would never share data and information via the info-portal, as they could not see the value of such a tool.

The biggest *threats* identified (Figure 5.3) related to the speed of loading of images and spatial data over the internet which may lead to user frustration and non-use of the tool. These are major concerns as these would deter users from using the info-portal. This was taken into consideration in the info-portal version 1. First, steps were taken to reduce loading speed through the compression of images and second, navigation was refined to reduce the number of steps for a user to navigate to find what they require. This reduces the loading page wait time and the bandwidth utilised.

5.4.5. Refining the info-portal

The feedback from the test group meant that the info-portal needed to be significantly reviewed and refined prior to release to all users. Thus, the design and development stage was revisited (Figure 5.2), the look and feel of the info-portal was updated and the functionality of the tool simplified for the info-portal version 1. The info-portal version 1 was then released to all users and the test group for use, review and to provide feedback on the tool so that additional refinements could be undertaken. Seventy-five percent of the test group are of the opinion that the visual appeal of the info-portal is vastly improved, which was identified as a weakness of the Beta info-portal (Figure 5.3). In addition, 80% felt that the overall usability of the tool was significantly improved, and that it was far easier to navigate. User feedback (Beta version) highlighted that the home page did not have enough relevant information to direct users correctly. The refined home page has brought the four main access points together, as a focus of the page, making it easier for users to find what they are looking for (Figure 5.4(b)). Further, advances in technology have led in refinement of the user-interface, allowing for a contemporary look with simple, effective navigation (Figure 5.4(c)).

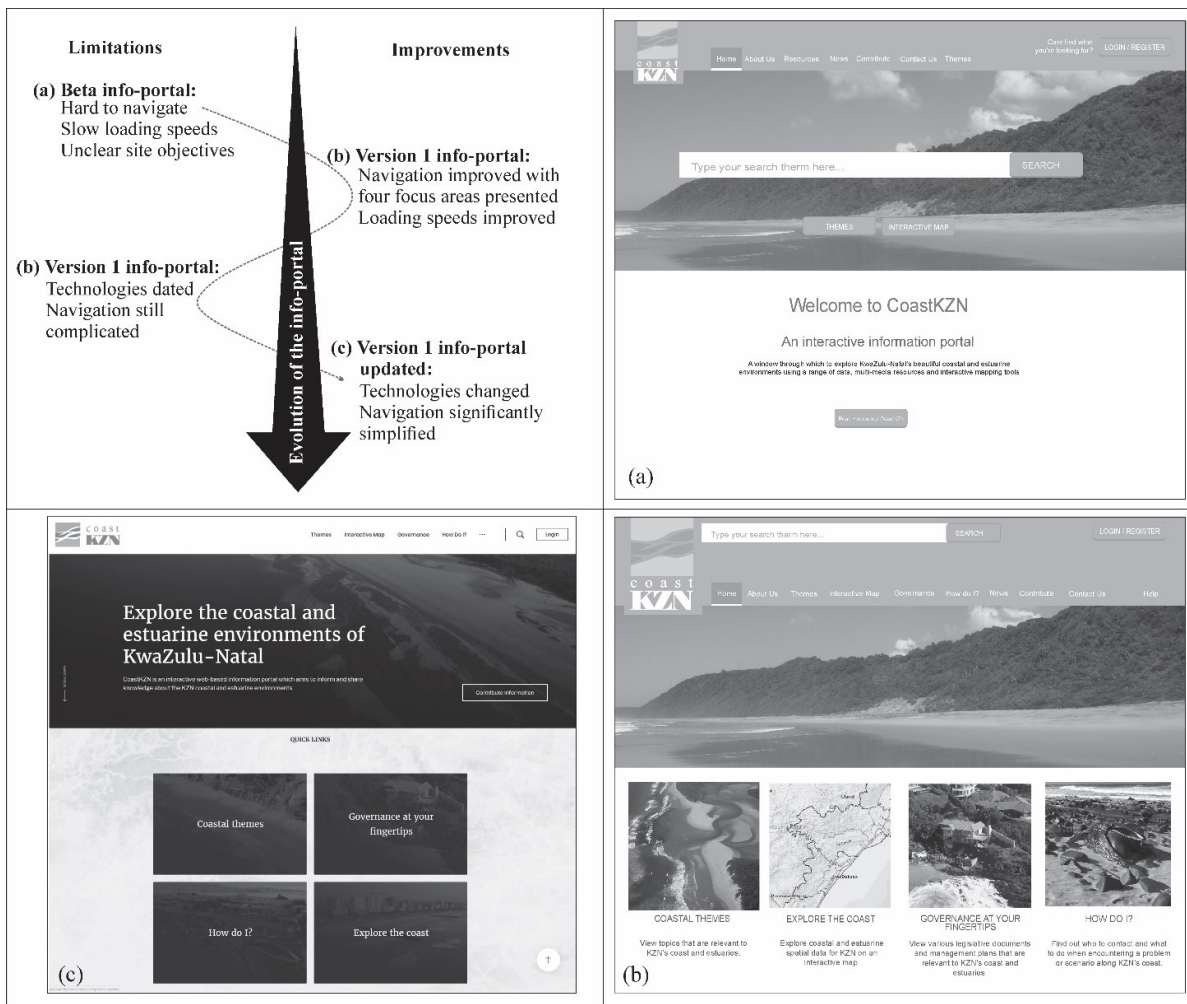


Figure 5.4: Evolutionary change to info-portal look at feel (a) Beta version and (b) Version 1 (c) refinement of Version 1.

To encourage ICM decision makers to utilise the info-portal, training sessions was undertaken to demonstrate how to access and use various aspects of the tool and how it can be applied to their management activities. The spatial component of the info-portal was the most challenging to users and required detailed attention and stepwise examples at the training sessions. The sessions were well supported, with 88 attendees (60% of which were from provincial and local government), over four sessions. All attendees derived significant value from the session, and additional sessions with other user groups are proposed. Given the capacity issues in government and staff turnover rates (Goble et

al., 2017), it is envisioned that these sessions will be undertaken on an ongoing basis to create awareness about the info-portal and its functionality.

Following on from the training session, many users accessed the info-portal. In the month following the training session, there were 1700 info-portal visits. The preliminary feedback from general users is overwhelmingly positive; stating that this system allows them to “easily refer to it for good scientific information about the KZN coastline” and that it is “a very important step towards achieving Integrated Coastal Zone Management” (User feedback – version 1, 2017). Since the initial release, use has dropped to just below 1200 sessions per month, averaging two minutes each browse. Of these sessions, 75% are new and 26% are returning users. At present there are 172 registered users with new users being added daily. While it is important to note that new users are starting to access and utilise the tool, a higher return of repeat users is desired to fulfil the objective of providing innovative, alternate decision-making capacity.

The dynamic nature of the tool was tested when the KZN coast experienced an extreme weather event on 10 October 2017, which wreaked havoc along much of the coast (Kaveel Singh, 2017). This event resulted in a container ship losing its cargo which led to a significant spill of plastic nurdles, which are small plastic pellets that are the precursors for plastic products. Millions of these small nurdles washed up along the KZN coast. An information gap was identified in terms of both a repository for tracking the clean-up efforts and for keeping the public informed of these efforts. The info-portal served as a repository for capturing public feedback on sightings of nurdles, clean-up efforts and best practice. In addition to keeping the public up to date, it provided an overview of the extent of the impact of the spill and allowed managers and decision makers at a glance, to see areas of concern along the coast and where to focus clean-up efforts. If this tool had not been operational, the management of this information would have been extremely cumbersome for the lead environmental agency and local government. In addition, the public made use of the site to access available and

current information, including where and how to participate in the clean-up over many months. This event was a learning experience for the capabilities of the tool and how to deal with, and accommodate, such an event given its diverse data requirements. The development team has taken much from this experience. Although unforeseen in the visioning phase, the info-portal serves and disperses information well in such emergency events.

5.5. Conclusion

Coastal management is a highly complex arena, requiring managers and decision makers to have a wide range of knowledge on multifaceted specialisations often competing, as it is perceived in the South African backdrop. Coastal management initiatives often fall short as managers and people residing in coastal areas have a limited understanding of economic, cultural and aesthetic values that a sustainably-managed coast can provide (Sale et al., 2008). These short-comings are especially recognised in the KZN context, where human and financial capacity are lacking resulting in a notable lack of implementation. The South Africa government has made attempts to rectify this situation through the provision of guidelines, support documents and, more recently, through basic DSSs which focus on a single aspect of ICM. However, little improvement in ICM implementation is noted. This has led to the need for inventive ways to support coastal decision makers in KZN, to improve their capacity and understanding of socio-ecological coastal aspects and to provide them with the spatial tools to support the decision-making and management process. There is still debate as to the best way to assemble this knowledge, with many advocating for a participatory interface that includes all coastal stakeholders and their knowledge systems (Bremer and Glavovic, 2013). This is the approach that the info-portal attempts to follow, hosting a range of data and information; all of which have had peer review or expert validation. The culmination of which is presented via the info-portal for the benefit of all parties actively involved in the coastal management within KZN.

The info-portal is perceived as a ‘one-stop’ tool for ICM in KZN, offering decision makers a platform with all the relevant information they require for decision making - in keeping with the objective of the tool and users identified needs. Importantly, the tool offers avenues for ongoing feedback from users providing them with the opportunity to a part of the success of the tool. In addition, the info-portal offers a platform for public members and stakeholders to provide citizen-science generated information relevant to estuaries and coasts. Through this approach, the info-portal provides an interface between science and socio-economic needs, to capacitate managers and decision makers to make well-informed decisions on provincial coastal issues. In turn, this aligns well with globally relevant SDG 14, focussing on the conservation and sustainable use of oceans, seas and marine resources.

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CHAPTER SIX: BUILDING INSTITUTIONAL KNOWLEDGE FOR EFFECTIVE INTEGRATED COASTAL MANAGEMENT DECISION MAKING; KWAZULU-NATAL, SOUTH AFRICA

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Abstract

Coastal zones are highly utilised making the management thereof complex. To support this many coastal nations have developed coast specific legislation; South Africa being no exception. However, implementation remains the biggest hurdle; some of the best environmental legislation is offered but the skills, capacity and financial resources to achieve this are lacking. National and provincial governments have made efforts to ensure knowledge transfer and capacity building for ICM, but is this enough? Is there is a real improvement in the capacity of managers and decision makers and are we seeing resultant effective ICM? This paper reviews the success of traditional training approaches for knowledge transfer and capacity building within the KwaZulu-Natal Province (South Africa). It further reviews a KZN specific information support tool to aid in on-going knowledge building and storing of institutional information and considers if this is complementary to or divergent from traditional approaches. While participants of traditional training sessions gain value from these, the link to implementation is largely lacking. This, coupled with high staff turnover rates creates a barrier to reaching the objectives of the ICM Act. In comparison the use of an information support tool potentially adds value by storing information and data in a readily available format and serves as an ‘institutional information bank’, thereby contributing to improved, informed coastal decision making, which ultimately leads to better implementation of ICM objectives.

Key Words: ICM implementation, info-portal, information support tool, knowledge transfer, capacity building

6.1. Introduction

Coastal environments offer a unique zone in which human activity, socio-economic influence and ecological diversity interface. Estimates suggest that approximate 44% of the world's population are resident at or near the coast, being within 150 km of the shoreline (UN Atlas of the Oceans, 2016). As population density and economic activity increase, coastal areas continue to experience high levels of utilisation, significant development pressure and rapid change, with natural areas being transformed to accommodate the needs and desires of people (Creel, 2003). Concerns for coastal areas are exacerbated by the projected effects of climate change, with coastal zones being highlighted by the Intergovernmental Panel on Climate Change (IPCC) as an area of concern (Poh Wong et al., 2014). Sea-level rise is identified as one of the greatest future risks for coastal areas which will increase the coast's exposure to other hazards, such as coastal erosion, potential intensification of tropical and extra-tropical cyclones, and flooding (Nicholls et al., 2007).

Consequently, coastal authorities are faced with the challenges associated with managing a highly complex environment and ensuring that the public can continue to sustainably access the coast and benefit from its resources. These pressures result in a complex management arena, which has led to a plethora of guidelines and legislation relating to the coastal zone, as well as the emergence of Integrated Coastal Management (ICM) as a 'holistic' management approach; predominantly as a response to the well-documented failures of historical sectoral management of fisheries, coastal hazards, mining and land use (Cicin-Sain and Knecht, 1998). Integrated coastal management aims to ensure a balance between the demands on the coastal environment from socio-economic activities and the needs of the natural coastal environment for ecosystem functionality (Beeharry et al., 2014), through the provision of an evidence-based framework for decision makers (Phillips, 2018). For ICM to be effective, there needs to be strong governance models in place to improve integration (Alves et al., 2013), and decision makers require a combination of scientific and social information, modelled data and environmental indicators to assess the likely level of impacts and to decide on feasible mitigation measures (Living with Environmental Change, 2014; Phillips, 2018). However, ICM is often undertaken in the context of lack of personnel and financial resources, thus requiring ICM initiatives that integrate natural and social sciences into the decision making process (Cicin-Sain and Knecht, 1998; Goble et al., 2017; Phillips, 2018). This, in turn, empowers coastal managers with the best available knowledge, which is required to achieve effective ICM (Bremer and Glavovic, 2013).

South Africa, having more than 3 000 km of coastline, is one such country struggling with ICM implementation. The South African coastal zone offers a diverse array of social and economic

resources, which are heavily utilised for subsistence harvesting, religious ceremonies and recreational activities (Goble et al., 2014a). In South Africa, ICM is governed by a legislative framework, the Integrated Coastal Management Act (Act 24 of 2008, amended 2014) (ICM Act), which outlines roles and responsibilities for all three spheres of government (Table 6.1). Significant responsibility for implementation and enforcement are placed at the provincial and local levels. National governments priority actions are more strategic, providing guidance and oversight to the provincial and local levels that are tasked with implementation. However, a failure in governance leadership has led to delays, hampering implementation efforts at all spheres of government (Glavovic et al., 2018).

This research considers ICM at provincial and local levels within South Africa and focuses on KwaZulu-Natal (KZN); one of four coastal provinces. The KZN province is located on the east coast of South Africa and covers almost 600 km of coastline. KZN's coastal zone boasts a year-round 'summer' climate and warm sea temperatures, making it a renowned international and domestic tourist destination. In addition, KZN is home to 11.1 million people, 50% of which live in the coastal areas of the province and directly benefit from the coast; be it through recreation, leisure or subsistence activities (Statistics South Africa, 2015; Goble et al., 2017).

The province is divided into three types of municipalities; firstly, metropolitan municipalities, which have exclusive executive and legislative authority in its area. Second district municipalities (DMs) being a broader management area that comprises of, and shares executive and legislative authority with, the local municipalities within its geographic area. The role of DMs is to assist and capacitate local municipalities (As outlined by the constitution of South Africa (SALGA, 2016). In terms of the KZN coastal zone and ICM implementation, the coast is divided into one metropolitan municipality (eThekweni) and four district municipalities being made up of eight local municipalities (Figure 6.1). The ICM Act states that implementation requirements for local government should be undertaken at the metropolitan or district level unless, by agreement, the functions have been assigned to the local municipality. In addition, the northern section of the KZN coast falls within the iSimangaliso Wetland Park and is managed under the World Heritage Convention Act (49 of 1999). In terms of coastal governance, the requirements of the ICM Act are nested below the World Heritage Convention Act and the National Environmental Management: Protected Areas Act, 2003 (Act 57 of 2003) (iSimangaliso Wetland Park Authority, 2016). Reporting is undertaken at the national level, with the provincial authority having little jurisdiction within the park boundaries (Goble et al., 2017).

To illustrate the complexity of the situation, coastal management approaches within the four districts differ, based on differing knowledge levels and financial resources (Goble et al., 2017; Rosendo et al., 2018). Different designations or units within each district are assigned the various functions associated with ICM and the ICM Act.

