University of KwaZulu-Natal

THE APPLICATION OF PLANNING SUPPORT TECHNOLOGY TO URBAN COASTAL RESEARCH AND MANAGEMENT: A CASE STUDY OF THE SOUTH DURBAN BASIN

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DECLARATION

I ....Tanya Dayaram.. declare that

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ABSTRACT

Sustainability has become synonymous with development. The concept of integrated coastal management (ICM) was derived from sustainability theory. The planning profession has an impact on the development of coastal zones through land use plans. This study aimed to demonstrate through case studies, the pros and cons of applying technological methods for the purpose of creating better quality plans. Literature, precedent studies and a local example of dualities in KwaZulu-Natal, South Africa, has provided evidence toward the practicality of monitoring and controlling urban coastal land uses via support technology. Conclusions have been drawn based on critically analysing the data and were presented through maps, tables and graphs throughout the paper. Changing trends and patterns in the natural world, namely the impacts of climate change, have affected the urban environment. Therefore recommendations were made for further research into technological support systems available for the planning profession.

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GLOSSARY OF ACRONYMS

AR	Admiralty Reserve/ admiralty reserve
DSS	Decision Support System
GIS	Geographic Information System
GPS	Global Positioning System
ICM	Integrated Coastal Management
ICZM	Integrated Coastal Zone Management
IDP	Integrated Development Plan
KZN	KwaZulu-Natal Province
LUMS	Land Use Management System
PSS	Planning Support System
RS	Remote Sensing
SDSS	Spatial Decision Support System
S.A.	South Africa
KII	Key Informant Interviews
SDB	South Durban Basin
CMP	Coastal Management Plan
HWM	High Water Mark
NEMA	National Environmental Management Act
ICMA	Integrated Coastal Management Act
CM	Coastal Management
PSSD	Planning System for Sustainable Development
SPARTACUS	System for Planning and Research in Towns and Cities for Urban Sustainability
GAMe	Growth Allocation Model
GAP	Geospatial Analysis Platform
MSA	Municipal Systems Act

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CHAPTER 1: INTRODUCTION

1.1. INTRODUCTION

In planning as with other aspects of life, nothing is constant. Disasters that are the result of or due to natural/ human-made disruptions are possible, and not easily predictable. Despite the introduction of legislation to protect the coastline and primary dune areas, there will always be a need for and pressure on the resource-rich coastal land for development. Planning plays a role in determining the land uses which can impact upon the development of coastal zones. At the same time, land use planning has been considered a fundamental tool for disaster risk reduction in the urban development process (UN-HABITAT, 2007). So the conundrum confronting this research is to consider the application of existing technological methods which can enable sustainable integrated development planning to take place in a context where inappropriate planning and development has already occurred. Attention is required (much more than this short dissertation can provide) toward the practicality of *Monitoring and Controlling* coastal land use development for the future.

Managing the urban coast requires integrated knowledge about the natural and built environment. Coastal zones have different needs which are dependent on numerous location factors. The outcomes of planning processes to manage coastal zone development can be influenced by support technologies. Accurate data provides the basis for creating the maps that are crucial for the preparation and implementation of integrated planning projects. Hence supporting technology, in the form of Planning Support Systems and communication tools (Salet and Faludi, 1999; CSIR, 2010), could enable more efficient planning and the allocation of appropriate land uses along the urban coastline. The implication is that if sustainable planning and development is to take place one has to assess what needs to be done to manage the urban coast. In addition, decisions need to be made regarding how viable development along the current flood-lines of eThekwini‟s urban coast is, and specifically along the sea edge of eThekwini‟s South Durban Basin.

Coastal management has recently become a greater planning priority in South Africa with the publication of the *National Environmental Management: Integrated Coastal Management Act (G 31884, GoN 138)*, on February 2009. There has been a gradual change in weather patterns observed around the world which have been evident in events such as: hurricane Katrina in America and the cyclones of India. These changes in weather patterns have generated storms which triggered marine surges and coastal flooding in Durban during March 2007 and destroyed coastal infrastructure along the coastline of eThekwini. Businesses were forced to close; properties and recreational facilities were damaged. Historically, the coastline of KwaZulu-Natal which extends 600 kilometres in length has been protected by the creation of legislative environmental planning mechanisms and policy instruments such as the Admiralty Reserve which provided for setbacks along the coastline (updated in 2008). The implementation of similar legislative regulations needs to be strengthened through coastal zone management because regulatory setbacks can have a significant impact in mitigating the damage caused by surges. Recent observations along the provinces coastline have illustrated that, in coastal areas where a buffer has been maintained (in compliance to the Admiralty Reserve), less damage occurred when storm surges hit the KwaZulu-Natal coastline in 2007. Furthermore, areas that had compromised the sensitive coastline were severely affected (Mather, 2007). It is acknowledged that the impacts of environmental problems can be difficult to predict and plan for, however technology has advanced to provide tools that make this science more applicable and useful in practice.

The urban coastline is a focus for planning because settlements along the coast provide a microcosm of the interaction of the built environment (and its human activities) with the natural environment (Vallega, 2005). In this research, the interaction of variables, namely: How to manage the existing development along the coast; What additional planning interventions and regulations are needed to manage new developments, in light of the impact of the 2007 storms and The lessons learned regarding urban coastal land use. This interaction will be explored within the assertion that Planning Support System tools can be incorporated to efficiently generate better planning methods for coastal protection.

Extensive damage was caused to public and private infrastructure along the coastline during the March 2007 storm in Durban. This research has focused on the area of southern Durban, specifically studying the dualities in land uses of the South Durban Basin (SDB), in South Africa. The coastal edge of SDB provides a number of features to consider and research, from residential to industrial land uses (refer to photograph panel 1 below). The study area falls into six precincts, situated between the Bluff and Amanzimtoti North area, which formed a distinct area of the city. A South Durban Basin Coastal Management Plan has been prepared for the specified precincts (Refer to Map 1).

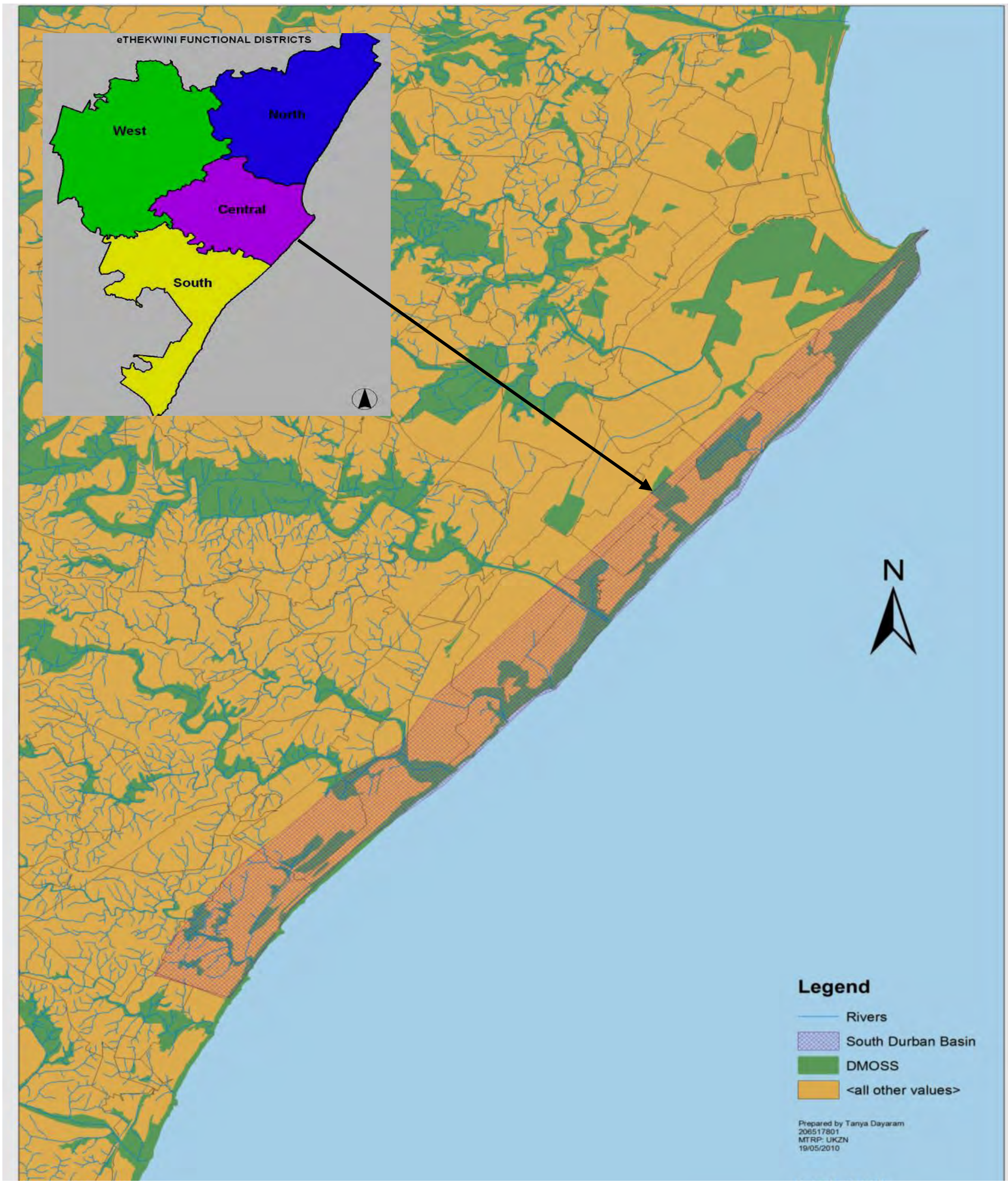
Above left; Photograph 1- '**Golden Mile'.**
Above Left; Photograph 2 –**Amanzimtoti, Main beach**
Below Left; Photograph 3- **Brighton Beach**.
Below right: Photograph 4 –**Amanzimtoti North**
Photograph panel 1: Destruction.
(PPDC, 2008: 24. and SystemShock, 2005-2011.)

1.1.1. Recognized Outcome

One of the proposed outcomes of this study is that more research will be necessary if sustainable coastal management strategies and planning are to be undertaken. This assertion can be made because the implementation of a Planning Support System for coastal management is still in its infancy. A combination of automated tools with traditional methods can be used to identify areas along the coastline which need protection because they are undeveloped and those which require additional planning, engineering or design.

This study explores planning tools that are currently available and how to apply them to urban coastal research and management. The purpose was to define land use guidelines and recommendations, by integrating computer systems for analysis and communication, to create practical strategies for urban coastal research and management could enable sustainable development. Therefore research using planning support technologies would add value to current knowledge of land use in coastal zones. The research questions highlight the aims and objectives of this thesis and the key concepts are defined to understand the contextual background to the research.

Location of the South Durban Basin within the eThekwini Central Functional District



Map 1: Locality of the South Durban Basin Case Study

(Created by T. Dayaram (2010) using ArcGIS and eThekwini GIS data and eThekwini Municipality IDP review 2009/10 Annual Review. eThekwini functional Districts. Pp. 3. Not to scale.)

1.2. RESEARCH QUESTIONS

1.2.1. Aim

The study aims to demonstrate that planning support technologies provide the analytical tools for research and communication that enables sustainable integrated coastal management at the local level. To determine where planning support systems can be applied to bolster research and the management of the urban coastline a case study of SDB has been incorporated. Therefore the primary research question can be framed as follows:

What role does support technology play in research and in designing plans for sustainable urban coastal management?

1.2.2. Objectives

To answer the main question several objectives were considered, then divided into four categories, and are posed as the following sub-questions:

- What is a Planning Support System?
    - How does support technology contribute to a PSS?
    - What technological tools are available that can be used in urban coastal management planning?
    - What are the challenges faced in designing integrated systems for urban coastal management?