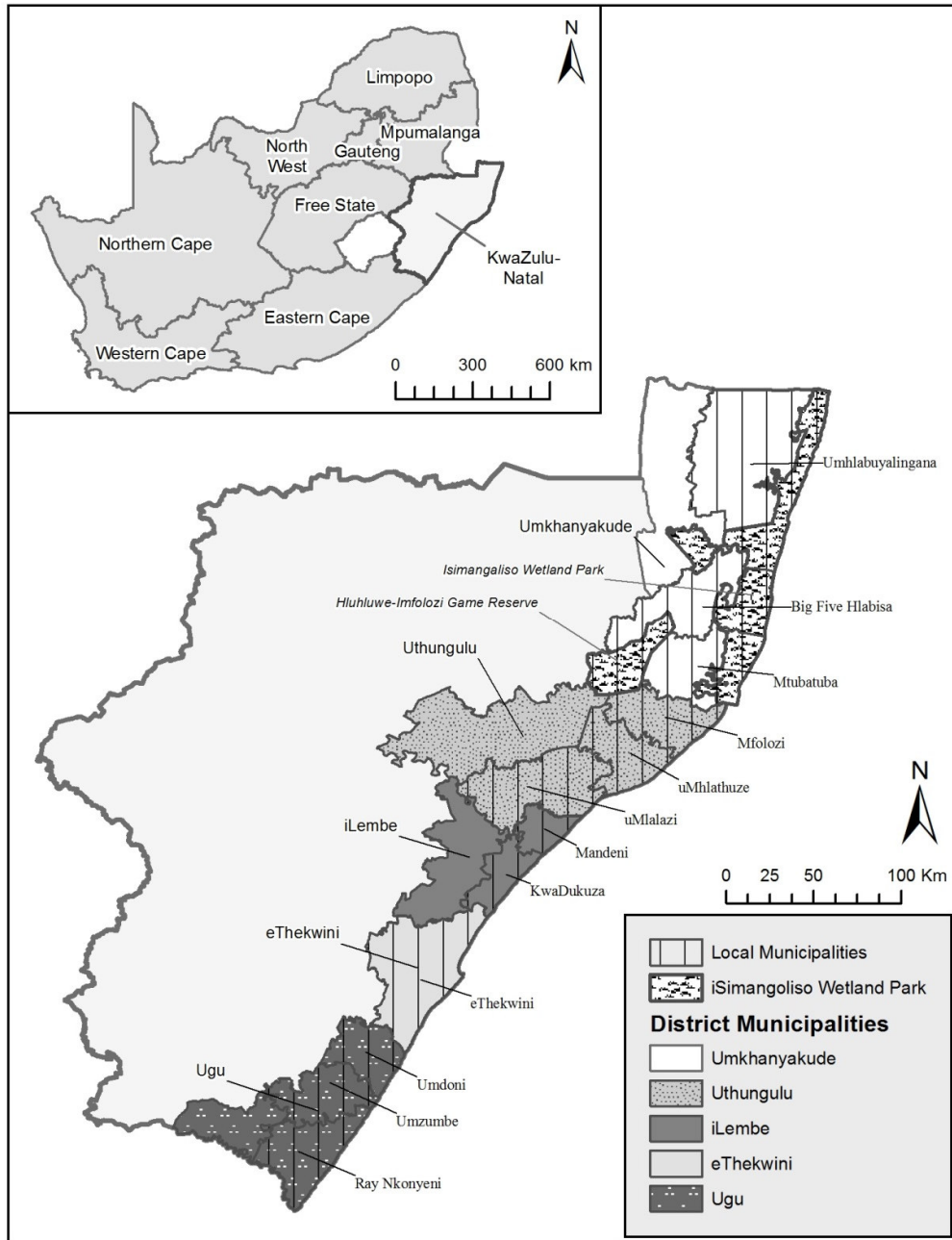


Figure 6.1: KZN coastal municipalities

Within the Province of KZN, significant efforts in achieving the broader objectives of ICM have been made. These range from local guidelines, to dedicated training sessions on specific ICM challenges. In 2010, following a significant storm event (2007), that resulted in damage to infrastructure and

properties, the KZN government undertook a coastal vulnerability assessment and developed a coastal vulnerability viewer to aid decision makers to address issues relating to development in light of risk and vulnerability (Palmer et al., 2011a). To ensure that this tool was utilised by government, several training sessions were facilitated by the provincial government. An ‘understanding our coast’ guide followed shortly thereafter in 2011, which provides a summary of the KZN coastal zone, the legislative framework and the ‘do’s and don’ts’ within the coastal zone (Palmer et al., 2011b). Five thousand copies of this guide were printed and distributed to government officials at the provincial and local levels, as well as to the public and to learners. In 2014, as a pre-cursor to the KZN Coastal Management Programme, a coffee-table book profiling the KZN coast was developed and distributed; ‘Ugu Lwethu – Our Coast, a profile of coastal KZN’ (Goble et al., 2014b). It provided a detailed overview of the KZN coast, the unique habitats and ecosystem, key species and the pressures and threats faced by the coastal zone of KZN. While being useful, for information sharing, these interventions and key documents do not address the crucial underlying challenge of capacity within government, which highlights the need for training and support tools for ICM implementation.

This research assesses ICM training and decision support initiatives over the nine years since enactment of the ICM Act (2009) and evaluates implications for ICM capacity and institutional knowledge within KZN. The aim of which is to improve information or ‘institutional knowledge’ for sustained ICM. In the context of this research institutional knowledge refers to the information and knowledge developed by individuals within government, that is lost with their departure. This research looks to innovative approaches for storing this knowledge so that it is not linked to individuals and can be used by new officials or decision makers to make better, informed decisions.

6.2. Integrated Coastal Management in South Africa

Local and provincial level responsibilities are complex and require intricate, detailed ICM knowledge and a thorough understanding of the ICM Act. For example, designation of coastal access land (Table 6.1), requires local government to have an understanding of: how to define coastal access (its objective / intention), what is considered appropriate coastal access (distance between access points, type of access etc.), current access, how this can be improved and how it should be formalised. These onerous background information requirements demonstrate the need for support from national government, however if national government cannot effectively progress the implementation of the ICM Act, the challenge to improve ICM knowledge at the local level is monumental (Glavovic et al., 2018).

Despite local municipalities recognising ICM implementation as one of their core functions (Rosendo et al., 2018), uptake has been slow and has been met with a number of challenges. Prescribed timeframes have lapsed and little tangible progress is evident (Goble et al., 2014a, 2017). Lack of human resources (both in terms of numbers and appropriate skills) for ICM as well as financial constraints are cited as the primary reasons affecting the ability of local municipalities to meet the ICM requirements (Glavovic et al., 2018; Rosendo et al., 2018). This is often exhibited by widespread lack of political will (Glavovic et al., 2018).

Table 6.1: Roles and responsibilities of the three spheres of government in terms of the ICM Act

National Government	Provincial Government	Local Government
<ul style="list-style-type: none"> • Management of CPP • Develop and implement a National Estuarine Management Protocol • Monitor the appointment of provincial lead agencies • Establish and facilitate a National Coastal Committee • Develop and Implement a National CMP 	<ul style="list-style-type: none"> • Oversight on the provision of coastal access to CPP • Determination and management of CPZ • Determine and establish CMLs • Develop estuarine management plans for estuaries within provincial jurisdiction • Designation of provincial lead agency • Establish and facilitate a Provincial Coastal Committee (PCC) • Develop and Implement a Provincial CMP • Develop State of the Coast Report 	<ul style="list-style-type: none"> • Marking coastal boundaries on zoning maps • Determining and adjusting coastal boundaries of coastal access land • Designation of coastal access land for access to CPP • Impose fees within coastal public property (if applicable) • Implementation of land use legislation in CPZ • Demarcate CMLs on zoning maps • Develop and Implement a Municipal CMP

CPZ: Coastal Protection Zone I CPP: Coastal Public Property I CML: Coastal Management Lines I CMP: Coastal Management Programme

In KZN, at the local level, the functions related to ICM are generally assigned to planning departments, with only one coastal municipality having hired a staff member specifically to coordinate ICM (Rosendo et al., 2018). This highlights a mismatch for large regions of the coast that have inadequate ICM capacity (Glavovic, 2014; Sowman and Malan, 2018). Second, financial constraints are highlighted as a barrier to implementation (Goble et al., 2017). In spite of municipalities reporting that funds are allocated to ICM, these are limited to preparing Coastal Management Programmes, with no associated funding for their implementation (Rosendo et al., 2018). Celliers et al. (2015) highlighted that local government are unlikely to take a proactive approach to coastal governance, largely being unsure as to what is required of them and how best to meet the objectives of the ICM Act (Goble et al., 2017). One of the most difficult challenges for ICM in South Africa is that of building sufficient capacity within government to institutionalise a more sophisticated approach that will ensure the benefits and efficiency gains associated with effective ICM (Glavovic et al., 2018). In order to succeed, national and provincial governments need to provide

greater support to local governments (Glavovic et al., 2018; Rosendo et al., 2018) as highlighted by the Constitution of South Africa [Section 154(1)] which states that national and provincial governments must, by legislative and other measures, support and strengthen the capacity of municipalities to manage, exercise powers and perform functions. In response to this constitutional requirement, a number of education and training initiatives have been implemented, however, despite this there still remains insufficient personnel and institutional knowledge (Coley et al., 2002).

6.3. Methods

This paper considers two approaches to improving provincial and local level ICM knowledge in KZN; traditional training courses or workshops and the use of an online interactive information portal. Between 2014 and 2018, the provincial government facilitated focused training sessions for provincial and local government. All courses were well supported being attended by 44, 25 and 39 people respectively. Two of the three courses were facilitated by an international presenter. In addition, these courses were complemented by nationally facilitated training programmes; covering an overview of ICM (2013), focused estuarine management (2014), marine protected areas (2015), and compliance monitoring and enforcement for ICM (2017, 2018). Both the provincial and national courses are in line with the ICM Act and identified knowledge gaps for implementation, the need for which was confirmed by attendee's feedback (Table 6.2). Attendees completed a survey following each session to evaluate the sessions and to inform future training sessions. As this work forms part of an ongoing project, all survey questions were considered and approved by an ethics committee, while anonymity of survey and interview respondents was guaranteed.

Secondly, an online decision support information portal (info-portal) was developed (www.coastkzn.co.za) to complement traditional capacity building initiatives. The info-portal is an innovative decision support platform aimed at assisting coastal managers in the absence of human capacity support and tools, through the provision of a 'one stop shop' platform, housing all data and information relevant to ICM in the province. To assess if this info-portal does in fact complement training and assist in improving knowledge its 'success' was measured. A measure of 'success' is the adoption or uptake of the info-portal by the intended end-user and their continued use of the tool. Feedback from registered users was gathered via an online survey, which fed into a conceptual info-portal adoption model the framework for considering the success of the info-portal (Figure 6.2).

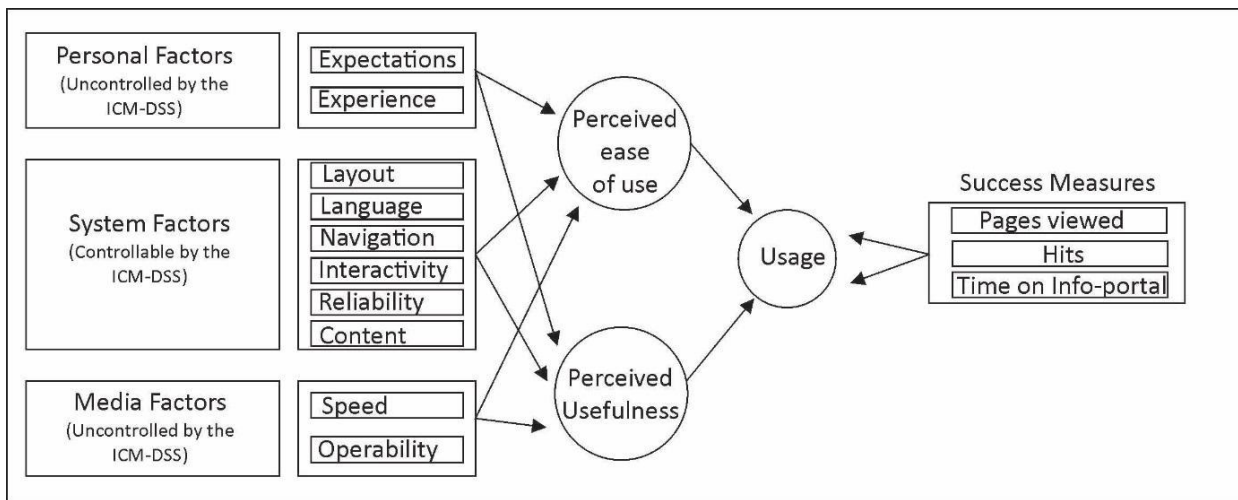


Figure 6.2: Conceptual info-portal adoption model (Adapted from Scharl et al., 2004)

As a part of the capacity building agenda and to facilitate use of the info-portal, dedicated training sessions were undertaken to demonstrate how the info-portal works and can be utilised in support of ICM. Four training sessions were held, the focus of which were to ensure that all potential users have been exposed to the tool and been shown how to utilise it, ultimately aiding in the success of the info-portal. The training focused on navigation, content and the spatial component ensuring that users were able to find locations, turn layers on and off, make a map and export them for use in reports. To-date, training has been attended by 89 people (Session 1: 28, Session 2: 31, Session 3: 15, and Session 4: 15). Session 3 and 4 were smaller groups as it was felt that this was more appropriate for ensuring knowledge transfer. Attendees included government (75%), consultants (13%) and conservation agencies / NGOs (12%). Follow-up surveys were sent to users that had attended training sessions to determine if they were using the info-portal for daily ICM. Surveys followed a structured approach and were kept concise to encourage feedback.

6.4. Results

6.4.1. Training sessions

Consolidated feedback from the three KZN dedicated training sessions indicates attendees believe the courses offered are relevant and added value (Table 6.2). The first course focused on ICM (Course 1); what it is, its value and provided an overview of the ICM Act and requirements for management. This was necessitated in light of the enactment of the ICM Act and as a follow on from the National course the preceding year. Attendees felt that the training provided “*extensive information on ICM, enhancing their knowledge of the importance of coastal management and giving direction as to what actions need to be taken*” (Respondent – course 1, 2014). Attendees felt that the course “*was well*

structured and presented by knowledgeable presenters with a simple clear format that was easy to understand” (Table 6.2). However, some attendees felt the training did not meet their objectives as they required “a more detailed presentation of the ICM Act”, while others believed that the course was “too slow with some irrelevant information presented”. As part of the feedback received from attendances, further training needs were identified. These included sustainable coastal development, compliance and enforcement and estuaries and estuarine management (Figure 6.3).

Table 6.2: Feedback from three training session between 2014 and 2018

	Course 1: Introduction to ICM (2014)	Course 2: Risk and Vulnerability (2016)	Course 3: Ecosystems-based management (2018)
Strengths	<ul style="list-style-type: none"> • Extensive information regarding ICM. • Gained information that will improve my skills on ICM and the ICM Act. • I am now aware of the ICM and can incorporate it on my work. • It further enhances knowledge of the importance of coastal management and what role I need to play when undertaking my duties. • Made us look at things differently. • Very informative and gives direction as to what actions need to be taken to promote coastal ecosystems • Programme well structured • Presenters were knowledgeable. • The course was informative. • The programme made me more aware of the challenges that occur along the coast. • Materials were in a simple and clear format, which made it easy to understand. 	<ul style="list-style-type: none"> • Better understanding of the international interventions or measures. • A clear focus on coastal management and tangible examples and solutions. • Better understanding of sustainable coastal management using soft engineering and ecological approaches. • Exposure to thinking about coastal management novel approaches. • Further insight into the challenges facing coastal management. • Interesting examples in other parts of the world. • Learnt new examples for coastal management approaches. • The knowledge obtained is huge and relevant to daily operations. • The programme dealt mostly with the challenges that one is faced with. • The examples that were presented related closely to my situation. 	<ul style="list-style-type: none"> • All of the issues we facing were clearly explained together with do's and don'ts. • Excellent course. • Exposure to novel solutions used internationally. • Good introduction to concept of EBM. • The concept of EBM was interesting. • Relevant to current coastal management issues. • The importance of understanding coastal areas to change the perception and behaviour of humans • Understanding on the concept of how to build with nature. • The workshop added a new dimension into my understanding of coastal management. • There benefits of protecting the environment were well explained. • Understand how coastal management is important. • Was very informative.
Weaknesses	<ul style="list-style-type: none"> • Course was too slow. • I was expecting the discussion of the Act. • There has been some technical jargon mentioned and the same terminology found in reports. We need to be introduced to these. • Some irrelevant presentations • Have discussions during the morning half of the day, you'll get a better response from everyone. 	<ul style="list-style-type: none"> • Not really relevant to our district. • Opportunities of coastal management were limited and not relevant to our district. • Officials don't have much power. 	<ul style="list-style-type: none"> • Interested to know more about Coastal EBM • I was hoping to hear more solutions towards better coastal management • I was expecting to learn more about coastal challenges and expected mitigation measures.

The second course (Course 2) focused on coastal risk and vulnerability in light of suitable coastal development, as requested by attendees. The second course showcased alternatives to traditional shoreline defences, to encourage managers to think broader when reviewing new development applications. Attendees felt the training offered tangible examples and solutions and improved

understanding of sustainable coastal management using soft engineering and ecological approaches as well as exposing attendees to international examples. However, some attendees believed the training was not relevant to them (Table 6.2). Attendee’s feedback again highlighted the need for courses relating to sustainable coastal development as well as estuaries and estuarine management and co-operative governance (Figure 6.3).

Considering the repeated requests for more detail on sustainable coastal development and estuarine management, the third course (Course 3) presented an in-depth investigation into aspects of sustainable coastal development by integrating an ecosystems-based management approach for both coasts and estuaries. This highlighted the need to think differently, considering green engineering and working with nature. Attendees felt this training gave them exposure to novel international solutions and added a new dimension to their understanding of coastal management, while highlighting relevant current coastal management issues. Feedback from this most recent course (course 3) highlights the need for estuaries and estuarine management and more information on sustainable coastal development (Figure 6.3).

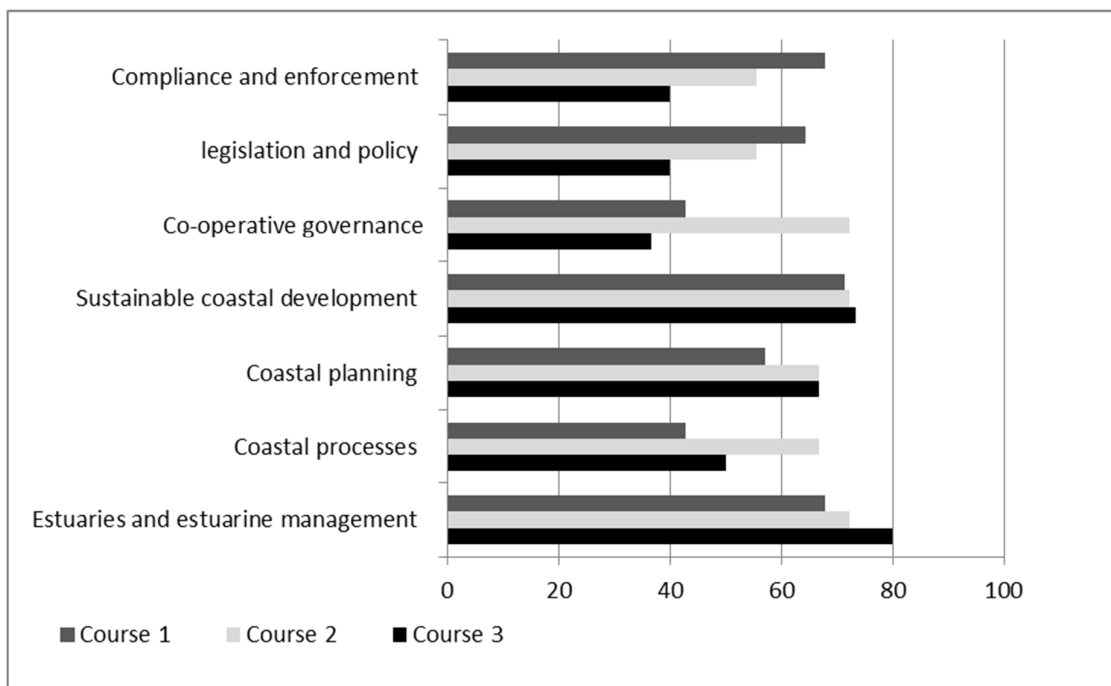


Figure 6.3: Future requirements for ICM knowledge building

The topics and level of information presented in all three courses was questioned in the survey, for course one, 85% of attendees believe the course to be relevant, 90% for course two and 75% for course three. Attendees were also asked, on a scale of 1 (weak) to 5 (excellent) the overall value of the course. For the three courses feedback was positive (85%, 95%, 73%) for the three courses

respectively. These positive responses speak to the value of topic selection and need for such training opportunities. While participants gained valuable knowledge and insight from these courses, being more aware of coastal issues and management alternatives, many feel there is no link to action (Respondent – course 2, 2016) and human capacity constraints continue to be perceived as the biggest challenge (Goble et al., 2014a; 2017). This in a setting where staff turnover rates are high (Goble et al., 2017) highlights that training alone is not sufficient as it does not retain personnel nor is instructional ICM knowledge necessarily improved (Deloitte and Touche, 2013).

6.4.2. Info-Portal

A total of 82 (92%) feedback responses were received from training attendees. Significantly, 61% of respondents stated that the training session was their first interaction or exposure to the info-portal, having not looked at it prior to the session. Ninety-six percent of respondents are of the opinion that the training session had enhanced their skills and knowledge of the info-portal with 87% stating that the training has improved their understanding and ability to use the tool.

However, a decision support system or tool is only as good as its adoption and use. Ninety percent of respondents believe that this tool will be useful in their work and are likely to return to and use the tool. One responded stated that the info-portal is brilliant. *“It’s like a library where you can find all the information you require for this field”* (Respondent – course 3, 2018). However, the success of the info-portal can only be measured if the info-portal is used post-training. Thus, follow up / post-training surveys were sent to users that attended the training, to determine if and for what the info-portal has been used. Of the 89 persons that attended the training only 24 (27%) completed this survey; however, this response rate is considered within the average for online surveys, with Nulty (2008) determining an average response rate of 33% for online administrated surveys.

Ninety-one percent of respondents have revisited the info-portal for a range of different reasons; with the majority utilising the spatial components of the info-portal and producing maps. To a lesser degree the info-portal was used for finding specific information or documents. Those that did not revisit the info-portal (9%) cited available time as a limitation. This is problematic as the info-portal is intended to aid in streamlining decision making and ultimately saving time for the user. However, some respondents did note that they felt the site was complicated and overwhelming, even suggesting additional training sessions for users to become more familiar with the info-portal (Table 6.3).

Table 6.3: Value of the training session and proposed tool

About the training	The entire course was informative. Learner aids added value to course.
	The practical session was valuable because you are able to play around with the information and the actual data is current and will be very useful for municipalities in terms of the availability of data.
	Coordinators explained very clearly on how to use the various tools. The facilitators were very helpful as well.
	Introduction to the tool. What it has to offer and how to use it.
	Very informative and hands on.
Most valuable aspect of the training	Understanding the power of this tool.
	I learnt how to use the site to create a map.
	Learning how to use the site and benefits in terms of our daily work.
	Learning where to find what.
	The course opened my knowledge of information about the KZN coastline and information available.
	Learning that we can access legislation, CVI and information relating to a specific place of interest.
	Exposure to different tools in the software and how you can use them to solve problems.
	Getting to know where to get the information about the coast and all activities taking place there.
	Becoming aware that there is quite a bit of info available for projects located in the coastal zone and that we can now be duly informed and make better informed decisions.
	To know that I will be able to get a lot of information about live activities happening around the coast.
	To learn how to use the package/ maps to locate different land cover/land uses.
	Using general functions of info-portal and interactive maps.
	Using the portal myself and searching for information.
	The whole course was most valuable however I have found the use of the interactive map to be at the top of the list.
	Understanding how to use the KZN portal and its importance on my line of work.
Able to navigate through the site and finding information on my own.	
Learning how to use the maps.	
Improvements to the training	Delivery may have been too fast; perhaps the speaker can slow down and make sure everyone is on the same page before moving.
	Day long training.
	Division into smaller groups per coordinator to go over steps.
	More time to interact with the portal.
	More time for the training and for practicing.
	hold more training sessions
	Better connection to internet.
	If possible to provide manuals upfront for trainees to familiarize themselves before they come to the course. This will give them more confidence while going through the training.
	Training should be rolled out over at least 2 or 3 days in order to be able to grab most of the information.
Refresher training is recommended.	

Overall users have a positive experience interacting with the site (Figure 6.4), they trust the information presented and will use it going forward. In terms of content, users were predominantly (88%) satisfied that they were able to find the information they sought, “*Coastal management related information is readily available, so this is an on-line library*”, which demonstrates that the info-portal has the ability to support users in their daily tasks and decision making. This is supported by users that state the “*Information will assist greatly*” (Respondents - course 3, 2018). Furthermore, respondents (63%) found that the site was user-friendly. The interactive map and option to make a map is a key feature of the info-portal and 63% of respondents found this very easy or easy to do, which is important in ensuring that users will revisit and utilise this aspect of the info-portal.

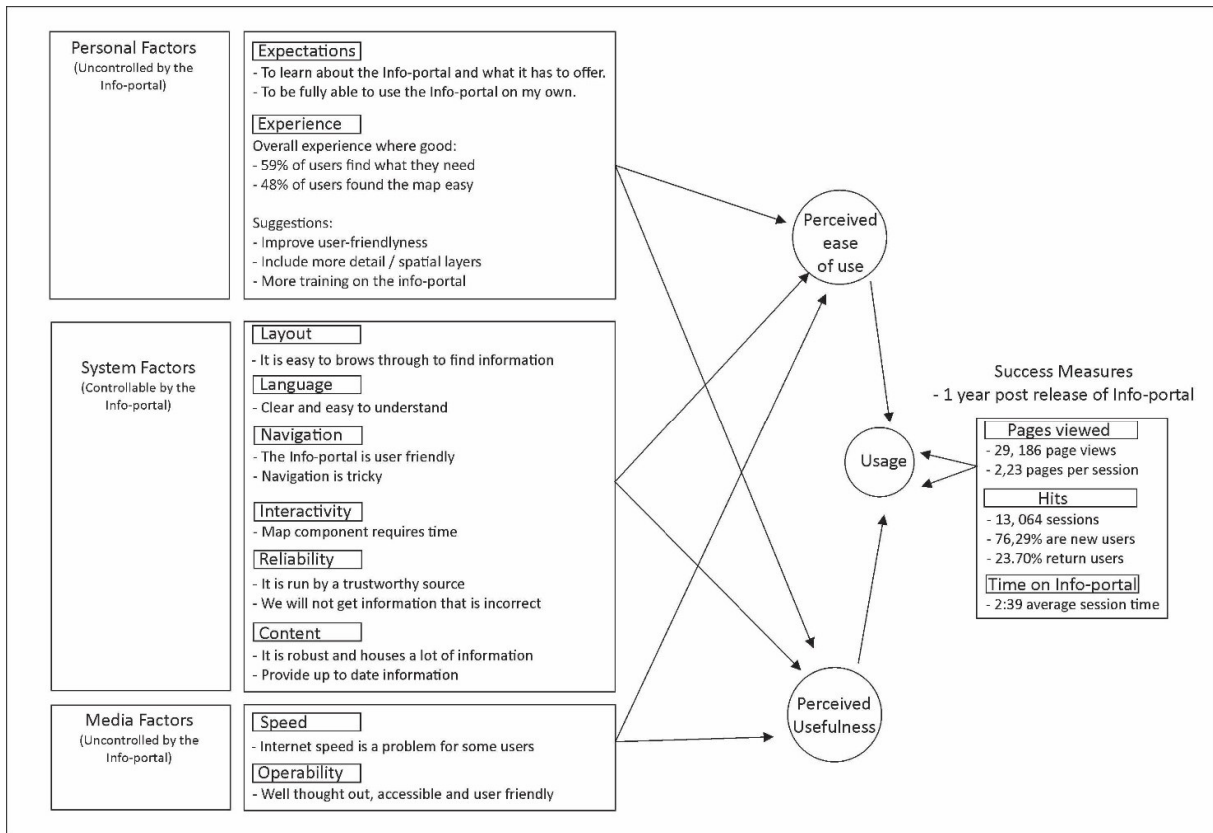


Figure 6.4: Info-portal user experience - Input factors and success measures

Respondents found value in the info-portal (Table 6.4), for a range of reasons, from the documents presented (Acts and policies) to the interactive map and ability to make maps for reports they require particularly for non-GIS users. Users stated that this should further aid in the environmental authorisation process whereby environmental practitioners could draw relevant coastal information prior to the submission of reports (Respondents – course 3, 2018; Table 6.4).

Table 6.4: Value of the info-portal to users

Value of the Info-portal	Easy to access to the information that has been uploaded on the website.
	Coastal management related information is readily available, so this is an on-line library.
	The themes and the How do I function - this will help people report illegal dumping/discharges of waste/pollution in the coastal area.
	The tool is useful and can be used in a variety of ways.
	The whole info-portal is a valuable asset especially for EIA processes and decision making.
	All the Acts and policies regarding the environment are put together.
	The articles and links to case studies are useful resources.
	It's really going to assist in verifying information received from Environmental assessment practitioners.
	Being able to look up different types of info along the coast.
	GIS application in coastal management
	Being able to generate maps for work purposes.
	That environmental practitioners are able to use the maps from the site for the submission of EIAs
	The interactive map was helpful and informative.
	The interactive map is fantastic.
	The interactive coastal map viewer is user friendly even if one has not GIS background. The fact that one can generate and save maps will add value in one's work.
	Having access to edit maps and being able to download them for report purposes because some municipalities don't have GIS.
	To be able to create maps that will be used for a variety of purposes.
	Use of the interactive map.
Information will assist greatly with coastal EIAs, development and land use change projects.	
The spatial data available/provided to the general public at no costs. The website is relatively easy to use.	

6.5. Discussion and conclusions

ICM knowledge is repeatedly identified as the primary hindrance to effective ICM implementation for KZN (Goble et al., 2017; Glavovic et al., 2018; Rosendo et al., 2018). Sowman and Malan (2018) highlight that the situation has not improved, the provincial lead agencies are still predominantly under-resourced, overburdened and experiencing high staff turnovers with loss of institutional memory. In 2014, Glavovic (2014) assessed the five-year implementation of the ICM Act for KZN, interviewed respondents agreed that the province had made little progress (Glavovic, 2014). For example, the preparation and publication of the CMP has been protracted making sequenced alignment of municipal plans impossible (Glavovic et al., 2018). This failure of provincial government to meet deadlines has resulted in instability of ICM at the local level (Glavovic et al., 2018). That said, if the core requirements (highlighted in Table 6.1) are revisited, KZN has made some progress reaching these targets (Table 6.5). Timeframes were not met; however the province has achieved four of these targets, three are in progress and one is still to be initiated (O. Parak, 2018, pers. comm.).

Table 6.5: KZN progress in meeting the requirements of the ICM Act

Task	Timeframe / deadline	KZN Progress 2018
Oversight on the provision of coastal access to CPP	None	Desktop assessment done at provincial level – ongoing support to local government
Determination and management of CPZ	None	In Progress
Determine and establish CMLs	None	In Progress
Develop estuarine management plans for all estuaries in the province	None	In Progress: 2 of 76 completed
Designation of provincial lead agency	Within 2 months* / early 2010	Completed 2017
Establishment and facilitate a Provincial Coastal Committee (PCC)	Within 12* / end 2010	Formally established 2015
Development and implementation of a Provincial CMP	Within 4* / end 2013	Gazetted 2018
Develop State of the Coast Report	Every 4 years / end 2013	Not initiated

* Timeframes are determined in relation to the enactment of the ICM act which was 2009

To improve implementation, efforts need to focus on improving capacity. Given the complexities and spatial nature of coastal systems and the multidisciplinary nature of management, computerised systems are often used to integrate and distribute data and expert knowledge and aid in bridging this capacity gap (Fabbri, 1998). In recent years, advances in technology have seen information systems increasingly become an essential component of decision making and management through the development of decision support systems or tools (Phillips-Wren et al., 2009). These tools can improve one’s understanding of the inter-relationships between the natural and socio-economic variables, leading to improved decision making (Westmacott, 2001). However, the effectiveness of these tools, and the value they add, is only as good as the use by managers (Phillips-Wren et al., 2009). The value of information derived from the tools can therefore be defined as “the difference between a decision maker’s payoff in the absence of information relative to what can be obtained in its presence” (Banker and Kauffman, 2004, p283), and its usefulness often dependent on the type and nature of the information presented by the tool (Phillips-Wren et al., 2009). However, it is important to highlight that effective use of a tool(s) is reliant on users understanding of coastal systems and how to apply the tool(s); this highlights the value of traditional training approaches that complement such tools.