- What changes have occurred along the eThekwini Municipality's coastline, specifically but not exclusively in South Durban? And what are the implications for urban coastal management?
    - Using the case of South Durban: what impact did storm surges have on coastal management plans? And how was the information dealt with?
    - How are coastal management plans formulated?
    - How can the use of technology improve these management plans?

- What technological approach is used to design coastal management plans in terms of international good practice precedents?

- What applications can be applied in the context of eThekwini?
- What is the role of support technology in urban coastal management?

➢ What recommendations can be made, regarding land use management, in terms of applying planning support technology in designing management plans for the study area?

1.3. KEY CONCEPTS

There are several key definitions that are critical to this research and which are briefly outlined below. They will be discussed and elaborated on within the proceeding chapters of this dissertation.

1.3.1. Sustainable Integrated Development Planning

‗*Sustainability*' or sustainability science is a broad concept. For the purposes of this research, it has been unpacked as follows:

Sustainable development reflects the need to consider the limitations of natural resources and to develop them in a manner that would meet the needs of the present without compromising the generations of the future. It includes the three aspects of the human habitat: the natural, social and economic environment. However, as the concept has been developed in practice, it has come to include research from academic institutions and appropriate governance of the environment (See figure 1 adjacent).

Figure 1: Collaboration among Stakeholders for Sustainable Development

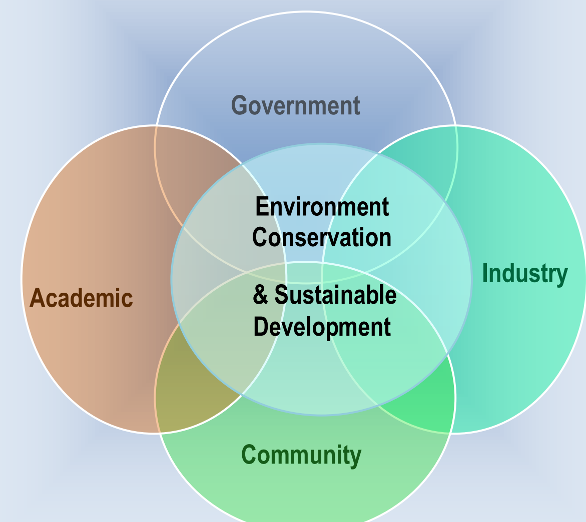


Figure 1 - modified from online source: http://www.upv.edu.ph/news/newspics/2010/20100126cruz4hel x.jpg [May 2010]

1.3.2. Integrated Coastal Zone Management

‗*ICZM*' i.e. the Integrated Coastal Zone Management approach applies the concept of „Sustainable Development" to the coastal context. A common perspective of the coastal situation is that the land / sea interface provides a unique system of varying land use patterns and ecosystems. A national database for coastal management was considered necessary as there is a need for information and decision support system for coastal mangers to work with (DEAT, 2000).

1.3.3. Integrated Development Planning

‗*Integrated development planning*' requires a movement away from fragmented planning processes toward a development of plans at all governance levels that are mutually reinforcing and combine to address strategic issues (Robinson et. al., 2003). Alternatively another definition suggests that it is a single, inclusive strategic plan for the development of the municipality. One of the key aspects of integrated development planning is that it requires consensus among stakeholders over the use of space and resources which means. This there has to be a higher degree of participation and communication.

1.3.4. Planning Support Systems

What is a Planning Support System (PSS)? Geertman and Stillwell (2004) have generally defined PSS as systems that bring together various technologies for the purpose of professional planning. A PSS may consist of a wide variety of methods, techniques, and models developed to analyze spatial problems, to evaluate alternative scenarios, and to provide for strategic future development options (Geertman, 2006; Slager et. al, 2007). Tools that form PSS include Geographic Information System datasets, Global-Positioning Systems (GPS), and Remote Sensing (RS) and will be explored further in Chapter 2: Literature Review. A conceptual framework has been incorporated into the literature review to describe the diverse interaction of the research topic.

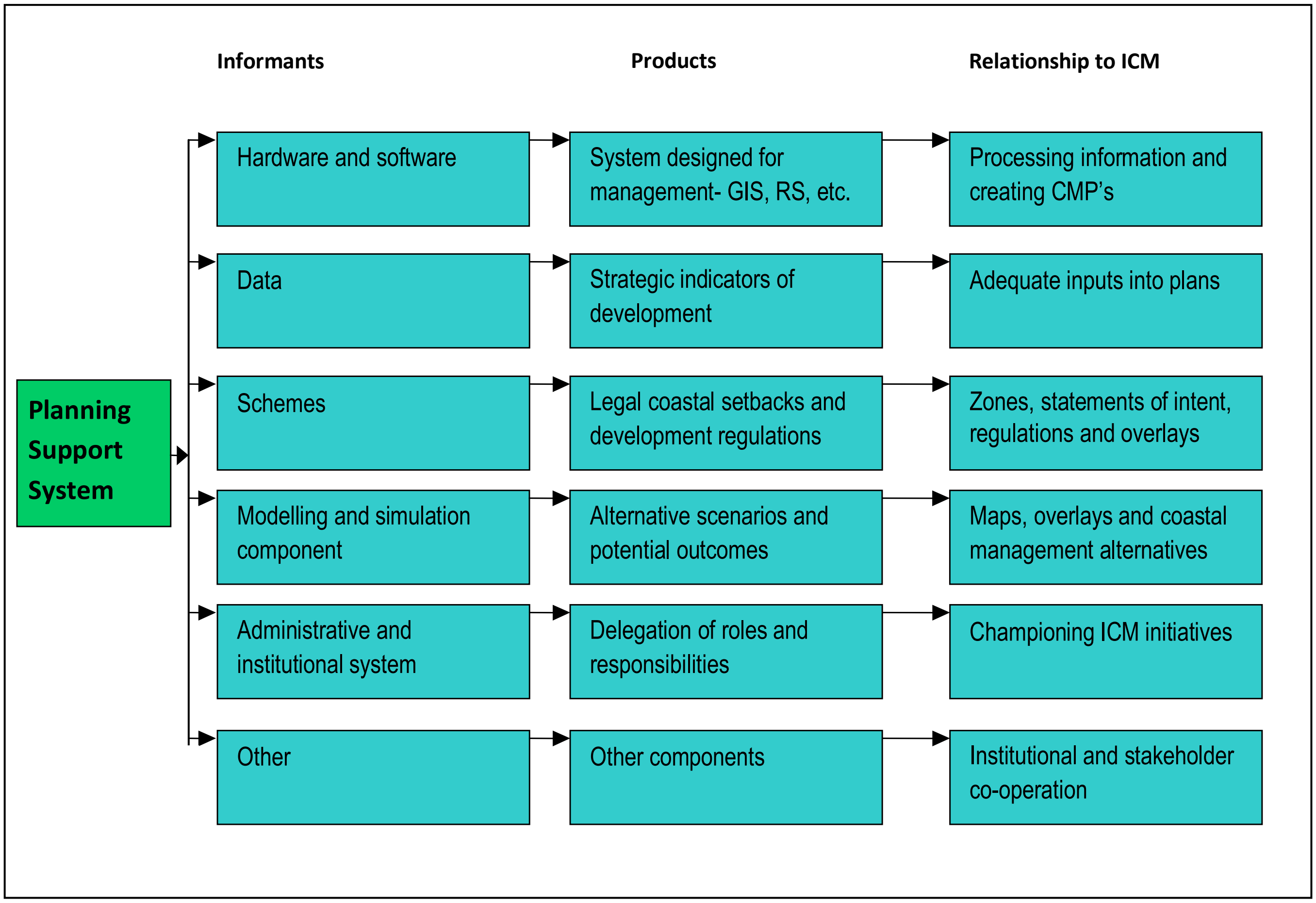


Figure 2: A Conceptual Model of a Planning Support System for Coastal Management
(Adapted From: A Diagram Prepared By Atelier Von Riesen, Peter Jewell Consulting Services, Michael Kahn, November 2002 In (2004) Kwazulu-Natal Land Use Management System Guidelines For The Preparation And Implementation Of Schemes).

The concepts that informed the research were derived from a process of critical thinking about the functionality of Planning Support Systems (PSS) tools that augment professional planning. The diagram above was derived by reviewing how the authors demonstrated their LUMS and represents what would be required for a coastal management PSS. Key components that were conceptualised for PSS to produce outputs toward managing the urban coastline are depicted (see figure 2 above). The informants construct products directed toward developing integrated coastal management. The research design reveals the process which has been used to test the applicability of a coastal PSS for the urban environment.

1.4. RESEARCH DESIGN

Research processes have been designed to answer the main- and sub- research questions. The overall approach made use of both primary and secondary data. This research is a mixture of the quantitative and qualitative approaches. Since the paper was evaluative there is more emphasis placed on the latter methodology. Professional opinions have been obtained through semi-structured interviews and a survey determined whether current coastal development corresponded to the local land use plans. The quantitative data served to substantiate the findings of the interviews so that there was a degree of check and balance in the structure of the research methodology.

1.4.1. Aim

The aim was to complete a successful thesis making use of a mixture of methods with the intention of assessing the applicability of Planning Support Systems (PSS) in urban coastal research and management.

1.4.2. Research methods

1.4.2.1. Data collection procedures

Different methods have been used to answer the research questions, namely: Key informant interviews; Observations from a survey of the coastal strip; Conceptual studies using mapping and literature; and Precedent case literature reviews. The literature review provided the context and the conceptual framework for the study. Relevant sources from journal articles, books and the internet have been used to describe the theory of Planning Support Systems (PSS) and Integrated Coastal Management (ICM). The precedent case literature aimed to provide greater insight and understanding of the topic. Contemporary literature from the last five years has been used as well as older material to reflect shifts in paradigm and the ideology of PSS over time. Therefore perceptions surrounding the application of support technology to urban coastal research and management have been understood and documented.

There is no singular approach to uncovering answers due to the interdisciplinary nature of the subject. The use of literature reviews assisted in developing an understanding of coastal hazards and providing an overview of international coastal management practices. These findings were verified by observations, information systems and follow up informal interviews undertaken locally. Subjective observations using short descriptions and self-reflective notes were used to provide a local area analysis of the South Durban Basins‟ coastline. The analysis using datasets from local geographical information systems confirmed the findings from literature review. In addition, workshops (as a participant - observer) and semi-structured interviews were conducted as part of the Council for Scientific and Industrial Research‟s (CSIR) Integrated Planning and Development Modelling (IPDM) project.

1.4.2.2. Samples

To determine the challenges of coastal management and the tools used to create coastal management plans, a process of semi-structured open-ended interviews and snowball sampling, using key informants has been utilized (Graham et. al., 2009; Nieuwenhuis, 2007; and Bak 2004). Beyond addressing the challenges and methods of coastal management, key informants were asked to identify projects that would be useful precedents to follow. The following interviews were conducted with the key informants are presented in table 1.4.2.3 below.

1.4.2.3. Table of Key informants

Key Informant	Area of expertise	Motivation
IDP manager	The informant participated in the development of the draft SDB CMP and works with IDP's	Highlighted the challenges of developing plans.
Provincial coastal committee member and currently a private consultant.	Coastal management and planning	Challenges and objectives of coastal management.
Workshops as part of the IPDM project	The Integrated planning and development modelling project inspired this research	The workshops provided a platform to discuss PSS.
Members of the CSIR Built environment	Information pertaining to the Geospatial analysis platform [GAP]	The practical application of PSS.
Private consultant	Integrated Coastal Management	In depth knowledge of ICM practices and relevant sources of data and contacts.

Direct interviews lasted an hour and indirect interviews via email were used when the informant was not personally available. The information obtained from key informant interviews facilitated detecting patterns of successful and less successful coastal management precedents. Key informants were asked if there were other criteria that should be considered in an analysis of the current socio-economic and spatial context of the case study in Durban, South Africa. This data was then used to categorize key themes to build a context for the representative case study areas identified in the research process. Hence a mixture of qualitative and quantitative data has been incorporated in the research design.

1.4.3. Measures to ensure validity and reliability

Similar methods which were used to address the main research question were also applied to answer the following sub-questions:

- *What changes occurred along the eThekwini Municipality's coastline, specifically but not exclusively in South Durban, and what are the implications for urban coastal management?*
  Method: Use of literature, documentation, observations and photography to identify development that is situated on the coastline. This information has been used to show the impact of natural phenomena in urban spaces. The study area was assessed based on setbacks defined by legislation and the High Water Mark (HWM).

- *How are coastal management plans formulated? and what are the challenges faced in designing for urban coastal management?*
  Method: Semi-structured key Informant interviews conducted with coastal project managers / members involved in the project (namely in the design of the coastal management plan) and with informants involved in data management of information. Additionally workshops (as a participant - observer) and semi-structured interviews were conducted as part of the Council for Scientific and Industrial Research"s (CSIR) Integrated Planning and Development Modelling (IPDM) project.

- *What is the approach used to design for coastal management plans in terms of international good practice precedents? What applications can be applied in the context of eThekwini? And what is the role of support technology in urban coastal management?*

Method: Use of precedent literature via secondary sources was chosen to express the role of planning support technologies because it can provide a comprehensive overview of research that would not be possible to collect primarily within the current time and budget. Literature reviews on international precedents; considering Australia and New Zealand"s advanced coastal management initiatives, as well as looking at the case of Thailand"s post-tsunami programmes.

- *Using the case of the South Durban Basin: what impact did storm surges have on coastal management plans? And how was the information dealt with?*

  Method: Observations (refer to Appendix 1: Observations of existing land uses) to provide evidence of development post-2007 storm. Two options were available to answer this question: a) Interviews with members of the coastal management team, and if this was not possible, b) a questionnaire prepared for businesses relating to development after the 2007 storm. Option (a) proved to be a successful approach to use.

The methodology was feasible because it was not overly ambitious in terms of sampling. Therefore the thesis could be completed within time and resource constraints.

1.4.4. Process of Data Analysis

An assessment of the application of technology in the design of coastal management plans was conducted. The conceptual / theoretical framework formed the context against which to determine the indicators required for the assessment. Lessons learned were derived from an evaluation of the precedent studies, and from this, recommendations for the application of PSS could be made. A number of conclusions for applying a PSS have been presented in the last chapter. These conclusions are based on the criteria deemed necessary for successful urban coastal research and management practices.

1.5. CHAPTER LAYOUT

Chapter 1: Intent

Chapter one presents an overview of the background to the topic, aim and objectives of this research, key terms the research design as well as a summary of the chapter outline.

Chapter 2: Literature review

A comprehensive look at the relevant literature was undertaken. A conceptual framework has been provided which discusses where this research falls within the broader concept of sustainability. The perceptions surrounding the application of support technology in planning was examined to discover how planning support systems can be used.

Chapter 3: Precedent studies

To derive good practice guidelines literature reviewed from local and international cases, which used Planning Support Systems for urban coastal research and management, have been looked at. Information derived from key informants was presented in this chapter. Lessons from international practice were used to discuss the application of PSS and its role in the local case study.

Chapter 4: Discoveries from the Durban case study

In this chapter an overview of the primary and secondary information about the South Durban Basin case study is presented. The case studies considered where support systems are being applied as well as where they could potentially be used; and gauges the perspectives of the coastal managers and other professional perspectives in relation to the application of these tools.

Chapter 5: Lessons Learned and Conclusion

In the concluding chapter, the research is discussed and assessed. An argument that the research objectives of the study have been fulfilled was presented. The application of research to planning support technologies for coastal research and management was recommended.

1.6. LIMITATIONS AND CONCLUSIONS

Despite the intention to thoroughly investigate Planning Support Systems for coastal research and management, there were several factors that limited the research. The main limitations are: the cost and time factors in the purchase and use of a PSS for analysis. Literature reviews and key informant interviews were used to assess the opportunities and challenges of utilizing planning support technologies in a local context for urban coastal management. The research methodology has been incorporated into the chapters which are designed to answer the research questions. A process was devised to meet the time constraints in which to conduct this study and achieve a complete short dissertation. It was not feasible to purchase the datasets and Planning Support Systems required for doing analyses of South Durban. Hence this report will only describe the application of PSS attributes for ICM.

In short: the topic, study area, and methodology have been defined to provide an introduction to this thesis. The context and main paradigms that influence this study have been researched and presented in chapter two before the evaluation of the usefulness of support systems.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

Coastal management, more specifically the use of land in coastal zones, forms the selected platform for the practical understanding of planning support technologies. A diversity of topics has influenced this research. A historical perspective and the legislative environment influence the application of planning and therefore form part of the debate being considered. A key point of departure is defining the PSS in the coastal situation which it operates both locally and internationally. Establishing the tools and the processes that PSS have been used for were gleaned from the readings. They have been used to form the context within which this research will be explored. From the literature review, several deductions have been made pertaining to; a) What constitutes a PSS itself; b) Planning support technologies as a tool for coastal management; and, c) The relevance of a PSS to this research.

2.2. THEORETICAL PERSPECTIVE

The information revolution describes a growth in the use of technology for information and communications. Deken (1990) stated that computer functions are not a factor but a medium for a new framework for productive economies and societies. Efficient communication, modelling and distribution of knowledge have created a new way to perceive and understand the environment. Planning problems are inherently situated in space and have to be contextually understood through knowledge. The theory suggests that social behaviour impacts on the creation and decomposition of urban environments. Castells presented ideas on the power of „social life" and discussed the theory of an information city: how it has been formed throughout and because of society.

In a world where social and economic trends are key drivers for the restructuring of territory, Castells (1993) discussed the change in space and place in the context of the „Informational City"; "*The Informational City is the urban expression of the whole matrix of determinations of the informational society, as the industrial city was a spatial expression of the industrial society*," (Castells, 1993: 565). The Informational City describes the value in the production of knowledge and how society has embraced technology incorporating it into the urban domain. Global influences impact on local environments which means that despite the contrast in access to global networks, there is pressure in the capitalistic society for all organisations to conform to higher information and technological development.

The expression: „knowledge is power," symbolizes that evidence-based information is considered critical in the decision-making process. Using the knowledge / data, captured from different places, a number of PSS have been formulated and reformulated over time. They are based on the technology that is available and the demand for software. Batty (1978) stated that there was a common problem of a paradox between the „*well defined social science and the ill defined nature of its application*". Despite the development of technological tools there has been a constant debate on the usefulness of the technology for the planning profession and policy. Batty (1978) foretold a cyclic trend in the faith of practitioners using land use modelling, which from the literature reviewed, proved to be the case. Batty (2006) stated that Planning Support Systems have been comprehensive in design and output but underutilised to the point of becoming obsolete. Furthermore, Batty (1990) discussed the trend of increasing numbers of personal computers in Britain. He explained that, due to the growth in technology, spatial patterns would dramatically change. The "*unevenness in the penetration of microcomputers is likely to give as much concern to spatial planners of the post-industrial future as unemployment patterns did in the industrial past,*" Batty (1990: 186). These changes have been reflected globally. The impact of technology can be seen through the locational changes made by businesses from the CBD to dispersed office parks, to changes in individual decision-making processes due to communications technology.

Essentially planning support technologies used by professionals could be considered an inherently technocratic process due to the training required to operate the systems. The use of a technocratic method of planning alone is not considered viable in a democratic era. Stein and Harper (2003) acknowledged that public planning, although aiming for the best solutions, was not always „good". Planning has been used as an „instrument of oppression" and there is a wealth of evidence in the spatial planning history of South Africa to support this point. The potential benefits from planning support technologies depend on the vision and direction it encapsulates which is dictated by societal norms. Effectively the technical assistance that Personal Computers, the internet, and data storage devices have provided to professionals services has revolutionized the world. Hence no singular theory can be applied when generating plans.

2.3. CLIMATE CHANGE AND TECHNOLOGY

Changing trends and patterns in the environment create various scenarios for planning and development. There are many indicators for potential development that planning has to consider. Climate change, for example, is currently a discourse describing the changing weather patterns occurring in the world. Climate change can be seen as actual events, measurable patterns and cataclysmic events such as the floods, droughts, storms and heat waves. These events have both a direct impact at the time of their occurrence and additional longer terms effects that contribute to severe urban problems (such as water shortages, and a reduction in food production).

Many of these larger climatic events include risks that dramatically impact upon the status of the world‟s environmental systems, but often the hardest impacts are experienced by the local environments. As a result, there has been a focus on reaction-based approaches, and less of an influence of long term plans as a response to these events. What was considered imperative to this research was the designing of both a reactive and strategic response. Evidence of the change in toward strategic plans is an emerging trend. The Kyoto protocol which seeks to cut carbon emissions over a period of time, and the Bruntland Commission report (1987) which stated over two decades ago that *„development should meet the needs of the present without compromising the ability of future generations to meet their own needs',* was evidence which indicated the trend. Within South Africa the changes in environmental management has been evident in the passing of legislation promoting preservation of the environment (such as the National Environmental Management Act- NEMA) and its suite of related laws. Laws reflect the contributions made by national and global role-players in a more pro-active role toward mitigating the risks which are contributing to natural disasters.

The ten key challenges listed in the State of the World report (Worldwatch Institute, 2009) are; thinking long-term, innovation, population, changing lifestyles, healing land, strong institutions, the equity imperative, economic stability, political stability, and mobilizing for change. These challenges represent different areas of focus for the planning professions‟ common goal: sustainable development. The scenarios that can be formed from these principles have the potential to be useful in providing direction for coastal management plans, or contradictorily, for stirring panic and mayhem depending on how the scenarios generated are used.

Local innovations created to deal with the impacts of coastal hazards are built upon an interaction with district and national goals which produces national change. The importance of this interaction can be shown in a local example, namely; discussing and analysing linear and non-linear sea level changes along the coastline of Durban. Sea levels are expected to change as a direct result of global warming: "*These results are important in that they provide for the first time a locally measured rate of sea-level rise that can be used for strategic coastal planning, coastal management, and in the design of future port infrastructure and marine structures in the region*" (Mather, 2007: 512). More research on the subject has to be conducted to determine coastal planning strategies and applying technology to planning; *"will more likely help to make planning more responsive to human needs and will aid planners in becoming more of a catalyst for learning and action,"* (Fabos, 1985: 53-54). Enabling a mechanism for the creation of an integrated system, where updated and accessible data about the coastline can be found, constitutes a coastal PSS. Technology comes into play in integrating factors that would not be possible to consider without the ability of programmes to undertake intensive processing through modelling and overall support systems.

Scientifically derived knowledge to inform planning practice could be considered to be an approach taken for granted. Democratic processes are essential in the context of current world politics, but technocratic input is required to make strategic decisions. Decision making should be informed by a combination based on people, places and needs. Since there are many influencing factors in this research deciding on which theoretical approaches to use was a complex process. Key ideas had to be distilled despite the interconnectedness of the topic. It was established that technology has become integrated into almost every aspect of society albeit in different concentrations. There is no escaping its usefulness but also its limitations.

2.4. CONTEXT

Planning has been a tool for reconstructing and engineering urban spaces often in line with a particular political agenda or dispensation. Planning design and laws were used during the apartheid era for the spatial manifestation of racial segregation. Whilst the urban space was carefully managed, the natural space was largely neglected under the previous government pre-1994. Glavovic (2006) stated, that in the 1970"s, coastal management was carried out in an ad hoc manner by a range of agencies. In line with the strong spatial characteristics that define South Africa, the coastline was also afflicted by fragmentation of resources – the dependant poor, and wealthy thriving residential and tourism sectors (Glavovic, 2006; Biermann 2010). The change to democracy has resulted in planning initiatives that are utopian, with broad based ideals, that strive to dismiss the notorious history that spatial planning had received (Biermann, 2010; Naude et. al., 2008; Marine and Coastal Management and Department of Environmental Affairs and Tourism, 2000; Breetzke et. al., 2009). The White Paper for Sustainable Coastal Development describes the distorted settlement pattern and inequality that the social engineering of space had left behind thus:

> *"In South Africa, in addition to the more commonly referred to dualisms, the spatial planning context is dominated by a highly bifurcated economy/society, characterised by dualisms or the co-existence of a globally integrated "first economy" and a marginalised "second economy" reliant on subsistence activities and over-traded local markets. In addition, dualisms relating to differential levels of access to information technology and differential user skills and capacity levels also exist and influence the ability to access and use PSS,"* (Biermann, 2010: 4).