In KZN, the coastal info-portal has been well received by users, who highlight the value of the various sections presented by the tool and that it can be used in a variety of ways. Users felt that it was “*easy to access the information*” and that “*coastal management related information is readily available*” (Respondent – course 3, 2018). Some users felt the info-portal would add value to the EIA process, as environmental assessment practitioners could generate appropriate maps for inclusion in submissions and it would assist authorities in verifying information received and informing the

decision-making process (Table 6.4). Users were most excited about the interactive map function offered by the info-portal, stating it is “*helpful and informative*”. It allows users to generate maps for daily work functions and is a simplified GIS application in coastal management, even for users with no GIS background (Respondents –course 3, 2018). This is particularly useful for municipalities that do not have access to a traditional GIS system (Respondents –course 3, 2018). Analysis of use, via google analytics, shows that generally users visit the site between 8 am and 16.00 pm, showing that this is linked to working hours and activities.

Adoption of a tool is often the simplest measure of ‘success’, as it acts as an umbrella indicator for a range of ‘success’ criteria and provides a positive indication that the tool meets the end users’ requirements. Moreover, adoption of a tool is relatively easy to measure; at the most basic level a tool is either adopted and continues to be used, or is abandoned (Herron and Cuddy, 2008). The uptake and use of this tool has been somewhat slow, however user numbers are increasing and there are several success stories where authorities are now using the info-portal to address ICM assessments and quarries. However, does such a tool negate the need for ICM related training sessions? User feedback from the training sessions, including those relating to the info-portal, is overwhelmingly in favour of additional training, thus the info-portal serves as a complementary information source for managers. The advantage is it contains the most up-to date ICM-related data and information relevant to decision-making, resulting in it being an extremely effective ICM tool or aid for coastal managers in KZN. It also serves as a ‘memory’ bank in the absence of traditional institutional knowledge. The info-portal has successfully been used to inform decision making related to determining what, if any, environmental authorisations are required through showing the position of the 5 m contour around estuaries, and identification of the risk zones and areas 100 m from the high-water mark. It has been used in support of identifying encroachments into coastal public property from private property. The info-portal has further simplified access to relevant legislation and supporting information, thereby simplifying the ICM planning process. (O. Parak, 2018, pers. comm.).

Significantly, 61% of respondents stated that the training session was their first interaction or exposure to the info-portal, having not looked at it prior to the session. This highlights the value of these sessions, with respondents stating that the training showed how to use the info-portal, were to find information and access a knowledge-base about the KZN coastline (Table 6.3). In terms of the user experience, 59% of users felt it was easy to find what they needed for decision making, while 48% found the map easy to utilise, both of which align with their expectation to be ‘fully able to use the info-portal on their own’ (Figure 6.4). Consideration of the system factors highlight that users

are overall positive with regards to layout, language, navigation, interactivity, reliability and the content of the info-portal. Areas that need to be re-looked at include navigation, the ease of map use and ensuring that content is kept up to date (Figure 6.4). Uptake of the info-portal reflects successful use, with 13 000 sessions on the info-portal and almost 30 000 pages within it viewed (Figure 6.4). However, the use of such a tool needs to be balanced in light of the knowledge of the intended users and the ease of using the info-portal and turning information into effective decision making. Feedback from respondents shows they found the sessions to be informative and made them aware of a range of projects related to the coast and coastal management (Respondent – course 3, 2018). This highlights the value of effective training, both on the application of the info-portal, how to interrogate for decision-making and more generally on ICM knowledge building which improves understanding within the ICM management framework of KZN.

In summary, analyses and evaluations showed that participants gained value from training sessions, although links to implementation were not clear. A challenge in retaining staff meant institutional memory was lost, which affected capacity building. The aim of the info-portal is that it would be able to serve as an institutional knowledge bank, storing ‘knowledge’ and information generated by authorities during their time employed and that this can, through the tool being passed on to new staff, allow them to build on this information. The info-portal ensures information remains readily available to decision makers and managers and consequently this research showed that its availability improved coastal decision-making and increased capacity.

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CHAPTER SEVEN: SYNTHESIS

7.1. Introduction

We live in the digital age; it is therefore not surprising that technological approaches are used to inform or assist coastal managers with their management objectives. This is evident in the plethora of spatial and decision-making tools available to managers, including information or data sites such as OZcoasts or NZ coast (Commonwealth Scientific and Industrial Research Organisation, 2017; NIWA, 2016). Through consideration of the international landscape, this research investigated ways of addressing the human capacity challenge through an information support system or info-portal (Information portal). The info-portal serves as a one-stop information hub, storing data and information relevant to the ICM decision making process. The motivation for this research was first identified by historical works relating to risk and vulnerability within the KwaZulu-Natal (KZN) province and the value add of an interactive support tool; namely the CVI-viewer. The CVI-viewer was developed as a result of an extreme weather event in 2007; it considered the physical risk of the coast to erosion and impact of future extreme events. However, the focus of this was narrow in application; while risk and vulnerability are critical ICM management foci, managers need support with short-term current management challenges, such as addressing new coastal development applications, coastal access transgressions, sewage spill actions, and estuarine breaching requests. These are the current management issues that are causing immediate adverse effects within the coastal zone and affecting coastal livelihoods, notwithstanding the long-term projections of climate related risk and vulnerability.

Chapter One provides an introduction, research aim and objectives and an overview of the methods applied and the process followed. Chapter Two is an overview of the current literature, considering global approaches to coastal management and the emergence of ICM; it looks more specifically at ICM in South Africa and the development of the ICM Act. This chapter considers the implementation of the ICM Act and the functions it assigns to provincial and local governments and the challenges they face. Lastly it provides an overview of decision support systems, tools or documents for coastal management both globally and in South Africa.

The crux of this research is presented in Chapters Three to Six as a series of peer-reviewed publications and submitted manuscripts that speak to the objectives detailed in Table 7.1. Chapter Three reviews historical and current coastal management policies and initiatives, both in South Africa and KZN, placing these within a global context. Chapter Four focuses on the ICM implementation

and limitations in KZN through consultation with those tasked with ICM implementation at the provincial and local levels. Chapter Five follows the lifecycle development of an information support tool to assist in improving ICM in KZN. Whilst Chapter Six considers how an information support tool adds value to the range of capacity building approaches available and how these complement each other to aid in coastal management decision making.

This chapter (Chapter Seven) integrates and provides a critical interpretation of these objectives and highlights how this contributes to improving ICM implementation at provincial and local levels.

7.2. Discussion

7.2.1. Integrated Coastal Management in South Africa

Integrated Coastal Management (ICM) in South Africa has undergone a significant transformation, shifting from a sectoral, bureaucratic and biophysical focus to a more holistic integrated approach rooted in participation, empowerment and the promotion of sustainable coastal livelihoods (Glavovic, 2006). The ICM Act goes beyond the scope of previous statutes to align with global issues such as climate change and promotes the pro-active interventions for this, such as the determination of coastal management lines (or setback lines) to control or limit future development. Significantly, it marks a change in how coastal space is managed; coastal public property is held in trust by the State on behalf of the Citizens of the Republic, it is inalienable and cannot be sold, attached or acquired (ICM Act, S11).

However, this has not been a simple feat; coastal management in South Africa has followed a lengthy process, taking ten years to move from a Green Paper to a dedicated Coastal Management Act. In addition, significant work was undertaken prior to this policy development phase with a Coastal Management Policy Programme (CMPP) being established between 1992 and 1997 (Glavovic, 2000; 2006). Participants in the CMPP process included representatives from government, business, community-based organisations (CBO), environmental non-government organisations (NGO) and sports and recreational sectors (DEAT, 1998); thus ensuring that the process was participatory and inclusive. Furthermore, there were a series of participation meetings held countrywide to identify issues and define visions for each coastal region (Glavovic, 2006). While lengthy, this process highlights the value of involving stakeholders as it insured public and government buy-in to the notion of ICM and the need for a dedicated coastal management act. Thereafter, the Green Paper was developed (1998), followed closely by the White Paper in 2000. However, the following eight years saw a lengthy, iterative process of developing the ICM Act, with the first draft receiving numerous

comments in 2006 and the Act being enacted in October 2008 (Glavovic et al., 2018). While the enactment of the ICM Act is a landmark achievement for South Africa, in many ways this marks the beginning of the complicated implementation challenge.

In an effort to improve integration of management, the ICM Act has decentralised management with greater provincial and local authority roles and responsibilities. While effective from a governance point, that local issues can be addressed at a local level, this has been assigned without any financial support or resources (Interview respondent pers. comm.). This is exacerbated by the fact that authorities' resources are already stretched, lacking the capacity to respond to service delivery and increasing development pressure. Not surprising, the uptake of this additional mandate has placed unwanted pressure on already under resourced authorities (Palmer et al., 2011). Thus, as can be expected, implementation of ICM and the ICM Act at the provincial and local levels has been slow with several milestones required by the Act not being achieved and very little 'change' in management evident. Local government's capacity to address ICM has been identified time and again as the main challenge; the National Coastal Management Programme for South Africa identifies capacity concerns as a major threat to sustainable coastal management in the country (DEA, 2014) and this is reiterated by this research. However, these issues are not new, with a lack of funding and human capacity having been identified as key issues in a 1997 assessment of ICM in KZN (Environmental Advisory Services, 1997).

The question remains: how do we improve implementation and achieve effective ICM? First, provincial and municipal authorities' ability to meet the targets posed by the Act are linked to a sound understanding of the legislative requirements and having the human and financial resources to achieve these, which appear to be lacking (Goble et al., 2017; Rosendo et al., 2018). So where do the resources for this additional unfunded mandate sit? Logically national government should support provincial government and provincial government should support local government, in terms of mentorship, facilitation, guidance and where necessary financial support. Higher spheres of government need to create an environment that helps lower spheres of government achieve better management. However, there is a clear absence of support from higher levels of government (Interview respondent pers. comm., 2014; Celliers et al., 2013). Thus as a coastal community for management and research, what we require are coastal management initiatives that empower government departments to support decision making through the best quality knowledge available that integrates natural and social science within the decision-making processes (Bremer and Glavovic, 2013).

7.2.2. Supporting ICM in KZN

While the ICM Act provides a sound framework for ICM, a framework is only as effective as its implementation, for which sufficient human capacity and knowledge are required. This was highlighted by an exercise undertaken with coastal managers during a 2018 training session in which they were asked to provide one word to describe their current views of ICM, and future wishes for ICM (Figure 7.1). It is evident that they feel under resourced, that management efforts are poor and challenging. Positively they desire training and education programmes, improved enforcement and integration (Figure 7.1).

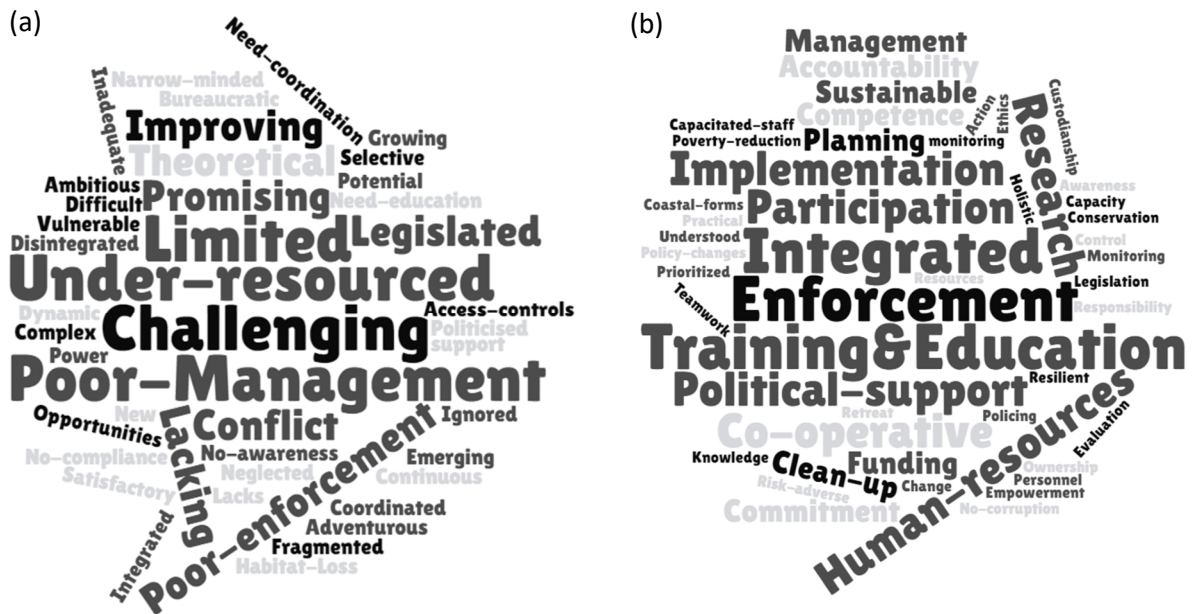


Figure 7.1: Coastal managers (a) current views of ICM on South Africa and (b) desired state for ICM (Source: ICM workshop, 19 June 2018, Durban: Esteves and Goble)

This research provides the first comprehensive assessment of the status of ICM in KZN and the implementation challenges being faced by managers; highlighting that the delegation of authority to provincial and local governments is where the greatest challenges lie. Pivotal to improving ICM, at both the provincial and local levels, is the role of the lead agent for ICM in the province, for KZN this is the Department of Economic Development, Tourism and Environmental Affairs: Biodiversity and Coastal Management Unit. The unit needs to take a more proactive role and move away from a ‘precautionary, diplomatic’ approach (Interview respondent pers. comm., 2014) and show accountability, taking on administrative responsibility (Environmental Advisory Services, 1997). So what is required for ensuring effective ICM? Are the knowledge requirements and technical skills

needed at these levels an elusive, unattainable concept (Celliers et al., 2015), or can interventions aid in improving this situation?

Training and capacity building workshops have been offered by both national and provincial governments for several years on a wide range of topics, including an overview of ICM and the ICM Act, compliance monitoring and enforcement for ICM, coastal risk and vulnerability, estuarine management and ecosystems-based management for coastal areas (Appendix A). This research considers the value of these to managers through ongoing engagement with attendees; it determined that while sessions were well received and are considered to have improved the knowledge of government officials, there are some concerns or limitations. Focus on training should be constrained, as high staff turnover prevents the continuity of this knowledge and sessions need to be repeated (Interview respondent pers. Comm., 2014; Deloitte and Touche, 2013). This has resulted in the consideration of alternative approaches to transferring or sharing knowledge and improving governance capacity. This research considered the development of an alternative information support tool or info-portal; the aim of which is to house all data and information relevant to the ICM decision making process, simplify this and present it in a user-friendly format that can inform the decision-making process. In addition, this tool acts as a 'knowledge bank', retaining information, data and knowledge in spite of staff turnover.

The need for such a tool was identified by the shortcoming of a historically developed tool for the KZN province; the CVI viewer (Appendix B). The main constraint was that it was limited in its application, focusing on issues pertaining to risk and vulnerability, albeit a critical aspect of coastal management, with risk and vulnerability being linked to loss of life and property within the coastal zone. However, coastal managers require increasing assistance with current or daily management challenges in addition to longer term planning for risk, vulnerability and climate change. Managers need information readily available to inform on applications for estuarine breaching, for new coastal developments and for identifying transgressions within the coastal zone. Pressures on the coastal zone for new developments are increasing significantly and managers need integrated information to inform decision making. One of the main hurdles is that managers are required to have a broad range of expertise relating to the coastal environment, the social dynamics and economic setting. These challenges lend itself to the introduction of an info-portal that provides the information to support this decision-making process.

One of the challenges this raises is that of custodianship of the tool and responsibility for its maintenance and management. While the tool has been developed through a participatory approach to ensure buy-in, it is currently independently maintained and managed by an NGO. This does raise a number of issues. The long-term sustainability of such a tool if funding is not maintained and significantly having individuals or organisations to buy-in to the process and contribute information and data. While users indicated they are happy and willing to share information via the info-portal, this still needs to be tested. Gaining political or government buy-in is a challenge, as there is no legal requirement for government officials to utilise the tool or data it provides. However, the strong focus on the participatory development aims to ensure all stakeholders have input into what should be presented. Thus ensuring they utilise the tool and its functions voluntarily, and user feedback supports this.

7.2.3. Developing the info-portal

This research conceptualised and developed an info-portal for the KZN province; this is a first for any of the provinces in South Africa (Appendix C). While subsequent efforts are being made at the national level, this is the only available tool focusing on provincial level information and data. Technical development of the info-portal followed a similar approach to that of developing a decision support system (DSS), using the DSS lifecycle development approach proposed by Turban et al. (2005). The approach considers the need for a support tool, the planning for the tool, analysis of data and information to be included, development and design phase, implementation of the tool and an evaluation. This process is robust and ensures that each phase of the tool's development is clearly planned and executed. A participatory approach was followed in developing the info-portal, which ensured input from key stakeholders and the intended target audience. The process was iterative, with a number of the lifecycle steps being revisited, refined and redesigned. Input from stakeholders and intended users were gathered via a series of surveys with key coastal managers at provincial and local level. By including stakeholders early on in the development process, they became invested in its success. However, some initial parties consulted in the test phase elected not to engage in the process; stating lack of time as the reason. Members of the public indicated that they had no direct link to ICM and were therefore not able to make time to comment on the info-portal.