Since the advent of democracy major changes to spatial and environmental planning legislation, which highlight the need for integration, have been passed. Under these conditions, the creation and use of a PSS could be considered a logical tool of the integrative process. However this is not the case in regard to coastal management. Breetzke (2009) provided an introduction to integrated coastal management (ICM) and its application in South Africa. Biermann (2010) better specifies the intrinsic and extrinsic factors that influence a PSS in the planning context and has discussed the current spatial planning context in S.A. (Biermann, 2010: 4-6). Bille (2008) insinuated that integrated management is essentially another utopian ideal. Legislation is influenced by integrated management theories but the directives for environmental legislation come from the national constitution and the Bill of Rights section 24. Bille (2008) considered ICZM to have reached its first phase of maturity as a concept, with many more practical applications that need to be implemented. Nevertheless ICZM is a key paradigm for the sustainable development of coastal areas.

2.5. SUSTAINABLE DEVELOPMENT

Sustainable development has formed a shared vision and understanding of current challenges. As previously indicated the concept of sustainable development has three main pillars, namely; social, economic, and the environment. However the influences of academic and governmental / political spheres are also important and included in the explanation below.

- The *social* elements of the urban environment contain communities and networks. The interaction of people in the environment influence and affect development. Social groups can influence as well as discourage development. Furthermore, in this chapter the shift from technocratic to democratic processes, which should enable greater community participation, has been explained;
- *Economic* elements involve the incorporation of local economic development and employment opportunities that influence the livelihoods of inhabitants. The urban economy is made up of formal and informal markets that occupy the same spaces;
- A*cademic* in the form of education and the development of planning tools uses indigenous and formal knowledge. This is considered key to making informed design decisions. The continuous growth in research and professional training provides for knowledge based growth which is considered to be sustainable;
- The *environmental* facets of sustainability generally refer to conservation or preservation of the natural environment. „Environment" is a broad term, used here, to signify the integrity of the natural environment including the importance of biodiversity and maintenance of ecosystems; and
- *Governance* involves how an area is managed. For example, at a local level the South African municipalities have legal requirements (Municipal Systems Act 2000) to formulate and perform Integrated Development Plans (IDPs). IDPs contain Spatial Development Frameworks (SDFs) that are plans which guide spatial decision-making. Institutional arrangements affect planning for a sustainable city (The constitutional rights mentioned in 2.5. legislation below should be perpetuated at all levels of governance).

Features of the sustainability approach, that combines to form the long term vision for growth in the world, are an ever present feature in contemporary planning debates. However, discrepancies are rife because the principles and projected outcomes are multi-faceted and too complex to achieve in totality. There are segregated land uses effectively dividing people (particularly in the South African context) which seem beyond rational solutions. Tools have been used by people with the capacity to perform creatively to find innovative ways to meet challenges. These tools often evolve out of academic debate and research. Ideology proposed that academic progress as a link toward the elusive goal of sustainable integrated coastal development. However, current practice indicates that this approach is problematic.

Spatial planning requires a stronger understanding of the social and economic dynamics that affect the environment. There has been recognition of a need for the creation of a national decision support system specifically designed for the coast (ICMA, 2008), and "*a long-term perspective is generally missing in adaptation strategies and coastal erosion problems have often been solved at small spatial scales. Sometimes, this resulted in local solutions exacerbating coastal erosion problems at other locations,"* (Horstman et. al., 2009). The lack of integrated data has created homogenous islands in geographical spaces which promoted ill-derived planning mechanisms (Van Huyssteen et. al., 2009). Thus the future development of the coast will be dependent on long term scenarios. The selection of preferred scenarios, that are planned and enforced through legislation, would play a major role in shaping coastal zones.

2.6. LEGISLATION

Urban Planning is guided by a composition of legislation and policy. There are several interrelating factors which influence plan-making under South Africa"s **Constitution** (1996). Integrated development planning and sustainability are entrenched in the legislation of South Africa. Section 24 of the Bill of Rights states that everyone has the right "*to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures,"* which, "*secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."* The concept of sustainable development was briefly introduced in chapter one as an integral concept to this study (refer to Figure 1: Sustainable Integrated Development Planning above).

2.6.1. Hierarchy of Plans

Numerous plans have been created over time to serve different agendas. In South Africa there are a number of preceding plans that govern local plans. The diagram below represents a simplified hierarchy showing how plans descend from a national to local level. It represents, in part, the scale of plans generated in S.A. showing the interrelations between them toward the common goal of sustainable development. After looking at the theory and trends this simplified hierarchy has been incorporated in this paper to show the external influences to land use management planning.

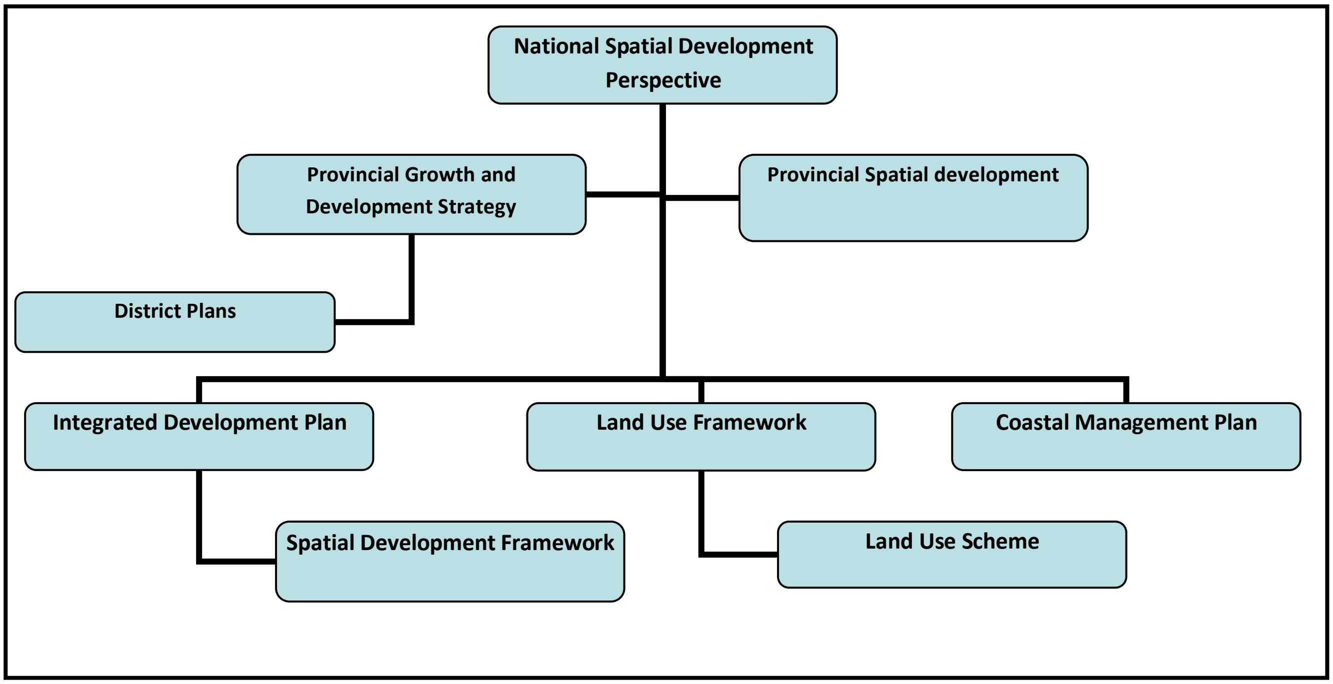


Figure 3: Simplified diagram of a hierarchy of plans in S.A.

The research is framed by three main ideas, namely; natural coastal environment, land uses and sustainable development. The legislative framework that informs these ideas is governed by the National Environmental Management Act (NEMA). The environmental stresses from land uses have resulted in cumulative damage to the quality of the natural coastal environment. Therefore the legislative framework supports the concept of planning for sustainable development.

Legal tools have been designed to combat historically resource centred approaches to coastal management. The White Paper on Spatial Planning and Land Use Management (2001) stated;

> "*That development and developmental programmes are holistic and comprehensive so that all factors in relation to land resources and environmental conservation are addressed and included. In considering competing needs for land, and in selecting the "best" use for a given area of land, all possible land-use options must be considered; That all activities and inputs are integrated and coordinated with each other, combining the inputs of all disciplines and groups; That all actions are based on a clear understanding of the natural and legitimate objectives and needs of individual land users to obtain maximum consensus; and That institutional structures are put in place to develop, debate and carry out proposals."*

Legal documents provided the statutory guidelines and obligations, but more practical plans are required to achieve the necessary outcomes for management. These plans have to be designed and incorporated for ICZM (Breetzke, 2009). The figures show that legislation informs the argument for management of the coastal zone (refer to figures 3, 4 and 7). NEMA is the overarching environmental management legislature. At a national level NEMA sets the principle of environmental justice. In South Africa, coastal management is driven by the Integrated Coastal Management Act (2008). The objectives of the ICMA stated that; "*Within the framework of the NEMA, there has to be provision for co-ordinated and integrated management of the coastal zone," (*Republic of South Africa, 2008: 24). The Integrated Coastal Management Act (2008) has been derived from and forms the coastal component to NEMA.

The ICMA (2008) in conjunction with NEMA was designed to enforce legal procedures for coastal management practices. The ICMA uses the premise of defensible scientific information, together with co-operative governance, will result in sustainable coastal development (DEA and SSI, 2009). The acts set out numerous legal procedures including;

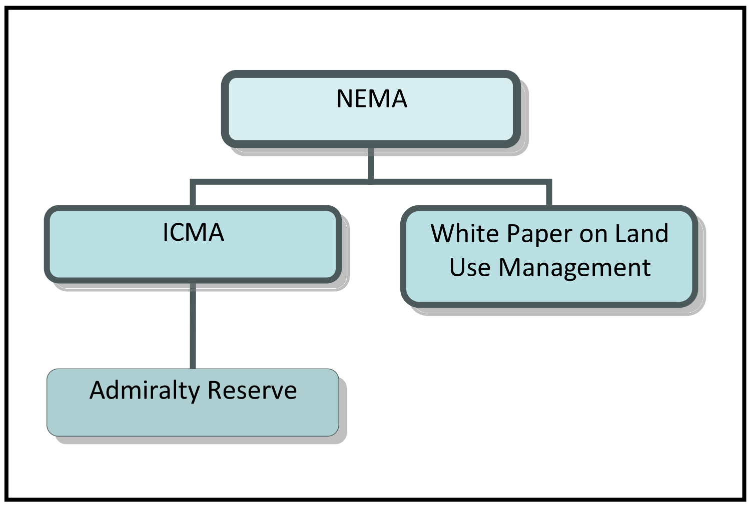


Figure 4: Legislative framework

- Implementing coastal setback lines in areas that pose hazards and risks. Setbacks are a provincial responsibility but marking coastal boundaries on zoning maps is within the jurisdiction of a municipality;
- That; if in the public interest, expropriation could be a tool to accommodate CM practices. Admiralty reserve (AR) informs coastal management practices as it provides for a boundary of state land and coastal public property. The AR is accounted for in the ICM Act. It refers to the identification and establishment of a coastal zone in South Africa (refer to figure 5); and
- The CMA which acknowledges that the initiatives have to be implemented at a local level. The MSA that facilitates the IDP planning has brought about a method in which to address coastal concerns. Thereby legislation becomes an indicator toward achieving alternative scenarios in PSS.