Even though the info-portal is operational and in use by managers, the development and management remain an ongoing process, with feedback from users continuing to be assessed and integrated into the tool. Information sharing via the info-portal is two way, on the one hand scientific information is distilled and presented to managers and the public, and on the other it provides an opportunity for

users to offer information and contributions. In this way the info-portal is effective at providing an interface between science and socio-economic needs. Given this ongoing feedback, the tool is still being refined to present a wider array of data, information and policy documents, and ongoing improvements to the interface and navigation. This is necessitated by the rate at which technology changes for tools developed within a web environment.

7.2.4. Methods applied

A series of on- and off-line surveys and interviews with key coastal managers at a provincial and local level provided invaluable information as the basis for this research (Appendix D and E). One-on-one interviews with key government officials at the local and provincial levels followed a semi-structured approach. Interviews are imperative as there are a limited number of managers involved with ICM at these levels. Thus, interviews allow for personal interaction and an opportunity to gain a better understanding of the actual management challenge being faced, the frustrations felt and the areas where training and interventions could assist. Personal engagement with managers empowers managers to be part of the development process, offering their personal specific requirements and providing feedback on the info-portal.

Following each training session, attendees were asked to complete an evaluation survey, the response rates for which were high and informed how future training sessions were structured and the content presented (Appendix F). In terms of the info-portal, at training sessions and any users accessing the site are asked to complete an online survey pertaining to its use and functionality; given that this was a voluntary survey, the response rates were lower (Appendix G). However, feedback was extremely useful and ensured refinement and redesign of aspects of the info-portal. Given the nature of the info-portal, being an online tool, this approach to gathering feedback is considered to be the most appropriate. The challenge still remains as to how to encourage users to provide feedback, particularly users that are not satisfied with the tool.

7.3. Evaluation

The research aim and objectives are reviewed as follows.

Objective 1: To provide an overview of historical and current coastal management policies and initiatives in South Africa, with a focus on the KwaZulu-Natal Province.

Integrated Coastal Management is a complicated arena; managers are required to have a broad range of information, covering a diversity of topics. This objective considers coastal management in the

international area and the process undertaken in South Africa. This is achieved through a review of the current literature and the authors own knowledge and dealing with ICM within KZN. This highlights some of the challenges and links to the aim which speaks to an alternative for assisting in ICM decision-making.

Objective 2: To review current ICM implementation and limitations in the KwaZulu-Natal Province

ICM implementation within KZN, as with other coastal provinces in South Africa, has been met with mixed success. To better understand the challenges managers are facing, a survey was circulated and a series of one-on-one interviews with selected persons within the case study area were undertaken (Appendix D and E). Information obtained was synthesised through a DPSIR framework. This allowed for the identification of the ICM ‘pressures’ felt on the ‘state’ of ICM implementation the ‘impact’ this has on the coastal environment; as well as to identify the possible ‘responses’ that can be applied to facilitate better ICM at the local level. This suggested that respondents were generally positive with regards to the ICM Act and believed that it can lead to better management of the coastal environment. However, there are a large number of ‘pressures’ that affect the ‘state’ of implementation that need to be addressed. Most significantly local government’s capacity and ability to address ICM, given limited human capacity and financial resources. This publication highlights that human capacity issues and a lack of ICM are prevalent, meaning there is scope for alternative interventions as proposed by the aim of this research, which proposes the developed of an alternative ICM information platform to assist coastal managers.

Objective 3: To develop an information support tool for to assist in improving KwaZulu-Natal's coastal management.

Following on from objective two, where the space for alternate aids for provincial and local level ICM support was identified, this section reflects on the development of such a platform. Evaluating the design, development and implementation of a ‘one-stop’ information portal for KZN coastal managers and users and in so doing draws on a range of scientific data. Development of the info-portal followed an adapted version of the DSS lifecycle development as outlined by Turban et al. (2005), whereby six steps were followed; 1) need, 2) planning, 3) analysis, 4) development and design, 5) implementation and 6) evaluation. For the evaluation user-feedback was obtained via a series of surveys, which informed refinements and redesign of the portal (Appendix G). Feedback from users suggests that the tool is considered useful and meaningful for ICM decision making,

showing that this objective is met and speaks directly to the overall aim of the research of developing an alternative ICM information platform to assist coastal managers

Objective 4: To assess the range of capacity building approaches and how the development of an information support tool for KwaZulu-Natal has aided coastal management decision making.

This objective considers the value of the proposed information portal (info-portal), how successful its utilisation or adoption has been and how this integrates with the more traditional approaches to capacity building. Does it take the place of traditional training and capacity building approaches or do they in fact complement each other? Following each training session, surveys were used to gather information from course attendees and/or users of the info-portal (Appendix F, H, and A). Additionally, attendees of the info-portal training were encouraged to provide feedback on the tool (Appendix G). This was assessed through a conceptual framework that considered the success of the info-portal. Respondents found value in the info-portal for a wide range of reasons; however, some underlying knowledge with regards coastal systems is required. This speaks directly to this objective in considering the range of approaches applied within KZN. It highlights the value of both traditional topic specific training sessions and the value of the info-portal as a support tool to improving knowledge transfer and capacity building at the provincial and local levels. Again, this links to the overall aim of this research which is the consideration of such a platform to assist coastal managers (Appendix C).

7.4. Suggestions for further research

This info-portal has been well received by coastal managers within KZN, in fact user stats show that people outside of KZN and even South Africa are accessing the tool for information. Future research needs to consider the scope of such a tool and the advantages and disadvantages of making it applicable to a larger spatial area. The risk of this is that it may result in a dilution of specific management information.

There are two key factors that facilitate the need to revisit the lifecycle development of the info-portal and review the need, planning, analysis and development and design stages. Firstly, user needs and requirements change over time as their knowledge changes and the environment they are managing changes. Secondly, technology is continually developing and changing thus the system needs to adapt. This will require additional training sessions with users in order to ensure ongoing utilisation of the tool. However, one of the main obstacles in maintaining and refining the tool is generating or

accessing, relevant, applicable data and information that can assist in improving the quality of information presented in the tool. This requires a higher degree of engagement with experts in the field and agreement on the overall value of data and information sharing.

Aspects of this research have focused on a single tool and a single method of facilitating training. It touches on the value, or limited value, of traditionally developed guideline documents in South African for provincial and local level implementation. Future research should consider the value of these, and other novel approaches such as cell phone applications and webinars within a national or international context.

7.5. Conclusions

The coastal environment is complex, offering a diverse range of goods and services. This makes coastal areas extremely valuable to people worldwide. Coastal authorities are faced with the momentous task of managing and balancing long-term human needs, while maintaining coastal ecological functionality. It is critical that knowledge and information with regards to coastal areas is transferred to coastal managers leading to informed decision making and effective ICM.

This research followed a stepwise approach (Figure 1.3), from consideration of the ICM arena for South Africa, and particularly the KZN province to the development and realisation of an ‘info-portal’ support tool. This was undertaken by means of a series of objectives and associated publications (Table 7.1), which resulted in the development of a strategy for increasing institutional capacity and improving decision-making at the provincial and local level.

Table 7.1: Objectives and publications

Objective	Publication
To provide an overview of historical and current coastal management policies and initiatives in South Africa, with a focus on the KwaZulu-Natal Province.	Goble, B.J., Lewis, M., Hill, T.R. and Phillips, M.R. (2014) Coastal management in South Africa: Historical perspectives and setting the stage of a new era. <i>Ocean and Coastal Management</i> , 91: 32-40.
To review current ICM implementation and limitations in the KwaZulu-Natal Province.	Goble, B.J., Hill, T.R. and Phillips, M.R. (2017) An Assessment of Integrated Coastal Management Governance and Implementation Using the DPSIR Framework: KwaZulu-Natal, South Africa. <i>Coastal Management</i> , 45: 107-124.
To develop an information support tool for to assist in improving KwaZulu-Natal's coastal management.	Goble, B.J., MacKay, C.F. and Hill, T.R. (2018) Design, Development and Implementation of a Decision Support info-portal for Integrated Coastal Management, KwaZulu-Natal, South Africa. <i>Environmental Management</i> , 64 (1): 27–39
To assess the range of capacity building approaches and how the development of an information support tool for KwaZulu-Natal has aided coastal management decision making.	Goble, B.J., Hill, T.R. and Phillips, M.R. (2018) Building institutional knowledge for effective Integrated Coastal Management decision making; KwaZulu-Natal, South Africa. Manuscript submitted for publication. (Manuscript ID: CJOE-2019-0005).

This info-portal offers integration of holistic data and information relating to the coast and decision making, through which it aligns with the international objectives of ICM; Cicin-Sain and Knecht (1998, p39) highlight that ICM should:

“Overcome fragmentation inherent in both the sectoral approach and the splits in jurisdiction among levels of government”.

This is fundamentally what the info-portal aims to achieve, whereby information provided to managers and users helps tackle the interlinked problems of coastal development and conservation within KZN as required by the ICM Act. Furthermore, training sessions brought together a wide range of coastal managers across different spatial jurisdictions, spheres and levels of government.

While the development of this info-portal identified that a support tool of this nature is extremely valuable, in itself it is not sufficient. Managers are often from the planning field, with limited background in ICM, its complexities and management challenges (Rosendo et al., 2018). Thus, more is required, traditional training approaches on specific ICM topics or challenges was found to be effective at empowering decision makers to use the information presented in the info-portal to make informed decisions on coastal issues in the province. A combination of both is required to aid in improving ICM knowledge and in turn decision making in KZN.

This research aimed to facilitate direct support for KZN’s ICM programme through an info-portal, this is realised through an online platform, www.coastkzn.co.za. The finding of this research was undertaken over several years, with engagement of authorities and decision makers throughout. This allowed for a better understanding of the changing environment within which management is undertaken. While the historical content is outlined in chapter three, chapter four aims to develop a deeper understanding of the overall challenges in the KZN context. This in turn informs the process, testing and implementation of the unique info-portal. This process has added to the long-term management and sustainability of coastal areas in the province through improved understanding of the knowledge gaps and approaches to improving human capacity for under resourced and underfunded authorities. It has considered the traditional capacity building approaches and the success of integrating these with newer technologic approaches. Therefore, the thesis represents the incremental development of KZN’s implementation of ICM. The info-portal has shown success in informing decision making through assisting managers in their determination as to what, if any, environmental authorisations are required for new developments through showing the position of the various triggers. In addition, the info-portal has simplified access to relevant legislation and supporting information, thereby streamlining the ICM planning and implementation process. (O. Parak, 2018,

pers. comm.). This links back to the research aim of enhancing institutional knowledge within KZN through the development of an information support tool that improves manager's knowledge of the coast and integrated coastal management, leading to an improved coastal decision-making process. While this tool has seen success in its implementation and utilisation, what remains important is that the long term value will only be realised through ongoing utilisation and maintenance of the info-portal. This will ensure the inclusion of additional content by those that support ICM outside of the government framework. Furthermore, this is not a simple once off solution. Support for ICM is required through ongoing training sessions, both relating to the use of the info-portal and on specific ICM topics that will ensure users can use and interpret the information and data present in the info-portal appropriately.

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APPENDIX A: SUMMARY OF ATTENDANCE AT TRAINING SESSIONS

The following shows the breakdown of spheres of government that attended the various training sessions.

Table F.1: Three key ICM related training sessions hosted by provincial government between 2014 and 2018

	Training 1 (2014)	Training 2 (2016)	Training 3 (2018)
Provincial Government	4	8	15
District / local government	38	11	13
National government	3	3	5
Nature conservation / other		3	6

Table F.2: Four CoastKZN training sessions on use of the info-portal

	Session 1	Session 2	Session 3	Session 4
Provincial Government	20	11	3	4
District / local government	4	7	3	1
National government	1	6	5	1
Nature conservation / other	1	6	4	9

APPENDIX B: PRELIMINARY COASTAL VULNERABILITY ASSESSMENT FOR KWAZULU-NATAL, SOUTH AFRICA

The following presents a paper: Palmer (Goble), B.J., Van der Elst, R., MacKay, F., Mather, A.A., Smith, A.M., Bundy, S.C., Thackeray, Z., Leuci, R. and Parak, O. (2011) Preliminary coastal vulnerability assessment for KwaZulu-Natal, South Africa. *Journal of Coastal Research*, SI64: 1390-1395. This forms a key motivation for the development of this info-portal, as the process for the research that fed into this highlighted its short-comings and the need for something more holistic and integrated. This this has significantly informed the methods and motivations of this study.

ABSTRACT

The KwaZulu-Natal (KZN) coast is a popular tourist zone and therefore one of the most important assets underpinning the economic activities of this South African Province. As with many coastal regions, the disproportionately large human settlement at the coast has led to increased pressure on the coastal zone. Development increases bio-physical changes, leading to an escalation in environmental risks affecting coastal populations, infrastructure and natural coastal environments. The events induced by a rapidly changing climate added to coastal zone development potentially introduce synergistic negative responses that might or might not be predictable. Therefore there is a need to develop methods that assess coastal vulnerability, and determine how best to managed this risk. This paper reports on the development of a technique that investigated the relative coastal vulnerability of the KZN coast to erosion and extreme weather events. A Coastal Vulnerability Index (CVI) was developed based on remotely sensed data whereby a set of physical coastal parameters, which serve as indicators of risk or vulnerability, were captured. The CVI scores were used to rank the coast, based on its relative degree of vulnerability into five classes ranging from very low to very high and highlights what proportion of coast falls within each class. Coastal vulnerability must inform management, thus this assessment attempts to address social, economic and ecological factors by identifying indicators and assessing them in relation to the finding of the CVI to determine what structures and features are within areas of very high CVI scores. The information presented provides input into a decision support tool that will facilitate the effective and user-friendly transfer of this important information.

ADDITIONAL INDEX WORDS: Coastal Vulnerability Index (CVI), erosion, storm events, GIS

INTRODUCTION

In most coastal nations there is an uneven distribution of populations with the highest concentrations and associated developments located in coastal regions. More than a third of people in eastern and southern Africa reside within 100 km of the coast (UNEP/Nairobi Convention Secretariat, 2009). The KZN coast is especially popular being one of the densely populated coastal areas in Africa (Department of Environmental Affairs and Tourism (DEAT), 1999). The reasons for human concentrations at the coast include a preferred living environment and as a zone that provides additional ecosystem services, especially in times of drought, war and economic stress (DEAT, 2006). This disproportionate settlement at the coast has led to increased pressure on the coastal zone though resource exploitation, land-based pollution and coastal development (UNEP/Nairobi Convention Secretariat, 2009).

Developments affect natural coastal functioning, in particular, the equilibrium between terrestrial shoreline environments, the beach and near-shore bathymetry. In extreme cases, this leads to the loss of natural coastal functioning leaving the coast vulnerable to the impacts of sea-level rise, coastal erosion, extreme weather and other coastal hazards (O'Connor et al., 2009). It thus follows that coastal populations, infrastructure and natural coastal environments stand to be adversely affected as coastal

development escalates (Hinrichsen, 1995; Kumar et al., 2010; Snoussi, Ouchani and Niazi, 2008). In recognition of these risks, there is a need to develop methods that assess coastal vulnerability and how best this can be managed or mitigated (Cooper and Mckenna, 2008; McFadden, Nicholls and Penning-Rowell, 2007).

The limitations of many past vulnerability assessments have been characterised by having low spatial resolution, relying on averaged global data and simplistic assumptions (Hinkel and Klein, 2009). This, coupled with unprecedented coastal development and climate change risks, makes it imperative that vulnerability assessments are refined and upscaled to include coastal processes at a local scale. The need for local scale assessments is further highlighted by disaster events (McFadden, Nicholls and Penning-Rowell, 2007), such as the 2007 KwaZulu-Natal (KZN) coastal storm, a significant event which caused extensive coastal erosion and severe damage (Smith et al., 2007; 2010; Mather 2008). Recurrence estimates for the March 2007 event range from 10 to 12 years based on historical erosion events (Mather, 2008), 20 years, based on the historic record (Guastella and Rossouw, 2009), 35 years, based on wave heights (Mather 2008.), 500 years (Theron and Rossouw, 2008) and 600 years based on coincidence of the Highest Astronomical Tide and storm wave heights (Mather 2008).

In light of this 2007 event, and the potential for its reoccurrence the KZN provincial government recognised the need to better understand the vulnerability of its coast. This paper reports on the development and testing of a Coastal Vulnerability Index (CVI) that divides portions of the coast into relative, predefined 'risk' classes. Vulnerability is defined as the inherent risk, relating to its physical predisposition to be affected, or to be susceptible to damage from events (Kumar et al., 2010). The step-based procedure includes 1) Assessing physical coastal vulnerability 2) Listing resources and services 3) Assigning values to these goods and services 4) Identifying the vulnerabilities of each resource/service and 5) Mitigating or removing the risks for the most important resources. CVI assessment is based on remotely sensed data and processed by means of GIS methodology. This method is particularly useful as it does not rely on detailed, precise or long-term data, which when working at a regional scale is rarely available and costly to produce (Bryan et al., 2001).

A limitation of many vulnerability studies is that they focus only on the physical characteristics of vulnerability with little inclusion of economic and ecological aspects (Boruff, Emrich and Cutter, 2005). This assessment identifies social, economic and ecological indicators and assesses them in relation to the finding of the CVI to determine which populations and associated infrastructure are potentially at risk.

STUDY AREA

This research focuses on the 580 km sub-tropical coastal zone of KZN, a province on the east coast of South Africa (Figure 1) with a mean annual rainfall of 845 mm. The coast is generally linear with few bays and no islands or offshore barriers. About 80% of this coast comprises stretches of sand, with the rest characterised by intermittent rocky outcrops, especially in the south. Sandy beaches, combined with the high-energy, swell-dominated nature of the coast and an average 2 m diurnal tidal cycle make the coast vulnerable to erosion (Mather, 2010; Smith et al., 2010), which is exacerbated by sea-level rise (Mather, 2007; Mather, Garland and Stretch, 2009) and increasing storm frequency (Guastella and Rossouw, 2009). This was highlighted recently when a large swell, associated with a cut-off low weather system (Smith et al., 2007) struck on the 2007 March equinox, near the peak of the lunar nodal cycle (LNC) (7/10/2006). This triggered catastrophic erosion (Mather, 2008; Smith et al., 2007) and was further underpinned by a period of unusually high swells (Significant wave height $H_s = 3$ to 5,5m) prior to and during the 2007 austral winter (Smith et al., 2010). Historical image analysis has shown that this coastline experiences bouts of strong erosion alternating with periods of non-erosion and even deposition in some places (Cooper, 1991a; b; 1994). However, this information is coarse due to the lack of availability of continuous imagery for the coast. More recently Smith et al. (2010) have

suggested that episodic coastal erosion may be linked to the eighteen year lunar nodal cycle (LNC).



Figure 1: Location of the KwaZulu-Natal coastal zone

The warm climate, rich coastal biodiversity, availability of flat land offering high aesthetic value, coupled with concomitant lifestyle, tourism, wealth for coastal retirement and an increase in holidayhomes has resulted in intense urban development and high population densities along the coast (DEAT, 1999). KZN's coastal municipalities have a combined population density of 322 people per km², while inland municipalities have a population density of only 64 people per km² (Statistics South Africa, 2001). Notwithstanding this high density, the distribution along the coast is not uniform with almost no development in the far north, in the iSimangaliso Wetland Park (a proclaimed World Heritage Site of 332 000 hectares). At other locations, developments and supporting infrastructure have often been poorly planned and sited, frequently increasing the area's susceptibility to coastal hazards, erosion and storm events (*pers obs.*).

METHODS

Relative physical coastal vulnerability

The central element of this method involves dividing the coast into 50 m by 50 m cells and rating each in terms of its degree of vulnerability based on the identification and examination of key indicators of physical vulnerability. Rygel, O'Sullivan and Yarnal (2006) highlighted the usefulness of indicators as proxies for vulnerability assessments, especially if they can be used in identifying and monitoring changes in vulnerability over time and space, thereby improving knowledge about underlying processes of vulnerability and aid in the development of strategies for reducing vulnerability.

The CVI process is designed as a quick method of assessing coastal vulnerability; consequently the list of parameters used is kept short, stressing only the most important and easily assessed. In this assessment seven physical parameters were evaluated and reviewed by specialist consultation⁷. These parameters were critically examined as to the relative suitability of each in a coastal vulnerability assessment. Five physical parameters were

⁷ Involving a group of specialists in geomorphology, oceanography, coastal engineering, coastal management and sociology.

finally selected as the most suitable indicators, namely: beach width, dune width, percentage rocky outcrop, distance (width) of vegetation behind the back beach and distance to the 20 m isobath. It was further noted that the parameters would have different levels of response/protection of the coast depending upon the magnitude of the impact. Thus, each of the parameters was weighted according to its value and corresponding perceived level of risk. This was validated by comparison to historic data from known past coastal erosion event impact sites. Hence the weighting of the magnitude of individual parameters, as outlined in Table 1, was (1) extremely low, (2) low, (3) moderate or (4) high depending on its value and range.

The actual measurement of the indicators was based on orthophotographs. For the northern and southern coasts (Figure 1) imagery captured in late 2007/early 2008 with accuracy to standard deviation m.s.e. (mean squared error) of 0.25 m. For the central coast mosaic imagery captured in 2007 supplied by the eThekweni Municipality were used for this area (Figure 1).

Data were captured as point data along transects between the low water mark and the back beach (Figure 2), with transects roughly at 30 m intervals, depending on orientation of the coast. Beach width was calculated directly from transect length, while dune width was based on the width of the dunes behind the back beach coordinates. The distance to the 20 m isobath was calculated by identifying the nearest point of the 20 m isobath from the back beach coordinates while bathymetric data were derived from South African Navy Hydrographic charts. Percentage outcrop was based on the percentage of rocky outcrop exposed along each transect, while distance of vegetation behind the back beach was determined as the width of vegetation behind the back beach coordinates. To facilitate analysis, point data were then averaged into a grid file of 50 m by 50 m cells along the littoral active zone of the KwaZulu-Natal coast. Sites that portrayed evidence of historical erosion, primarily as a result of the March 2007 storm event, were identified from orthophotographs and assessed as a subset of the coast.

Statistical analysis and specialist input concluded that beach width, dune width and distance to the 20 m isobath were the most critical indicators. The wider the beach, the more wave energy is dissipated. Beach width is also a proxy for beach slope, as areas with lower beach widths are invariably steeper and less able to dissipate energy. Dune width gives an indication of coastal protection and provides an estimate of sediment available to buffer erosion and accommodate leeward deposition of marine derived materials.

Table 1: Rating of physical parameters

Physical Parameter	Extremely Low (1)	Low (2)	Moderate (3)	High (4)
Beach width	> 150m	100 – 150m	50 – 100m	< 50m
Dune width	> 150m	50 – 150m	25 – 50m	< 25m
Distance to 20m isobath	> 4km	2 – 4km	1 – 2km	< 1km
Distance of vegetation behind the back beach	> 600m	200 – 600m	100 – 200m	< 100m
Percentage outcrop	> 50%	20 – 50%	10 – 20%	< 10%

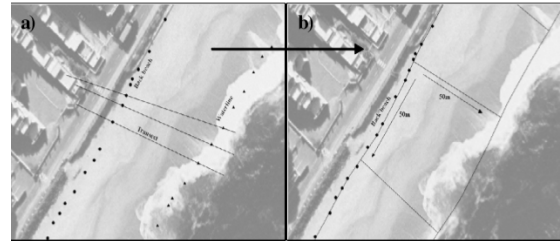


Figure 2: Depicts the method of data capture along transects. a) shows the transects along which data were captured, b) shows the 50 m x 50 m grid into which data were converted

The offshore distance to the 20 m isobath relates to subtidal bedform and wave energy; the greater the distance, the greater the dissipation of wave energy and therefore the greater the reduction of erosive energy (Mather, Stretch and Garland 2010). Thus sites that scored high on all three indicators were at greater risk (Table 1). In order to emphasise their high scores and collective impact, sites were identified and weighted by an additional factor of 4. In addition, due to their sensitive and dynamic nature, estuarine mouths⁸ were also weighted by an additional factor of 4, so as to highlight the potential increased risk for these sections of coast. Based on the scoring and weighting, each cell received a total relative vulnerability score.

$$\text{Relative CVI} = a + b + c + d + e + f + g$$

Where a = beach width vulnerability score, b = dune width vulnerability score, c = distance to 20 m isobath vulnerability score, d = percentage outcrop vulnerability score, e = distance of vegetation behind the back beach vulnerability score, f = additional weighting of highly vulnerable sites (if a, b and c = 4), g = additional weighting if the cell intersects an estuarine area.

Social, economic and ecological components

Key to the method is that physical vulnerability was assessed *a priori* and social, economic and ecological components were evaluated on the physical vulnerability *a posteriori*. A suite of key features was identified (Table 2) and their relationship to *very high* vulnerability cells assessed. Features were grouped into economic and

⁸ Only the mouth was included as this relates to its interaction with the coast and how it could be influenced by coastal processes

commercial activities, strategic infrastructure, recreational resources, subsistence areas, ecologically important areas and residential properties (Table 2). These features were seen to be located in one or both of two zones: (i) those that fall directly in the littoral active zone (and seaward), and therefore in areas of *very high* vulnerability, and (ii) those adjacent to, or inland of the littoral active zone and are therefore areas of *very high* vulnerability, (Table 2). Only features occurring within 100 m of the High Water Mark (HWM) were assessed, based on the coastal zone definition under the South African Integrated Coastal Management (ICM) Act (Act 24 of 2008)⁹. Data for this phase were sourced from several available spatial databases.

RESULTS

A total of 11 616 cells were identified and evaluated yielding CVI scores ranging from 9 to 28, with a mean of 17 (Figure 3). The distribution of the CVI scores was strongly aggregated around the mean with mid-half (25th to 75th percentiles) of cells falling between CVI's of 15 and 19. Accordingly, the mid-range was considered to be at *moderate* risk, higher values (20–28) at higher risk and lower values (9 – 14) at lower risk (Figure 3). The historical erosion site data were processed separately, giving CVI values of 13 to 28 in 1082 cells, with a mean of 20. The 25th to 75th percentiles (mid-half) were in the range of CVI values: 17 to 22, clearly higher than the total coast values (Figure 3). The higher CVI values thus ranged from 23 to 28 and the lower values from 13 to 16. These results were used to “refine” the main dataset by splitting the higher and lower levels of CVI as indicated in Figure 3.

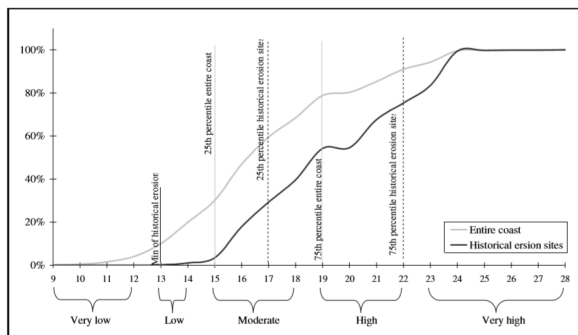


Figure 3: Range of vulnerability scores for the KZN coast

The study revealed that 9% of the KZN coast has a relative coastal vulnerability of *very high*, which equates to almost 52 km of coastline. Some 12% of the coast (~70km) has a vulnerability of *high*, the majority of the coast at 68%

(~343km) of *moderate*, 16% (~93km) of low and 4% (~23km) of *very low*. Not surprisingly, analysis of the historic erosion data subset gave significantly different results with 25% as *very high*, 21% as high, 53% as *moderate*, 1% as low and none for very low. Of the 52 km of the coast that scored *very high*, 26% of these cells corresponded with historical erosion sites.

Social, economic and ecological component

Features located in or across the littoral zone (Table 2) were considered at relatively higher risk if all, or a proportion of them, fell directly within a cell of *very high* vulnerability. The results are presented in Figure 4. From an ecological perspective, turtle nesting sites and estuary mouths are at the highest risk with 50% and 26% respectively falling within cells of *very high* CVI. Socially, swimming beaches are significantly affected, with 41% falling within cells of *very high* CVI.

Figure 5 shows the risk to inland features, 100 m from the HWM. Although dune mining areas and forest plantations were identified as key indicators for economic features, none of these activities are located within 100 m of the HWM, but are nevertheless very close to this zone and could still potentially be at risk. Similarly, sports facilities were identified as a recreational indicator but none are located within 100 m of the HWM. Rail lines are seen to have the highest proportion at risk, with 70% being adjacent to the HWM of *very high* CVI cells. Other economic features of concern are commercial and industrial buildings and commercial farms with 51% and 50% respectively being located adjacent to the cells of *very high* CVI scores. Socially, subsistence farming is of concern with 59% being located proximal to cells of *very high* CVI scores.

Not all features in the coastal zone (up to 100 m from the HWM) of areas adjacent to *very high* CVI cells are potentially at risk. Rather, this risk is influenced by actual proximity to the HWM. Figure 6 shows the distance of features from the HWM in these zones. It shows proportions within 2, 5, 10, 50 and 100 m of the HWM of *very high* CVI cells. It is evident that of coastal public property within 100 m of very high vulnerable cells, 37% are within 2 m of the HWM, resulting in significant risk for these areas. Of commercial farms 33% have their seaward boundary within 2 m of the HWM. For ecologically significant areas, protected areas have 67% of their seaward boundaries within 2 m of the HWM and an additional 33% within 5 m.

⁹ The ICM Act defines the coastal zone as being 100m in urban areas and 1000m in rural areas. For the purpose of this assessment only

features within 100m of the High Water Mark were considered as features further inland are unlikely to be at risk.

Table 2: The grouping at which social, economic and ecological assets were assessed

Economic & commercial activities	Strategic infrastructure	Recreational areas	Subsistence sites	Ecological important areas	Residential properties
Dune mining	Piers [#]	Boat launch sites [#]	Subsistence fishing sites [#]	Marine Protected Areas [#]	Residential erven
Forest plantation	Roads	Fishing hot spots [#]	Subsistence harvesting sites [#]	Bird sanctuary sites [#]	
Sugar cane	Railway lines	Swimming beaches [#]	Subsistence farming areas	Turtle nesting sites [#]	
Commercial & industrial buildings	Lighthouses	Sports facilities		Estuary mouths [#]	
Commercial farms		Coastal Public Property ⁴		Protected areas (terrestrial)	

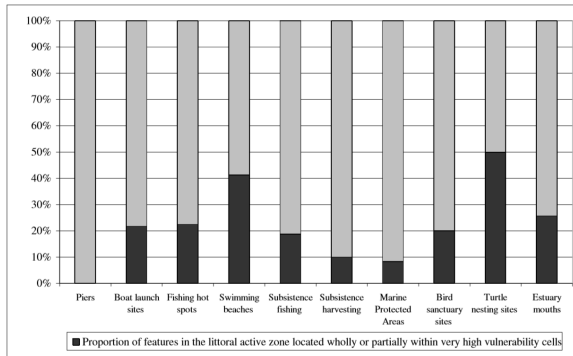


Figure 4: Proportion of features in the littoral active zone located wholly or partially within *very high* vulnerability cells

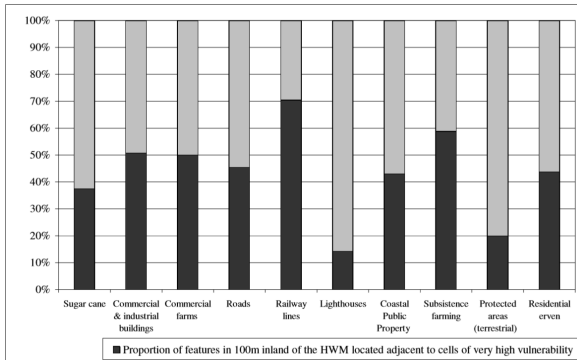


Figure 5: Proportion of features within 100m inland of the HWM and located adjacent to cells of *very high* CVI

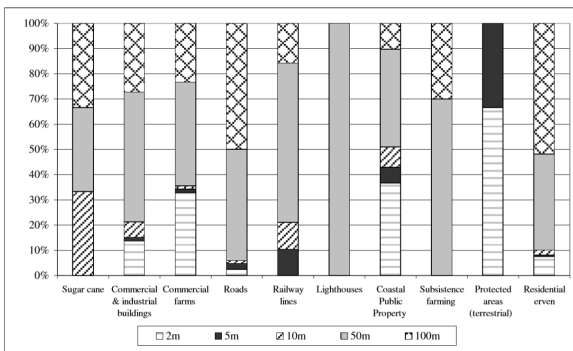


Figure 6: Features within varying distances of the HWM of *very high* CVI cells

DISCUSSION

Through an extensive process of iterative evaluation, five physical parameters were selected as indicators of coastal vulnerability in this study. These were either evaluated individually or given an additional weighting when they operated synergistically. Results were then “validated” by using known data from historic erosion sites. Although the CVI estimates are not an absolute indication of vulnerability, they do provide a relative index. Given that the KZN coastline has experienced considerable erosion damage in the past, and it is evident that there is a repetitive return period associated with these events (Smith et al., 2010) it is to be expected that such events will be experienced again and that the relatively higher CVI sites will be most at risk. Consequently, this provides coastal managers with planning advice and early warning insight for the future.