- Climate change and its associated impacts which have to be considered before implementing developments. Legal processes can be facilitated by developing indicators and continuous research about local coastal developments through PSS.

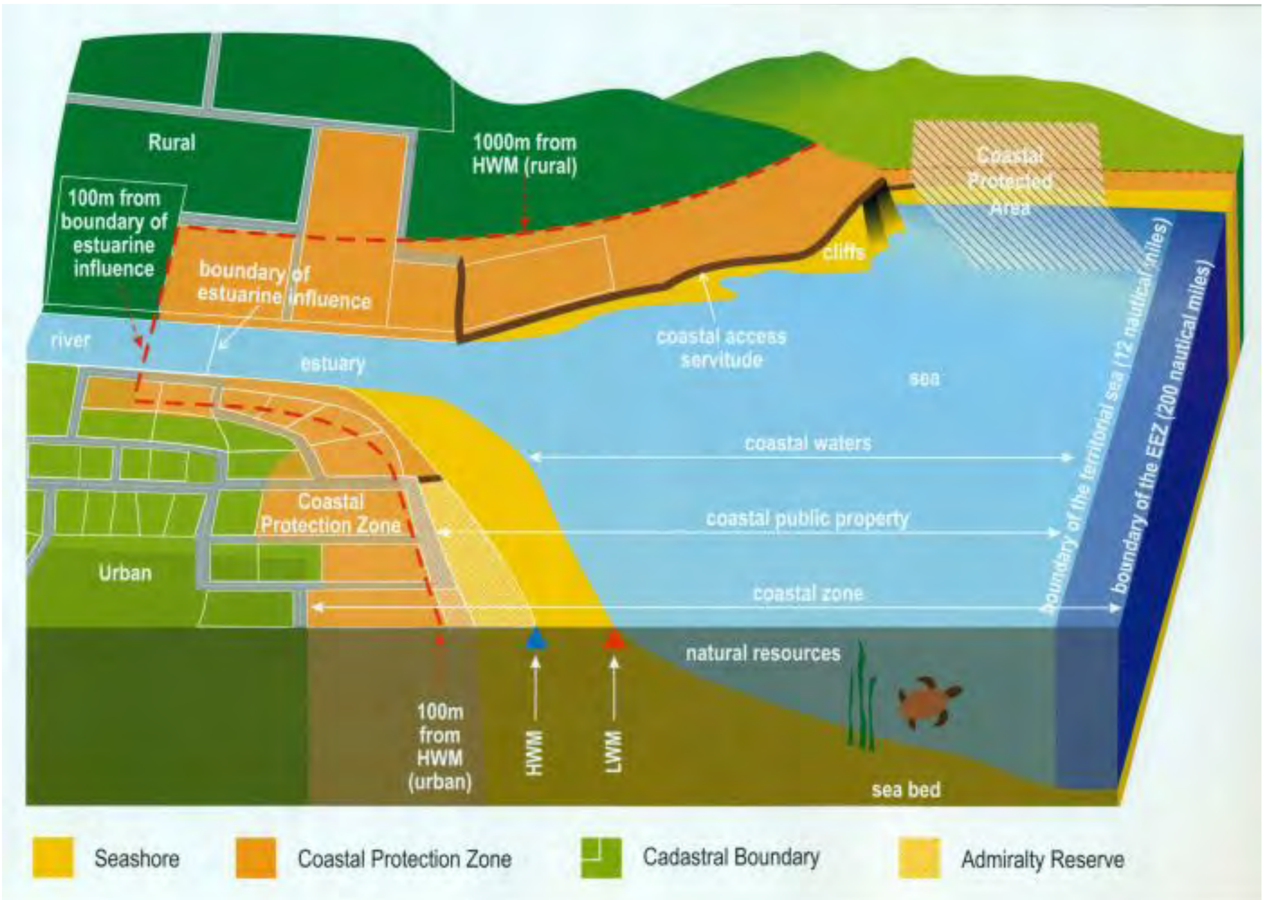


Figure 5: Coastal boundaries
(DEA and SSI, 2009: 19)

The ICMA (2008) provided a national perspective on the ideal management of coastal zones. However, there are conflicts that arise due to the diversity of features along the coast and the varied spatial scales used to define the area. Despite the provision for boundaries, the volatile nature of the HWM and wave conditions provides an unstable indicator for planning (Whittal, 2011 and Mather, 2011). Hence how to plan and implement the ICM Act becomes the predicament.

Land use management through planning via land use schemes and other local tools, such as Integrated Development Plans (IDP‟s) and Coastal Management Plans (CMP‟s), serve as tools to implement national and provincial agenda. In terms of coastal management; the influence of national and provincial legislation on the IDP, SDF and CMP affects development. Local schemes produced from the aforementioned strategic plans provide regulations for development. Therefore a logical approach to managing coastal development is to derive an overlay for coastal management that is contained in PSS.

The legislation for the protection of environmental assets is incorporated in local planning initiatives. The integrated development planning process functions as a platform for implementing coastal management planning. Planning support technologies to support these initiatives and the data produced could be designed through consecutive IDP‟s.

2.6.2. Integrated development planning

Integrated development planning is a process of creating a strategic plan for a municipality every five years.

"*The Municipal Systems Act 2000 introduced integrated development planning at municipal level; an important new form of strategic planning that has come to occupy centre-stage for many planners. It encompasses both broad social and economic development planning and strategic spatial planning through spatial development frameworks (SDFs).*" (Todes, et. al., 2009: 421).

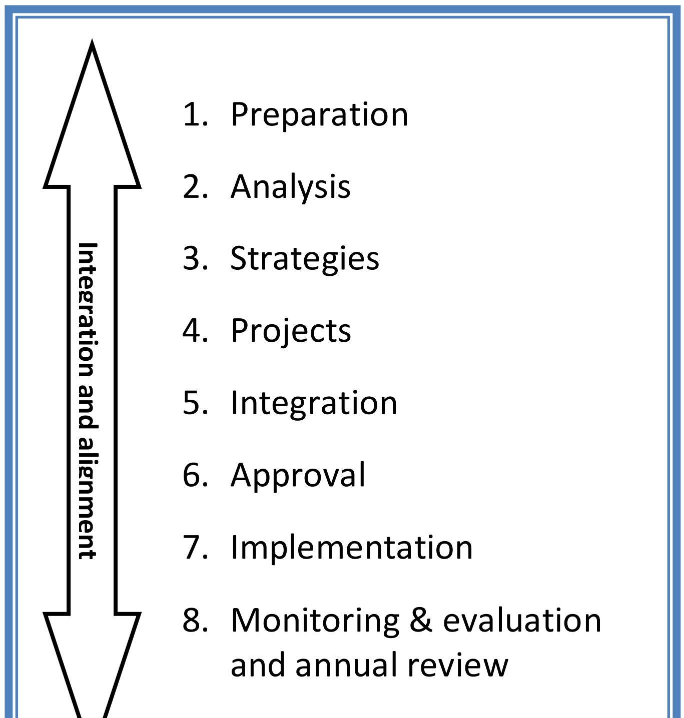


Figure 6: IDP Process

The formulation of the Integrated Development Plan (IDP) is considered an intensive process. Goals are set for a strategic vision for the future while addressing the cross-sector issues faced by localities. It is essential that the data collected is properly processed to determine the focal areas for land use management guidelines. Of equal importance is the monitoring and control of development which are part of the inclusive strategic plan at a local level.

The strategic plan derived from the IDP process is a Spatial Development Framework (SDF). This plan should contain the vision and goals for a longer term strategy for a particular area.

Integrated development planning process produces the IDP (shown in figure 6). The IDP is instrumental in guiding planning, budgeting, management and decision-making in a municipality. Sub-designing CMP"s based on the IDP has been piloted in Durban, South Africa (refer to chapter three). Developing planning support technologies would initiate increasingly available input for the local planning of coastal zones.

Key considerations derived from the diagrams show that availability of land, information and the sustainable development concepts are major influences in plan-making. Legislation and the processes of integrated coastal management have to amalgamate, to produce research and plans, for a PSS to be developed for urban coastal management.

2.7. CONCEPTUAL FRAMEWORK

A conceptual framework has been designed based on the context and evaluation of the current legislation. The framework in which this study is situated (see Figure 7 below) shows that Planning Support Systems (PSS) can be applied in specific land use contexts for the purpose of analysis. An example of PSS utility is in generating integrated information and mapping to assist in creating Coastal Management Plans.

Mapping and management plans are the outcomes of critical thinking processes that involve large amounts of information. The framework of generating plans includes several informants. Figure 7 indicated that this research has been situated within a network of concepts used for creating integrated coastal plans. The ideology used was that a PSS could be a tool, for the process of research and analysis, to facilitate the output of well designed plans and maps.

PSS were discussed as tools which support the creation and management of data. It was argued that to create viable plans, analysis and presentation provide a major influence in ICZM. Considering the hierarchy of plans, those that directly influence coastal management planning in a locality form an interrelated network (for example the SDF, IDP, and LUF). Another factor that affects the study is the triangulation of time / cost / quality. In the longer term cost versus quality is subjective. The diagram represents an emphasis on the value of PSS in the system of creating plans.

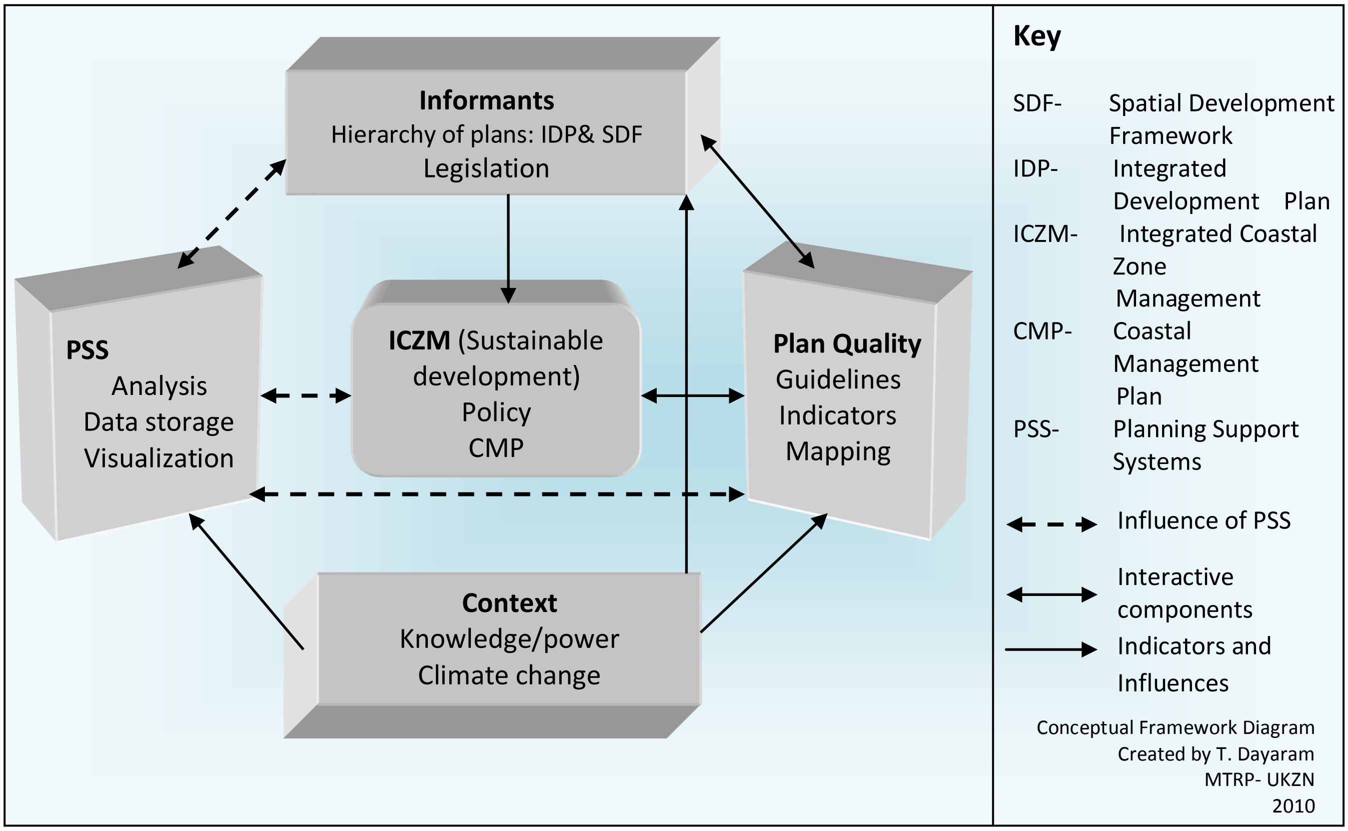


Figure 7: Diagram depicting the conceptual framework of this study

The quality of information used for understanding site conditions affects how an area is planned. Legislation and the site specific context influence the way plans are formed. PSS have the potential to positively influence plan quality by using integrative technologies to produce better quality plans. Additionally, PSS has been described as a package of technological tools that create a decision support system (DSS) which assists planners in the function of monitoring and managing the environment. The use of technology can be perceived as a technocratic process. Since specialized knowledge is required to operate systems and affordability accommodates mainly the higher income bracket. However, the application of professional input/output from a PSS also contains the ability to distribute information and aid in participation. The change in the role of a professional planner is linked into changes in society. Tools have been used by people, with the capacity to perform creatively. This has enabled innovative ways to meet challenges. Hence the ideology that academic progress could be a link in moving toward the elusive goal of sustainable integrated development.