Some high CVI values corresponded to natural physical parameters, such as narrow beaches, dunes etc. Others are directly attributable to development and other anthropogenic induced changes to the coastal environment. For example, developments too close to the HWM may impede the natural landward retreat of dune and beaches, thereby reducing their effect in preventing structures in these areas being placed at risk. (Figure 7). In terms of future management, authorities should ensure that natural areas where biophysical functionality is unimpeded are maintained and that developments close to the HWM are not approved without due consideration of the need for such development versus the associated negative impacts that may arise. In cases where developments already exist, but have been damaged, rebuilding in the same location should be reviewed or alternatively relocated leewards.

In the context of these social, economic and ecological features a better understanding gained as to the implications of this vulnerability for management. The measure of vulnerability is related to the coverage of the feature in or in proximity to a *very high* CVI cells and serves to indicate what actions should be taken to manage risk to these assets. Thus consideration was only given to coastal structures and features of social, economic and ecological importance that were located in proximity to the 52 km of coast that has *very high* CVI scores. Proximity to the HWM clearly needs to be considered when evaluating the degree of vulnerability of structures and features that are located further inland. For example, 51% of commercial and industrial

properties within 100 m of the HWM, are located adjacent to areas of *very high* CVI scores - a large proportion that potentially are at risk. Proximity of these features to the HWM is key to determining the degree of relative risk (Figure 8), with only 14% of them are within 2 m (vertical distance) of the HWM and therefore more likely to be affected than structures further inland (Figure 8).

Evident from this assessment is that zones of vulnerability can be identified for future management focusing on risk. Features that are located directly in the littoral active zone are somewhat easy to address - they are either in a *very high* vulnerability area or they are not. The implications for management may however be more complicated in urban areas where likely to be little room for retreat/ relocation or adaptation under future sea-level rise scenarios (Mather, Roberts and Tooley, 2010) and management interventions need to be carefully planned through the use of Coastal and Shoreline Management Plans. This assessment highlights that sections of the KZN coast are vulnerable to coastal erosion. In some instances social and economically important infrastructure also stand to be affected as it is too close to HWM. Present and future management needs to determine the best management: leave as is, defend or retreat, depending on the feature's nature, value, lifespan, and potential impact if lost (Mather, 2010).

In order to refine and assess the zone of impact, the following will be taken into account in the second phase of this work: coastal elevation, predicted sea-level rise and shoreline change. Additionally, information presented in this assessment, coupled with future modelling will feed into the final determination of coastal setback lines for the KZN province which, which will all contribute to better coastal management.

CONCLUSION

The methodology described here and its application to the KZN coast is useful in several respects. Notably, the indicators used can be derived from remotely sensed data, which means that a once off flight can derive near-instantaneous data, easily repeated over time. Note that this process develops not an absolute value of CVI, but rather a relative value. The absolute value of risk is to be quantified in terms of severity and likelihood.

The selection of parameters, and their respective weighting, can be adjusted to suit a particular local situation, especially in the context of documented erosion and high vulnerability sites. It is also important to note that historic erosion data strengthens the validation, so that an ongoing process of monitoring and refinement of the technique will result in a progressively better and more accurate decision support system. A further phase of this study is to develop a system that will facilitate the effective and user-friendly transfer of this information as a decision support tool to assist with general coastal management and coastal developmental authorizations.

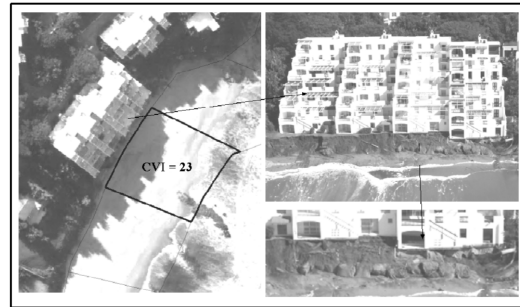


Figure 7: Example of development located too close to the HWM at cells with *very high* CVI scores (physical properties score low)

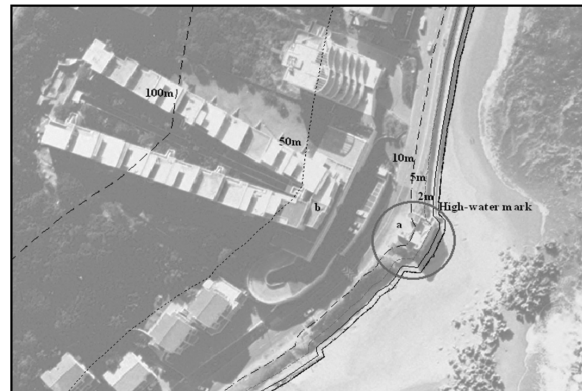


Figure 8: Impact on structures, influenced by distance from the high-water mark, building a is more likely to be damaged than building b, due to its location

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APPENDIX C: AN OVERVIEW OF THE INFO-PORTAL

The following provides an overview of the info-portal (www.coastkzn.co.za), key functionalities.

Figure G.1: Home Page, highlighting the main features

From the home page primary navigation is possible; there are four key access areas or links that will make you to the four main sections of the info-portal. There is also a standard navigation bar and a search function. The home page provides a newsfeed on current topical stories as well as a link to details of these.



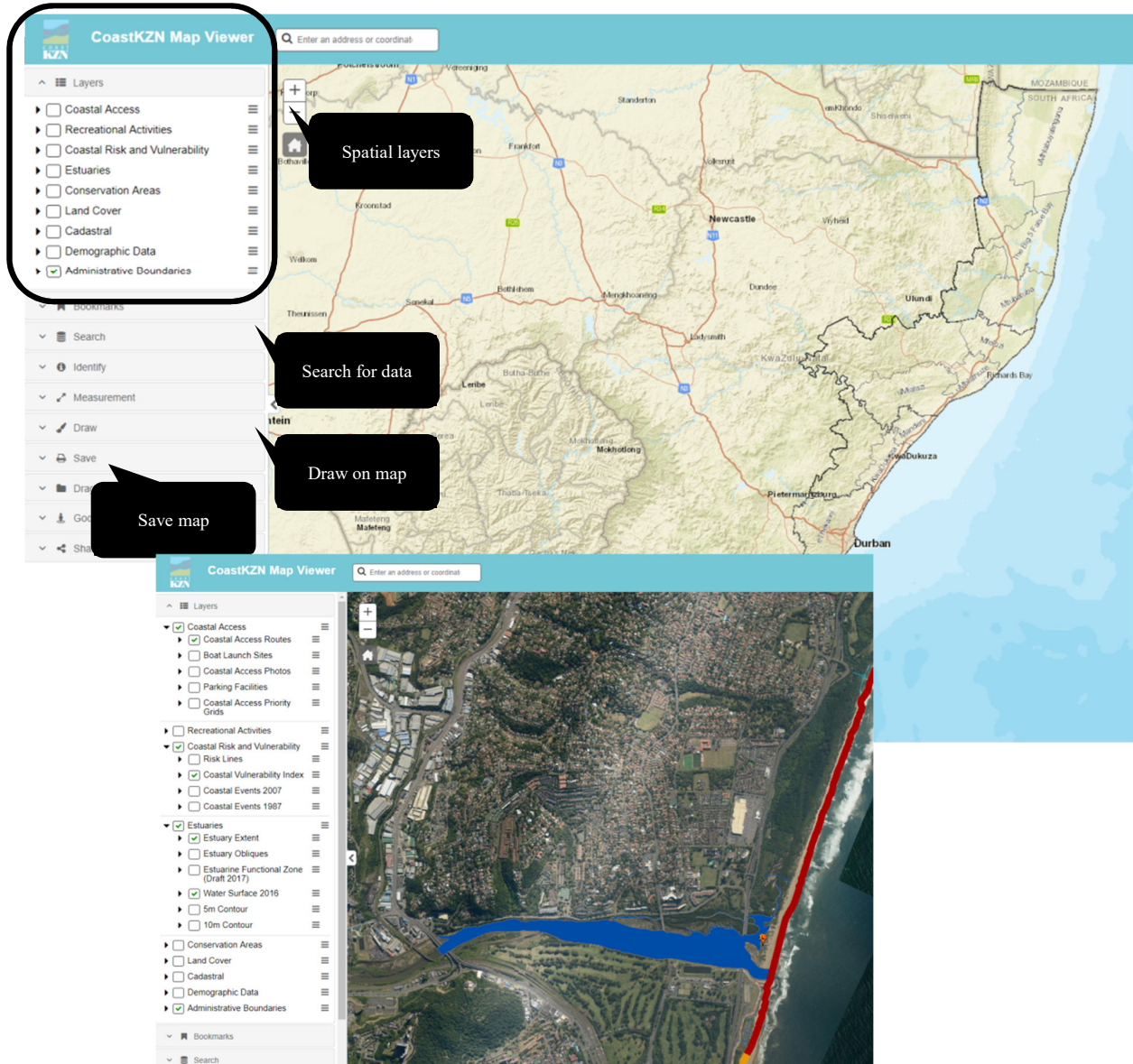
Figure G.2: Coastal Themes page and workflow for this

Once you select the COASTAL THEMES key access points, you are directed to a themes page, where you can select specific topics and link down to details.

The workflow starts at the top navigation bar where 'Themes' is selected. This leads to the 'Themes' page, which features a grid of topic images including 'The Profile of the KZN Coast', 'Coastal Access', 'Estuaries', 'Coastal Risk and Vulnerability', and 'Coastal Issues'. From the 'Coastal Access' topic, the path leads to 'Themes topics', which displays a detailed article for 'Access Routes' in KwaZulu-Natal, South Africa. From this article, the path leads to 'Categories details', showing a grid of specific categories like 'Access Routes', 'Boat Launch Site Monitoring System', 'Blue Flag Beaches', and 'The Human Dimension'.

Figure G.3: Explore the coast

Once you select the EXPLORE THE COAST key access points, a new page showing a map of KZN will open. This hosts a range of spatial layers that can be used to inform location specific management decisions. This also allows you to search the spatial data, draw and make your own map.



Example showing some spatial layers

Figure G.4: Governance at your fingertips page

Once you select the GOVERNANCE key access points, you are directed to governance at your fingertips page, where you can select specific topics and link down to details of any of these management related areas.

The image shows a multi-step navigation process on a website. At the top, a navigation bar includes 'Home', 'About Us', 'Themes', 'Interactive Map', 'Governance', 'How do I?', 'News', 'Contribute', 'Contact Us', and 'Help'. The 'Governance' menu item is highlighted.

The main content area is titled 'Governance at your fingertips' and features a grid of eight image-based links: 'Defining the Coastal Zone', 'Legislation', 'Regulations', 'Coasta', 'Guidelines', 'Governance Jurisdiction', 'Coastal Management Programmes', and 'Estuary'. A black arrow points from the 'Legislation' link to a detailed view of the 'Legislation' page.

The 'Legislation' page displays a grid of legislative acts with accompanying images: 'Integrated Coastal Management Act', 'National Environmental Management Act', 'National Water Act', 'Spatial Planning and Land Use Management Act', 'Marine Living Resources Act', and 'Pollution in the Coastal Zone'. A second black arrow points from the 'Integrated Coastal Management Act' link to its detailed page.

The detailed page for the 'Integrated Coastal Management Act' includes the following text:

Integrated Coastal Management Act
 The ICM Act provides for the holistic management of the coast and estuarine areas as an integrated system, through participation by all stakeholders (public, NGOs, Local, Provincial and National government) to ensure the protection of the environment and its natural ecosystem functioning, while promoting sustainable development in the use of coastal resources.

National Environmental Management Act: Integrated Coastal Management Act
 Original Act 24 of 2008 | Amendment Act 36 of 2014 | ICM Act including amendments (consolidated by the University of Pretoria)

"To establish a system of integrated coastal and estuarine management in the Republic, including norms, standards and policies, in order to promote the conservation of the coastal environment, and maintain the natural attributes of coastal landscapes and seascapes, and to ensure that development and the use of natural resources within the coastal zone is socially and economically justifiable and ecologically sustainable; to define rights and duties in relation to coastal areas; to determine the responsibilities of organs of state in relation to coastal areas; to prohibit incineration at sea; to control dumping at sea, pollution in the coastal zone, inappropriate development of the coastal environment and other adverse effects on the coastal environment; to give effect to South Africa's international obligations in relation to coastal matters; and to provide for matters connected therewith"

The purpose of the Act is to:

- to determine the coastal zone of the Republic;
- to provide, within the framework of the National Environmental Management Act, for the coordinated and integrated management of the coastal zone by all spheres of government in accordance with the principles of co-operative governance;
- to preserve, protect, extend and enhance the status of coastal public property as being held in trust by the State on behalf of all South Africans, including future generations;
- to secure equitable access to the opportunities and benefits of coastal public property;
- to provide for the establishment, use and management of the coastal protection zone; and
- to give effect to the Republic's obligations in terms of international law regarding coastal management and the marine environment.

Chapters of the Integrated Coastal Management Act

Chapter 1: Interpretation, Objects and Application of Act	Chapter 2: Coastal Zone
<ul style="list-style-type: none"> Definitions Objects of Act State's duty to fulfill environmental rights in coastal environment Application of Act 	<ul style="list-style-type: none"> Coastal Public Property Coastal Protection Zone Coastal Access Land Coastal Waters

Details of the legislation, guideline, regulations etc.

Details of selected area, e.g.: legislation applicable to the coast

Figure G.5: How do I? page

Once you select the HOW DO I? key access points, you are directed to a how do I page, where you can select specific topics that will guide you through how that topic is achieved.

How do I topics

How do I?

Report a/an...

- Pollution
- Sewage Spill
- Oil Spill
- Artificial Estuary Breach
- Unsafe Structures on the Beach
- Boat Distress at Sea
- Stranded Animal
- Shark Attack

Apply for...

- Water Use Authorisation Permit
- Discharge Permit
- ORV Permit
- Recreational Fishing / Collection Permit
- Commercial Fishing Permit
- Environmental Authorisation

Report Illegal...

- Dumping in the Coastal Zone
- Sand Mining

Contact...

- National Government
- Provincial Government
- District Municipalities
- Metropolitan
- Local Municipalities
- Local NGOs
- Ezemvelo KZN Wildlife
- iSimangaliso
- Useful Links

Find more information on...

- SASSI
- Recreational Fishing
- Commercial Fishing

Sign up for...

- Ulwandle- KZN Coastal News!

Sewage Spill

Sewage spills within estuaries and the coastal zone may have significant health repercussions on plants, animals and people in these coastal environments since many sewage works are based close to the coast. Approaches to remediation usually involves the cooperation of a number of government departments.

Who to contact			
Organization	Name	Contact Numbers	Email
DEA: Marine & Coastal Pollution Management	Yusef Petersen (Director: Marine Pollution)	021 819 2450 / 083 530 3827	
	Natasha Bajnath-Pillay (CEO: Land based pollution)	021 819 2409 / 072 173 6234	nbajnat@environment.gov.za
DEA: Legal Authorisations & Compliance Inspectorate	M. Dulane (Custodian)		mdulane@environment.gov.za
	T. Dangazale	084 358 8197	tdangazale@environment.gov.za
DWS	Nombuthi (Zethu) Malwabaas (Acting Manager)	031 336 2810	malwabaas@dws.gov.za
	Ranelle Karen Pillay (Water Quality Manager)	031 336 2742	rpillay@dws.gov.za
EDTEA	Boniswa Sithole (Coastal and Marine Pollution)	031 977 6681 / 084 688 7930	bsithole@edtea.gov.za
	Alfred Matabele (Coastal Unit Manager)	031 977 6682 / 082 330 2114	amatabele@edtea.gov.za

Report pollution incident to DEA: 021 8192450/ 021 8192457
Share call to assist the public with environment related queries, call the DEA Call Centre: 086 111 2468

Details for the selected How do I topic

APPENDIX D: SURVEY ON COASTAL MANAGEMENT IN SOUTH AFRICA

The following is the survey that was circulated to coastal managers in order to gather information from a broad group on ICM in South Africa and more specifically KZN. This information informed research pertaining to objective two: *To review current ICM implementation and limitations in KwaZulu-Natal*. This also informed the resulted publication: Goble, B.J., Hill, T.R. and Phillips, M.R. (2017) An Assessment of Integrated Coastal Management Governance and Implementation Using the DPSIR Framework: KwaZulu-Natal, South Africa. *Coastal Management*, 45: 107-124.

COASTAL MANAGEMENT IN SOUTH AFRICA

This survey aims to provide some information as to the current capacity for and limitations to the implementation of the Integrated Coastal Management Act. This survey provides preliminary information that will assist in refining the study.

ABOUT YOU

Name (optional)
Email address (Optional)
What is your gender?
What is your age?
What is your highest Qualification?
Other qualifications / Courses attended:
What is your qualification grounded in?
(biological, engineering, social studies etc. environmental sciences, zoology, soil science, geology, geography)

ABOUT YOUR CURRENT JOB

Where you are currently employed?
What is your post / job title?
How long have you been employed in your current post?
What are your current roles and responsibilities?
What does your daily job entail?
What is your role in terms of Coastal Management?

YOUR OPINION ABOUT THE COAST AND COASTAL MANAGEMENT

What is your opinion about the coast?

- It is great for recreation and leisure
- The coast facilitates development which assists in generating important revenue
- It is a precious resource that needs to be well managed to ensure long-term sustainability
- We cannot do enough to conserve this environment

In your opinion who should be responsible for coastal management?

- Coastal management is the responsibility of government
- Coastal management is particularly the responsibility of environmental affairs
- The general public have an important role to play in coastal management
- The coast needs to be co-operatively managed by a number of government departments and stakeholders

THE INTEGRATED COASTAL MANAGEMENT ACT

What is your knowledge of the Integrated Coastal Management (ICM Act)?

- I don't know what the ICM Act is
- I have heard about the ICM Act, but am not familiar with it
- I have a basic understanding of what the objectives of the ICM Act are
- I am familiar with the ICM Act and the requirements it places on my organisation

Which of the following statements do you believe to be true to the ICM Act (you can select multiple)?

- The ICM Act is critical and will improve future coastal management
- The ICM Act is sound, but implementation is a challenge
- The ICM Act has no teeth and will be over-ridden by other statutes
- The ICM Act requires buy in from all stakeholders in order to be effective
- The ICM Act needs political buy in in order to be effective

Are you aware of any other of the following statutes, and their role or effect on coastal management? Please select the appropriate response

	Aware of the legislation	Understanding as to impact on Coastal Management
Sea-Shore Act (Act No. 21 of 1935)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> None <input type="checkbox"/> Basic <input type="checkbox"/> Comprehensive
Marine Living Resources Act (Act No. 18 of 1998)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> None <input type="checkbox"/> Basic <input type="checkbox"/> Comprehensive
National Environmental Management Act (Act No. 107 of 1998)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> None <input type="checkbox"/> Basic <input type="checkbox"/> Comprehensive
The Biodiversity Act (Act no. 10 of 2004)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> None <input type="checkbox"/> Basic <input type="checkbox"/> Comprehensive
Protected Areas Act (Act no. 57 of 2003)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> None <input type="checkbox"/> Basic <input type="checkbox"/> Comprehensive
National Water Act (No. 36 of 1998)	<input type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> None <input type="checkbox"/> Basic <input type="checkbox"/> Comprehensive

Are there any other statues that you believe to be important in terms of coastal management?

Are you involved in the implementation of the ICM Act?

If yes, please continue to next section.

IMPLEMENTING THE ICM ACT

What is your role in the implementation of the ICM Act?

What do you believe to be the constraints to implementation of the ICM Act?

What, if any, are the opportunities presented by the ICM Act?

In your opinion, does the ICM Act facilitate better management of the coastal environment?

What would improve your ability to achieve the objectives of the ICM Act?

- Guideline documents
- Policy directives
- Training programmes
- Interactive decision support tools
- Information sessions
- Mentorship from other municipalities or NGOs
- Other: _____

Are you available for a one-one interview?

We would like to interview as many officials as possible to gain a better understanding as to current capacity opportunities and limitations. Yes No

Thank you for taking the time to complete this survey.

APPENDIX E: COASTAL MANAGEMENT IN KWAZULU-NATAL – INTERVIEWS QUESTION GUIDELINE

The following outlines the framework questions for the interviews with coastal managers, pertaining to ICM in South Africa and more specifically KZN. This information informed research pertaining to objective two: *To review current ICM implementation and limitations in KwaZulu-Natal*. This also informed the resulted publication: Goble, B.J., Hill, T.R. and Phillips, M.R. (2017) An Assessment of Integrated Coastal Management Governance and Implementation Using the DPSIR Framework: KwaZulu-Natal, South Africa. *Coastal Management*, 45: 107-124.

Management in Kwazulu-Natal – Interviews question guideline

1. Name
2. Position
3. No. of years in position
4. What is your understanding of the coast or coastal zone?
5. What is your role in Coastal Management? / What are your responsibilities?
6. How did you become involved in Coastal Management?
7. Is coastal management something you are interested in? What do you find interesting about it?
8. How much do you know about the ICM Act?
9. What capacity is there for Coastal Management / do you rely on external consultants?
10. When tackling a problem does it often involve other stakeholders? If so, does it complicate the situation and delay the process or does it facilitate the process? Examples?
11. What data / tools are available to assist you with coastal management?
12. What type of coastal issues are you dealing with in your LM?
 - What is the average timeframe you deal with when solving a problem relating to CM: since the problem/issue is noted until it is solved?
13. What current coastal projects are you busy tackling or are aware of?
14. What do you find most challenging / what are the obstacles you face in terms of coastal management?
15. Do you think current coastal management strategies are proactive or reactive? Why?
 - And how do you think this can be changed
16. Success stories regarding coastal management in LM?

APPENDIX F: TRAINING EVALUATION FEEDBACK

The following evaluation was completed by participants that attended the various training sessions offered between 2014 and 2018. This information informed research pertaining to objective four: *To assess the range of capacity building approaches and how the development of an information support tool for KwaZulu-Natal has aided coastal management decision making.* This also informed the resulted publication: Goble, B.J., Hill, T.R. and Phillips, M.R. (2018) Building institutional knowledge for effective Integrated Coastal Management decision making; KwaZulu-Natal, South Africa. Manuscript submitted for publication.

OVERALL PROGRAMME EVALUATION

We hope that you have enjoyed the **Course Name** and encourage you to give us feedback. To assist us in improving the programme, please will you take a few minutes to complete the following evaluation form. Please also list any additional training or skills development for future training programmes that you feel would benefit you to becoming a more effective and efficient coastal manager.

Programme evaluation

In order to assess the programme content and methods used, please rate the programme by marking the appropriate box with an X:

	Weak	Below average	Average	Good	Excellent	N/A
Structure of the programme	1	2	3	4	5	6
Relevance of programme content and scope	1	2	3	4	5	6
Relevance of programme materials	1	2	3	4	5	6
Extent of challenge provided by programme	1	2	3	4	5	6
General input by Course Presenter/s	1	2	3	4	5	6
Value of practical examples	1	2	3	4	5	6
Overall value of the programme	1	2	3	4	5	6

Do you feel that your objectives were met by the programme? Yes/No
Please explain...

Do you have any suggestions for improving the programme or programme materials?
Please specify...

Did you find the topic covered of use, and have you gained some insight on the topic?
Please specify...

Venue evaluation

Did you find the workshop venue conducive to learning?

Did you find the group session useful?

Were you able to ‘break-away’ from your workplace and focus on the training?

What focused training would you benefit from in the future?

Please mark which of the following training courses you would be interested in.

Estuaries and estuary management	
Coastal processes	
Coastal planning	
Sustainable coastal development	
Co-operative governance	
Legislation and policy	
Compliance and enforcement	

Are there any other training courses you could add to the list that you would benefit from?

APPENDIX G: INFO-PORTAL TESTING SURVEYS

The following surveys were used to gather feedback during the beta testing of the info-portal (www.coastkzn.co.za). The second survey is accessible on the info-portal and all visitors to the portal are encouraged to provide feedback. This information informed research pertaining to objective three: *To develop an information support tool to assist in improving KwaZulu-Natal's coastal management.* This also informed the resulted publication: Goble, B.J., MacKay, C.F. and Hill, T.R. (2018) Design, Development and Implementation of a Decision Support info-portal for Integrated Coastal Management, KwaZulu-Natal, South Africa. Manuscript submitted for publication.

CoastKZN User feedback (Beta 1)

Personal Information

Please can you provide your details for our records. This information will remain confidential.

Name and Surname _____
Organization / sector * _____
Title and Position _____
Sector (Select multiple if relevant) *
Check all that apply.

Researchers - Related to field
 Researchers - Not related to field
 Local Government officials
 Provincial Government officials
 National Government officials
 Government - Other
 General User - Related to field
 General User - Not related to field
Email Address _____

Impression of CoastKZN

What is your general impression of the CoastKZN Site.

What is your first impression of CoastKZN? *

Mark only one.

- Very positive
 Somewhat positive
 Neutral
 Somewhat negative
 Negative
 Other: _____

Please provide a brief motivation for your selection

How visibly appealing is CoastKZN? *

Mark only one.

- Extremely appealing
- Very appealing
- Somewhat appealing
- Not so appealing
- Not at all appealing
- Other: _____

Please provide a brief motivation for your selection

How user friendly is CoastKZN? *

Mark only one.

- Extremely user-friendly
- Very user-friendly
- Moderately user-friendly
- Slightly user-friendly
- Not at all user-friendly
- Other: _____

Please provide a brief motivation for your selection

How easy was it to find what you were looking for on CoastKZN? *

Mark only one.

- Extremely easy
- Very easy
- Somewhat easy
- Not so easy
- Not at all easy
- Other: _____

Please provide a brief motivation for your selection

CoastKZN Functionality

How did you find the functionality of CoastKZN.

How easy is it to understand the information presented in CoastKZN? *

Mark only one.

- Extremely easy
- Very easy
- Somewhat easy
- Not so easy
- Not at all easy

Please provide a brief motivation for your selection

How much do you trust the information on CoastKZN? *

Mark only one.

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1 | 2 | 3 | 4 | 5 |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Not at all | | | | A great deal |

Please provide a brief motivation for your selection

Overall, how well does our website meet your information needs?

Mark only one.

- Extremely well
- Very well
- Somewhat well
- Not so well
- Not at all well

Please provide a brief motivation for your selection

Would you share information through this site? *

- Yes definitely
- Yes, with some conditions
- Yes, only some information
- Not likely
- No, never
- Other: _____

Please provide a brief motivation for your selection

Errors / bugs on CoastKZN

As this website is in the testing phase we anticipate that there may be some issues affecting functionality. We would like your help to identify these bugs, so that we may correct them.

Did you find any problems where the site was not functioning correctly?

CoastKZN User feedback (and Beta 2)

The CoastKZN website has gone through a significant update, as such we would like your feedback on these improvements.

Personal Information

Please can you provide your details for our records. This information will remain confidential.

Name and Surname _____

Organization / sector * _____

Title and Position _____

Sector (Select multiple if relevant) *

Check all that apply.

- Researchers - Related to field
- Researchers - Not related to field
- Local Government officials
- Provincial Government officials
- National Government officials
- Government - Other
- General User - Related to field
- General User - Not related to field

Email Address _____

Impression of CoastKZN

What is your general impression of the CoastKZN Site.

What is your first impression of CoastKZN? *

Mark only one.

- Very positive
- Somewhat positive
- Neutral
- Somewhat negative
- Negative
- Other: _____

Please provide a brief motivation for your selection

Do you feel that the visual impression of CoastKZN has improved in this version?

Mark only one.

- A vast improvement
- A slight improvement
- No improvement
- The changes have made the sight less appealing

Please provide a brief motivation for your selection

Has the user-ability of the site improved? *

Mark only one.

- Significantly more user-friendly
- Slightly more user-friendly
- User-friendly nature unchanged
- Less user-friendly

Please provide a brief motivation for your selection

How easy was it to find what you were looking for on CoastKZN? *

Mark only one.

- Extremely easy
- Very easy
- Somewhat easy
- Not so easy
- Not at all easy
- Other: _____

Is the ability to search for and find better than the previous version?

Mark only one.

- Much easier
- Slightly easier
- No change
- Not easier
- Not at all easy

Please provide a brief motivation for your selection

CoastKZN Functionality

How did you find the functionality of CoastKZN.

How easy is it to understand the information presented in CoastKZN? *

Mark only one.

- Extremely easy
- Very easy
- Somewhat easy
- Not so easy
- Not at all easy

Please provide a brief motivation for your selection

How much do you trust the information on CoastKZN? *

Mark only one.

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1 | 2 | 3 | 4 | 5 |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Not at all | | | | A great deal |

Please provide a brief motivation for your selection

Does this version better meet your information needs? *

Mark only one.

- Yes, extremely well
- Yes, much better
- Somewhat better
- No, not so well
- No, not at all well

Please provide a brief motivation for your selection

Would you share information through this site? *

- Yes definitely
- Yes, with some conditions
- Yes, only some information
- Not likely
- No, never
- Other: _____

Please provide a brief motivation for your selection

How likely are you to recommend CoastKZN to someone you know? *

Mark only one.

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1 | 2 | 3 | 4 | 5 |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Not Likely | | | | Very Likely |

Interactive Map

How useful is the interactive map presented by CoastKZN?

Does the interactive map assist with your information needs?

Mark only one.

- Extremely well
- Very well
- Somewhat well
- No so well
- Not at all well

Please provide a brief motivation for your selection

Is the data presented by the map clear and understandable?

Mark only one.

- | | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1 | 2 | 3 | 4 | 5 |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| Not at all | | | | A great deal |

Please provide a brief motivation for your selection

Is the interactive map easy to navigate?

Mark only one.

- Extremely easy
- Very easy
- Somewhat easy
- Not so easy
- Not at all easy

Please provide a brief motivation for your selection

Errors / bugs on CoastKZN

As this website is in the testing phase we anticipate that there may be some issues affecting functionality. We would like your help to identify these bugs, so that we may correct them.

Did you find any problems where the site was not functioning correctly?

Recommendations

Please provide some recommendations as to what information you feel would make this site more useful.

What information would you like to access on this site?

What other functions and tools would be useful?

Do you have any other comments or suggestions about how we could improve the interface of CoastKZN?

APPENDIX H: INFO-PORTAL TRAINING FEEDBACK

The following evaluation was completed by participants that attended varies info-portal (www.coastkzn.co.za) training sessions. This information informed research pertaining to objective four: *To assess the range of capacity building approaches and how the development of an information support tool for KwaZulu-Natal has aided coastal management decision making.* This also informed the resulted publication: Goble, B.J., Hill, T.R. and Phillips, M.R. (2018) Building institutional knowledge for effective Integrated Coastal Management decision making; KwaZulu-Natal, South Africa. Manuscript submitted for publication.

Feedback on training session – CoastKZN

Part A: Introductory questions

Was this your first introduction to the CoastKZN portal?

Mark only one.

- No, I have used the portal previously.
- No, it has been demonstrated to me before.
- Yes, but I had an idea about the portal content.
- Yes

What did you expect to get from the training (can tick more than 1 box)?

Check all that apply.

- I expect to be fully able to use the portal on my own.
- To know where to find material.
- To learn about CoastKZN and what it has to offer.
- I had no preconceived idea of what was intended in the training.

Part B: Presenter/s

The presenter/s was/were effective in communicating the content on the site.

Mark only one.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

The presenter was knowledgeable about the subject matter.

Mark only one.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

The presenter/s spoke clearly, and I could understand the material easily.

Mark only one.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

Comments:

Evaluation

The session enhanced my skills and knowledge of the subject and the site.

Mark only one.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

After this training I now understand the site better and find it easier to use.

Mark only one.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I am likely to use the site on my return to work.

Mark only one.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

I would recommend the site to others now that I see how easy it is to access.

Mark only one.

- Strongly agree
- Agree
- Neutral
- Disagree
- Strongly disagree

What was the most valuable part of the course?

What was the least valuable part of the course?

Please provide any suggestions to improve the training.