2.8. PLANNING SUPPORT SYSTEMS

A paradigm shift has changed worldviews about how planning and development are practiced, for example, the shift from „blueprint" / master planning to more participatory approaches (Geertman, 2006). Similarly, there was a change in approach to creating plans that do not primarily focus on physical features of a landscape, but also the human components of space such as space economy and „human perception of place" (Brown, 2005; Geertman, 2006; and Naude, et. al. 2008). Development in technology has created new ways of approaching situations. Wegener (1990) discussed the post-industrial era and its transition toward an information age, stating that: *"just as the industrial age was brought about by the mechano-electrical revolution, the post-industrial era is introduced by accelerating advances in such fields as ...electronics,"* which can enhance rational planning through improved information-processing technology.

Harris (1989) and O"Reagan (1996) stated that the rise of the personal computers" availability and growth of software has opened up great potentials well as uncertainty for the planning profession. Planning Support Systems (PSS) were said to have emerged in the 1980"s as a generic term for computer based tools used by planners (Batty, 2007). By the 1990"s there was a variety of geotechnical instruments and tools to engage most planning processes (Geertman, et. al., 2009 and Batty, 2007). Broad based technological tools used in the planning profession made it difficult to specify a definition of PSS, however, according to Geertman and Stillwell (2004) PSS are generally defined as: systems that bring together various technologies for the purpose of professional planning.

A PSS also serves as a tool for education because of the potential it contains for communication as well as the concept of „serious gaming"[1] (Slager, et. al., 2007; Hollander and Thomas, 2009). There are a variety of methods, techniques, and models developed for various functions. They analyze spatial problems, evaluate alternative scenarios, and use the data to provide for strategic future development options. These are combined into a technological platform to facilitate unique planning practices have very broadly been called Planning Support Systems

[1] Urban and regional Planning courses can prepare students to deal with the cross sector issues of planning in a spatial context via virtual space, hence the term 'serious gaming' (Slagar, et. al., 2007). This term could also be adopted in a professional capacity but that can only occur if the PSS contains the components required by the professional practitioner, and if the PSS is accepted as an adequate tool.

(Geertman, 2006; Biermann, 2010 and Slagar, et. al., 2007). A breakdown of each word has been used to further define the tool:

- „Planning" refers to the professional practice;
- „Support" defines the purpose. Tools incorporated into a system which provides the knowledge and analysis required for decision-making; and
- „Systems" refers to the technologies used to approach the planning tasks. Ranging from Geospatial technology, modelling and simulation techniques.

Hence the definition clearly shows that PSS is not determined by the „System", but by the „Support" it provides to the planning profession.

Geospatial technology refers to the components of a PSS which maps features on the surface of the Earth. Use of mapping technologies, such as: Geographical Information Systems (GIS), Global-Positioning Systems (GPS), and Remote Sensing (RS). Geospatial technology was described as being synonymous with spatial information technology that can be used to track, map, analyze, and disseminate information (Panda, 2008). However a PSS can be used for long range problems and strategic issues, whereas SDSS supports shorter term policy making and operational decision making, which are not strategic in nature.

GIS differs from PSS because it is a general purpose tool for capturing, storing, manipulating, analysing and displaying spatially referenced data. Alternatively a PSS would be focused on a specific task, such as CMP"s, by containing a GIS (as seen in table 2.8.1 below). There are a range of variables, within the GIS, which are important for integrated development planning. A PSS would include a GIS particularly if the task required geographic / spatial data. PSS are closely related to information systems such as GIS and Spatial Decision Support Systems (SDSS) which are similar but not the same. PSS are focused on requirements of the planning profession.

Internationally planning support technologies have developed into a PSS for coastal management. However, more often than not there was use of a package of planning support technologies. For instance New Zealand has advanced in coastal management practices and incorporated a Spatial Decision Support System (SDSS) designed to be an integrative modelling tool. Australia was considered a leader in coastal management practices. However they have not implemented national approach or use of a PSS despite all the beneficial research and development surrounding the technology (the international cases have been presented in chapter three).

2.8.1. Table Showing the Range of variables to profile as part of a relational spatial analysis
(Source: Naude et al, 2008)

Intra-locational variables		Inter-locational variables	
Category	**Variables/examples**	**Category**	**Variables/examples**
CATEGORY 1 Places (local areas)	Shapes and sizes Field parameters Geographic location Area attributes	*CATEGORY 3 Relationships among places**	Network connectivity Network capacities Accessibility Surface impedance
CATEGORY 2A People and activities	Types of actors & activities Numbers & attributes of each type	*CATEGORY 4A Wide area relationships among people**	Translocal social networks Interregional supply chains
*CATEGORY 2B Local relationships and interactions**	Local social networks Local supply chains Local flows of ecosystem services	*CATEGORY 4B Wide area interactions among people and activities**	Types and quantities of people and commodity flows 'Pipelined' flows of ecosystem services

* Shaded blocks indicate variables that are not usually profiled as part of basic area statistics or GIS applications

According to ESRI (2010) GIS supports planning and public participation processes within a PSS. Geertman and Stillwell (2004) discussed the diverse applications and types of PSS, and provided a more comprehensive view of PSS. Generally they are technologies dedicated to the planning profession, defined as a „toolbox," which can be designed to deal with a wide diversity of aims. The functions of PSS range from facilitating participation, performing tasks as well as supporting specific forms of planning, for example: strategic planning. Batty (2007) had a similar view acknowledging that there was an increasing variety of visualization tools. Bottom-up technologies involving 3D virtual city modelling are incorporated in classifying the planners" technological „toolbox". With the increasing use of technology and a more inclusive approach to planning the idea of: "communication through visualization," was conceptualized (Batty, 2007).

2.8.2. Table of Types of PSS including their Functions

(Table created by author from sources: Geertman and Stillwell, 2004; Biermann, 2008; *GAP*, *K2VI* and *What If?* ™ (Online, 2010; O‟Reagan, 1996; and ESRI, 2010.)

	Planning Support System	Acronym	Description	Function
A	Planning system for Sustainable Development	PSSD	Web-based Toolbox supporting professional planners; used for environmental planning	Strategic planning tool
B	System for Planning and Research in Towns and Cities for Urban Sustainability	SPARTACUS	Contains a land use/ transport model, sustainability indicators, GIS-based raster method and a decision support tool	Task-specific on land-use, transport and the environment in an area specific context using simulation
C	Growth Allocation Model	GAMe	New Jersey Growth Allocation Model that develops scenarios from a model of user policy choices	Allow for visualization of potential spatial structures
D	What if? ™	-	GIS-based PSS that can be customized to the users GIS data and policy issues, and can produce maps and tables	Allows various users to determine what would happen if public policy choices are made and assumptions about the future prove to be true
E	Geospatial Analysis Platform	GAP	Meso-zones and spatially disaggregated social and economic data sets, including digital road networks and a geo-referenced dataset of South Africa's towns	A more detailed spatial distribution of economic activity in South Africa
F	Preference Predictor	-	Closed program setup module, Artificial intelligence-based, evaluation system Past user's planning behaviour	Learns decision priorities from past workshop attendees/users
G	Google Earth	-	Internet-based, general purpose tool with access to aerial images	Shows similarities and contrasts between different land-use patterns generated by land-use modelling PSS
H	Internet	-	The World Wide Web (www) consists of a large amount of data; inclusive of planning-related material	Provides for communication, data storage and comparisons; Many PSS are internet-based
I	Geographic Information Systems	GIS	Consists of tools that handle geo-referenced data [examples of GIS are ArcGIS, MapInfo Professional and IDRISI]	Perform spatial analysis, model operational processes, and visualization via maps

The items A-H on table 3 above are specifically designed PSS, while the latter three are general purpose tools that are useful to the planning profession. There are a variety of tools that can enable PSS to aid planning practice. Although this list is not comprehensive, it forms an introduction to the different uses of planning support technologies. It was assumed that there was intensive data collection and storage to support the various PSS shown on the table. The processes of research and data management are an important component of a system. There is a wealth of data and software for analysis that can be tapped into, which prompts the question: how can PSS be used to integrate legislative and local conditions to formulate coastal management plans?

2.9. INTEGRATED COASTAL MANAGEMENT

The coastline is a space where the earth and sea meet. Coastal areas contain attracting and repulsive factors for humans that are „value dependant". The value of a coastline was narrowly discussed as; cultural, transportation and aesthetic attributes of an area, but the socio-economic, and environmental attributes also have to be considered (Cau, 1996). Coastal management is a topic in itself with numerous literature and focal areas. The connections between Planning Support Systems (PSS) and coastal management have been explored because of the diverse land uses formed in questionable coastal zones of the urban environment. As depicted in the conceptual framework (refer to Figure 7: Diagram depicting the conceptual framework of this study) the significant theories applied to PSS for urban coastal management were „dimensions of sustainability" as well as Integrated Coastal Management (ICM) (Todes, et. al., 2009).

A common perspective of the coastal situation is that the land / sea interface provides a unique system of land use patterns and ecosystems. Coastal management has incorporated the concept of Integrated Coastal Zone Management (ICZM) which Clark (1997) viewed as treating the land / sea area as a single interacting unit called „unitary management". Coastal management has many activities to consider, namely: resource depletion; preventing / minimising pollution; conserving biodiversity; managing sea level rise; designing setback lines to minimize the impact of erosion; land use management (including the hinterlands effect on coastal areas); coastal tourism; policy formation; landscaping and resource conflicts and hazard management which is part and parcel of human security (Clark, 1997; Sonak, and Shaw 2006; Taussik, 2007; Tolvanen, and Kalliola, 2008). These processes require information and analysis: ―*The need for improved coastal management planning and decision-making requires* *holistic understanding and knowledge of vulnerable coastal areas and the predictive occurrence of threats to these areas*" (Pelot and Plummer, 2010: 229). The ICZM approach applies the concept of sustainability to the coastal context, by the creation of an integrative planning system (refer back to 1.3.3.).

The regulation of coastal zones was historically focused on human inflicted damage to the sensitive coastal environment. The main challenge, through no formal processes, was to prevent physical threats from causing further negative impacts (Glavovic, 2006). Over time the shifting perspectives of coastal management have increasingly placed focus on integrated processes that incorporate the „physical, social, economic and governance" aspects of development, i.e. sustainable development. The argument being for a more geocentric / earth centred rather than anthropocentric / people focussed approached to coastal management (Turner, 2000). Sonak and Shaw (2006) brought attention to the shift in perspective by reflecting that directions of planning processes shifted from „for society," to planning „for the community." Distinction between the terminologies revealed that society is essentially capitalistic, in that the benefits shown in plans are those which promoted the economy and wellbeing of certain classes, while planning for communities reflect the needs of people in a particular environment.

One of the challenges of the ICZM approach is how to deal with the lack of co-ordinated data specific to coastal areas; –*Another very significant problem is that while there is a wealth of data and information relating to the coastal zone, it is held in different locations, by different and disparate organisations, in incompatible formats, and data is frequently collected for the marine environment or the terrestrial environment and is rarely displayed together to show the full coastal zone (backshore zone, intertidal zone and offshore zone),"* (King and Green, 2001: 5). The problem of indefinite inland boundaries of the „coastal zone" which affect management decisions was the co-ordination of numerous stakeholders and authorities.

Coastal management legislation informs the sustainable practices incorporated in integrated development planning processes. Coastal planning is a task that requires foresight especially in determining factors of location. Sonak and Shaw (2006: 11) stated that: –*The role of shelterbelts in providing against storm surges and other natural hazards needs to be documented more systematically,"* as they have the potential to reduce coastal vulnerability. The potential of integrated research was seen as a determining factor in efficient management of coastal development. Low lying coastal areas require the identification of specific features to enable progress in sustainable development. Therefore tools for coastal research and management have to be explored to determine how they may be incorporated into professional planning practice.

Different activities define the planning profession. According to Harris (1989) planners:

1. Negotiate, bargain, explain, and argue about planning rules, changes and permissions;
2. Have been involved in the administration of rules and regulations; and
3. Make plans.

The latter activity has the most potential for the inclusion of technologies using computer based tools. Turner (2000) stated that at a global level changes that occur in coastal zones cannot be understood by purely observational means, and that modelling tools are vital to meet coastal management objectives. Demonstrating that the ideology for using tools to strategically plan the coastal zone existed but evidence has shown that practical implementation has been slower in achieving this objective. The growth in the use of technology in planning has yet to be used to its perceived potential (Geertman, 2006). UN-HABITAT (2007) defined land use planning as a fundamental tool for disaster risk reduction in the urban development process. Prediction of scenarios such, as the rates of migration, will be fundamental to the future management of the changing coastal environment (Pethick, 2001).

2.9.1. Planning Support in Coastal Land Use Management

Computers have been used for many tasks as software and hardware developed rapidly in a relatively short time frame. The planning support technologies used have been dependent on the required task/s. Creating and measuring plan performance has been an area that has become more digitized. Measuring the plan performance was determined to an extent by spatial interactions; maps; and cost. Using the computer to determine long term outcomes and guiding growth in a particular direction (O‟Reagan, 1996).

The activities in the coastal zone determine the management of land uses. The White Paper on Land Use Management (2001) defines spatial planning as; "*planning of the way in which different activities, land uses and buildings are located in relation to each other, in terms of distance between them, proximity to each other and the way in which spatial considerations influence and are influenced by economic, social, political, infrastructural and environmental considerations*," and land-use planning is defined as the "*planning of human activity to ensure* *that land is put to the optimal use, taking into account the different effects that land-uses can have in relation to social, political, economic and environmental concerns,*" (White Paper, 2001). This means that specific goals and outcomes of a locality need precise information.

There are numerous components that make up a PSS. Geospatial technology has many functions in planning for climate strategies and mapping. "*Researchers use the spatial information technology to prepare society to withstand the challenges. Hotspot identification and analysis is a prime tool of geographic information sciences. Through geospatial technology use, governments can identify factors and hotspots responsible for global warming and climate change and locate areas affected by them. Governments can then act accordingly to save vulnerable populations. Thus, the use of geospatial technology can help in mitigating global warming problems and after effects,"* (Panda, 2008). Various professions have adopted software and implemented it into their profession, for example a generalized case of: ArchiCAD for architects. The planning profession encompasses more than just designing plans, so various systems have been created over time for different purposes, but no system has been unanimously adopted.

Kay and Travers (2008) have discussed the evolution of tools and methodologies, specifically addressing the techniques of coastal vulnerability assessment. Literature reveals that there is substantial exploration in the fields of transportation modelling but little on other aspects of planning. Moreover the focus of support for planning is the use of GIS based systems (Celliers, et. al., 2009). Tools that make up components for PSS are used separately in planning but not as a system. Planning systems for coastal management, although specific, was very broad in terms of the types of PSS and the roles a PSS could play in the urban environment. Hence this chapter has attempted to generate an understanding of the types of uses planning support technologies have for coastal land use management.

2.9.2. Geographic Information Systems (GIS)

Geographic information systems (GIS) were commonly discussed as tool for spatial planning and coastal planning, for example:

- "*GIS are an essential tool for integrating land and marine datasets. They provide the ability, for example, to view land elevation data, as well as bathymetry. They can be used to show where marine features are in relation to terrestrial features. They can also be used for* *temporal comparison, for example the geographical position of a coastline can be mapped over a period of time, and accretion or erosion mapped and measured for different periods of time*." (King and Green, 2001).

- "*Coastal GI (geographic information) is essential for practical planning processes such as CZM (coastal zone management)*," (Tolvanen and Kalliola, 2008).

GIS provides a wealth of information for differing situations: such as data displays; raw incident data; simulated data or calculated risk distribution, which is sufficient to provide guidance in decision making. The visual products of GIS serve as effective means for distributing knowledge/decisions to stakeholders for educational and management purposes (Pelot and Plummer, 2010: 234). GIS has enabled planners that are visually oriented with mapping and display characteristics that are of psychological and operational importance. Harris (1989) also stated that a planner‟s capacity for mapping, management and control of urban affairs were advanced by use of GIS. However a GIS is not the only available mapping tool available for the planning profession.

2.9.3. Remote Sensing and Aerial Photography

Remote sensing and aerial photography provide information of physical attributes of an area as well as changes over time. *"coastal features such as defence and protection works, cliffs, beaches and areas of erosion can all be discerned from aerial photography remote sensing perhaps has a stronger terrestrial component in coastal zone monitoring, the broad scale coverage of satellite imagery, and the smaller scale but more detailed coverage of aerial photography means that remote sensing is a very effective visual information tool for coastal managers, and it has significant potential as a tool to bridge the gap between land and marine data sets, particularly in the absence of suitably integrated map data,"* (King and Green 2001: 6). Tolvanen and Kalliola (2008) stated that terrestrial information in the form of remote sensing (RS), geographic information layers and data bases with geographical labels are more accessible and available than aquatic information which has less uniform and less precise data sources. King and Green (2001) considered RS as a tool that could bridge the gap between land and marine data sets. O‟Reagan (1996) stated that RS provides effective unbiased information at different spatial scales, and as a management tool, repetitive coverage. RS has been used for PSS to depict changes in coastal features over time. The assimilated information gained from RS methods can be used as variables in modelling and simulation processes. Since this study concerns the changes in sea level, and its impact on the urban coast, it is necessary to find the methods that have an integrated approach in dealing with the coastal zone.

Access to the internet has enabled practitioners to be more connected and have access to technology that was previously only available to specialists, more especially in terms of GIS and RS; "*The progression of GIS and remote sensing on to the Internet and (world wide web) WWW has meant that both technologies are now available to anyone with a computer and modem or other form of access to the Internet network. While the GIS and remote sensing software is perhaps not as well developed as their more expensive standalone counterparts, it is ideally suited to the everyday coastal practitioner who may have little expertise in the field of GIS and remote sensing, but does have a requirement and a need to access up-to-date data sets, view them, interpret them, analyse and manipulate them and use them for map output to integrate in management documents or even for use in public awareness displays*," (King and Green, 2001). The wider use of technology, and the increasing accessibility to internet, drives planners to use GIS (Gocmen and Ventura, 2010). However Harris (1989) stated that PSS has more depth than that of GIS and incorporates technology specific to planning requirements. According to Harris (1989) a PSS has to consist of a good GIS. Recommendations that reviewers of PSS have suggested is that the „user-interface" of the PSS should be aware of the users features because the information it communicates can lead to a distorted reality based on how information is handled (Geertman and Stillwell, 2004).

As a tool for urban coastal research and management, there are standard applications like data management and mapping coastal vulnerability that contribute toward better practice. What stood out was that the methods used are not unique (e.g. scenarios and alignment of planned and programmes to a strategic vision). It is the way a PSS is constructed that provides efficiency if planning. The literature has confirmed that the use of planning support technologies is subject to many perceptions namely proactive usage or reliance on the tools without fully grasping its capability. There has to be an understanding the site specific conditions that predetermine use of tools.

2.9.4. Implications for South African Coastal Management

The South African coastline has a growing population inhabiting the urban coast. Broadly South Africa faces the legacy of segregation, "*The most obvious features of the South Africa context are the history of apartheid, and, from 1994, the transformation of the country's spatial,* *institutional and political environment. Apartheid resulted in severe racial inequalities coupled with a highly fragmented and unequal administrative system and associated spatial apartheid. In this context, planning and environmental management emerged as separate spheres, both overlaid by administrative fragmentation on racial line,"* (Todes, et. al., 2009:417); Data management is another challenge: "*data management and availability have increased the demand from government for integrated planning initiatives. More detailed mapping is required but the use of GIS is thematic, creating homogenous islands in space that reflect administrative boundaries regardless of the intricacies of a particular area. This promotes ill derived planning outcomes that blur the cross sector effects as well as the internal dynamics of an area*," (Van Huyssteen, et. al., 2009). There are numerous developmental and environmental data that has accumulated in a fragmented system, making access and storage challenging. A national database for coastal management is necessary as there is a need for information and decision support system for coastal management practitioners (DEAT, 2000).

The challenges that South Africa face are reflected in the local coastal zones. Development has occurred sporadically and there are various studies and sector plans which do not integrate across borders. There has been advancement in legislation and policy about coastal management practices. However the role of coastal management is less focused on conservation and ecosystems than on sustainable development (Glavovic, 2006). The argument for environmental integrity becomes more obscure when competing against developmental challenges of the socio-economic nature. Policies and guidelines have been developed, such as the Admiralty reserve, to facilitate better coastal management.

Changes in perspective from technocratic to democratic procedures are highlighted by legislation for coastal management; beginning with the White Paper for Sustainable Coastal Management and the advent of The Integrated Coastal Management Act (Act No. 24 of 2008). The ICMA (2008) intends for all spheres of government to develop Coastal Management Programmes (CMP) which accommodate the natural, social and economic differences along the coastline of South Africa (Breetzke, et. al., 2009). The Act provides legal mechanisms for the proactive planning of coastal areas. Supporting legislation are tools which are the plans and programmes that facilitate management, for example; IDPs are management tools which have to be prepared in terms of NEMA and therefore be aligned to both National and Provincial CMPs (Celliers, et. al., 2009; Breetzke, et. al., 2009).

KZN has protected its natural asset (the coastline) by using a policy of vague origin: the Admiralty Reserve (AR). The origin of the AR is vague, but the value it has provided can be seen in the conservation of South African coastal dunes (Gunn, 2009). The Admiralty reserve refers to a buffer strip of land setback from the high water mark, that is generally 45-60m wide (PPDC, 2008). The updated document of the AR in KwaZulu-Natal (2008) stated that the function of the reserve has environmental, geomorphologic, legal and public access consequences. The existence of the AR is legally determined by title deeds (further referred to in chapter 3). Nevertheless the management of land is based in approaches to spatial planning, land use management and sustainable development and this was evident in the literature.

Fabos (1985) discussed the continuum of land use issues from local to global scales. The significance of a land use depends on the threshold of the population that is impacted (Fabos, 1985: 5). Therefore the coast is governed by national bodies but the impacts have to be managed at a local level. Significant advances in spatial analysis technology has provided improved „granularity of analysis" and „relational spatial analysis" (Van Huyssteen, et. al., 2009: 196). The advances in technology provide the means for better understanding of the coastal zones over different areas, "*With the institution of the LUMS which extends planning controls beyond the former town planning scheme areas into rural areas, there is the potential for greater control of development in the Admiralty Reserve in the Ingonyama Trust areas adjacent to the coast. This local level planning did not exist prior to the new municipal demarcation which extended local government control into rural areas... For many years they controlled development on the seaward side of the railway line, thus preserving the Admiralty Reserve. However, the pressures for development became too great resulting in unplanned and uncontrolled development with houses being built virtually on the beach,"* (PPDC, 2008: 60). Celliers, et. al. (2009) suggested that in compliance with the ICM Act, a coastal planning scheme is tool for coastal zone management.

Boundary differentiation impacts on the management of coastal resources because different authorities are guided by different priorities. Building a coastal information system requires knowledge of the anticipated needs of the systems. The use of planning support technologies to strategically monitor and control coastal development through provision of data, models and plans to contest the differing analysis units and scales used by various sectors (Naude, et. al., 2008: 4).

2.10. CONCLUDING COMMENTS

The theories presented the destructive and constructive attributes of the use of technological methods in a changing environment. Climate change relevant to coastal planning and coastal zone management influences development along the coastline. The literature review separated the tools from the processes to show the variety of PSS. There are literally limitless opportunities to perform a diverse number of tasks using PSS. The focus of the chapter was not on coastal management but on highlighting systems and processes that can be explored with PSS. Connections between the use of technological tools and the tasks were then discussed to understand the context in which this study will be explored. From the literature reviewed several deductions can be made pertaining to PSS itself; Planning support technologies as a tool for coastal management; and the relevance of ICM and PSS to this research paper.

Firstly, PSS has numerous functions and can be specifically tailored toward planning tasks: Simulation to predict future challenges; Models that determine different scenarios; Classroom games that educate students about planning and developmental realities. In the real world technology has already formed a practical tool in the aforementioned areas. However Planning Support Systems have not been unanimously adopted by the profession. Generally the required spatial data is provided through a GIS. There are pros and cons in the use of GIS. The limitations of using GIS are the costs, and its limited support to planning beyond administrative and visualization functions. GIS has been considered a tool for reactive planning (Harris, 1989: 86). Geertman (2006) suggested that PSS should be an integral part of the planning process and context.

> "*In general, PSS applications are relevant for multiple stages of the planning process and do not require users to have advanced technical capabilities in order to undertake sophisticated functions like visualisation, analysis, and creating and evaluating alternative scenarios. Advances in geospatial technologies such as internet-based GIS have recently narrowed the distance between PSS and GIS, but PSS still supports more planning functions than are readily available in GIS, especially to those without technical training,*" (Gocmen and Ventura, 2010: 173).

There are three categories of barriers limiting the implementation of technologies; the technological limitations, in terms of the type of systems used to create PSS for coastal management; organizational factors, planning has various roles and common goals can get distorted by micro-level activities, and institutional issues in terms of communication (Geertman, 2006; Harris, 1989; Gocmen and Ventura, 2010). Technologies are created to improve quality of work, thereby improving people‟s lives, but there are discrepancies in implementation.

There is a gap between rich and poor, livelihood strategies of survival which occur beyond rational planning, and the inconsistency that social science encompasses ensures that there could be no accuracy in prediction. Planning support technologies provide professionals with the tools to forecast various scenarios using local indicators to communicate for the better direction of development; "*models to meet the needs are currently available, but have not been fully integrated into the planning process*" (Harris, 1989: 90). Locational factors and local contexts affect the implementation of a PSS and can be misrepresented if indicators used are false.

Mandelbaum (2008) argues against Klosterman‟s (1998) notion that PSS intelligence is central to planning in that „*practices are (*potentially*) intelligent when they address the web of concepts that both constrain and sustain them. Intelligence is a measure of institutional sophistication rather than technical craft,*‟ (Mandelbaum, 2008: 318). It then can be argued that institutional sophistication can be upgraded by the use of PSS intelligence. A blind collection of data is not a good approach because the situations and needs of a specific area differ and "*overwhelming and redundant data contents should be avoided as far as possible*," (Tolvanen and Kalliola, 2008). Due to the increasing innovation in information technology there have been rapid development in technological tools, which required training and skills development. Hence there are data problem for users and creators of geospatial tools in terms of standardization of information as well as the existence and access to data.

Forces that drive planners to using technology include the advances in hardware and software, promotion of geospatial technologies through higher education, increased access to datasets and the efficiency of the product/s. The pros and cons regarding the use of technology for coastal planning and management have been explored. Broadly the debates incorporated into the research state that support technology can enable "analysis and sharing of strategic geospatial information" e.g. location and quantitative data (Naude, et. al., 2008). Coastal GIS therefore is a mechanism for analysis in a PSS that could enable better land use and integrated management. Experience can determine the usefulness of PSS, as (Harris, 1989: 88) found regarding transport networks, optimisation theory is a defining factor in the use of technology. However there are several „Illusions‟ about integrated coastal management which involved the „Integration illusion‟ and „positivist illusion‟ (Bille, 2008). Practically "*digital data has to be* *updated regularly, obtained from a reliable source, be at suitable scale, available at different periods and requires support from various levels*" (Samat, 2006: 9). The notion of knowledge enabling power persists, so it will be argued that planning support technologies create efficiency in the management of coastal development, which enables better practices for sustainable development.

Technology can assist in avoiding overlapping and duplication of work by researchers and developers (Geertman and Stillwell, 2004). Pro-active micro-level planning is recognized as a tool that would be a requirement for ICZM (Sonak and Shaw, 2006). The positive role of PSS to the planning profession for coastal management involve better engagement of planners, politicians and communities for better communication (Pettit and Wyatt, 2009). A common information resource can result in reciprocal interaction for a participatory process, in which the language / communication is used similarly by all the stakeholders, to bring about accountability and responsibility in coastal management (Tolvanen and Kalliola, 2008).

Professionals make use of available methods to create a quality product. If the tools used are insufficient, then the decisions made, based on that information, are also inadequate. Quality, efficiency and sustainability are affected by PSS and the capacity of a user to implement a system. PSS is not a panacea, as nothing can accurately predict outcomes of a changing environment. A PSS functions as a tool to help better understand possibilities through knowledge and experiences. It provides support in the form of information as well as visualization which enables comprehension of scenario impacts and different land use choices that are available. Technology has limitations and thereby created situations where the people involved can be more capable of „understanding" and predicting some „behaviours" than others. The example used was that of erosion vs. migration (Geertman, 2006). Hence the acceptance and use of a tool is dependent on understanding its capabilities and weaknesses. Wegener (1990) stated that spatial planning in the information age provided for a change in methods and roles of planning, different and extreme scenarios were discussed by the author, which emphasised that change is inevitable. What can be managed is the choice of alternatives, and this means choosing to accept the limitations and opportunities technologies possess for the purposes of creating a more sustainable future.

CHAPTER 3: PRECEDING AND PRESENT CASES

3.1. INTRODUCTION

The implementation of sustainable development agendas has been established as a global challenge. Chapter Two presented the theories and arguments surrounding the research topic. Planning Support Systems (PSS) have been presented as a set of tools which, if used effectively, could provide better long-term plans and improve current planning practices (Petit, 2005). An overview of international case studies is presented below. These examples serve to illustrate how Planning Support Systems which have been used in coastal management elsewhere in the world can provide lessons learned from best practices.

Planning Support Systems have been developed and re-developed over time. There are many versions or models that have become obsolete which resulted in other approaches overtaking them as technological applications improved. The information that is utilised for coastal management planning could have equal applicability to integrated development planning as the following quote indicates "*What is too often absent from such discussions are systematic historical perspectives on the role of human decisions in shaping the outcome of so-called ‗natural disasters,*‟" (Trotter and Fernandez, 2009: 607). Reference has been made to this research‟s conceptual framework of the need for context and analytical elements that inform plan - making. These elements have an impact on the quality of the plans as the outcomes of a PSS process. Attempts were made to demonstrate how planning support technologies can be used for urban coastal research and management through a case study approach. In this overview an evaluation of past approaches to PSS has been explored.

The shift toward more sustainable development processes meant that Integrated Coastal Management (ICM) needed to consider socio-economic and environmental perspectives as well as the historical precedent. In this regard, several questions have been pondered over time, which include, but are not limited to:

1. "*What have been the impacts of coastal disasters on not only the built infrastructure on the coasts, but also on the human, social, and natural capital of the coasts?*
2. *How can we better predict and plan for coastal disasters?*

3. *How can we mitigate the negative effects of coastal disasters?*
4. *How can we use this information to redesign coastal areas in a more sustainable and desirable way?"* (Costanza and Farley, 2007: 250).

The combination of the answers to these questions produces different potential scenarios and priorities for consideration in an integrated development planning approach. As part of this analysis, it is imperative that there is adequate available data in relation to cross sectoral issues to simulate, analyze and then create a plan of action linked to the various scenarios that are considered.

The challenges for coastal management and the tools needed to plan for ICM had to be understood as having a purpose for:

a) clarifying the role of planning in coastal management ; and
b) providing the context for the use of PSS in the precedent case study.

Planning initiatives linked to a PSS, and the methodology incorporated in them, can be based on the requirements of an area. For example; there are diverse land uses especially along the coastline, but a GIS–based PSS can categorize the land uses, depict setback lines and provide for visual and data requirements for management and research into a particular coastal setting. In terms of a local planning context, best practices can be derived from policies, compliance with legal requirements, methodologies and programmes. The use of technology to achieve specific desired outcomes for coastal management is the focus of this research.

Approaches to coastal management are diverse. Countries that are prone to natural hazards have developed technological and policy systems to alleviate the potential impacts of those hazards. Different tools are utilised by planning and disaster management practitioners in areas along the urban coastlines of the world. Lessons from international coastal management practice can be considered for South Africa and incorporated into developing models to form contemporary research.

There were many options to choose from, but considering Australian methodologies and New Zealand"s advanced coastal management initiatives, good practice cases can be derived from these countries. New Zealand is located on top of the boundary between the Pacific and Australian plates (Rowan, 2010). New Zealand and Australia are examples of places that are exposed to hazards because they are situated on and along tectonic plates where there is geological instability. Recently the cities of Auckland and Christchurch have been the sites of earthquakes and related Tsunami warnings. Accordingly, New Zealand has been identified as the first case study areas in this research. Australia has one of the longest coastlines of any continent, and is experiencing rising sea levels, which pose a high risk to the increasing urban settlements located within these sea board areas. Australia is the second case study and it shows how the country has used the legal framework and technology to form strategies for adaption to climate change. In addition, the cases of Thailand"s post-tsunami initiatives have been evaluated in order to identify indicators for pro-active coastal planning in uncertain / disaster scenarios. These cases will be considered in more detail below.

3.2. CHALLENGES AND TOOLS OF THE TRADE

From the literature reviewed and key informant interviews, it was clear that PSS have not been well established in coastal management practises. Support systems in the form of technological tools such as GIS analysis have been widely used and accepted. This observation presented several challenges for this research and those challenges have been discussed in the final chapter. From the extensive literature review undertaken for this research, the challenges of coastal management planning have covered a very broad area. They have to be synthesised into a generalized set of concerns for the purposes of this dissertation. This chapter did not present a comprehensive set of issues for a coastal management model. Instead smaller scale coastal management solutions, with attention given to a larger paradigm, namely - a planner"s role in the land use management of urban coastal zones.

There are processes and methods used to create plans or to undertake research that informs plan-making. Similarly, there are tools that are used to achieve the object of plan creation. Engineering solutions have been widely incorporated into management strategies. According to Hansom (2001) different types of coastal formations respond differently to change in the environment. A sandy beach might wash away in a surge tide whereas a combined pebble / sand beach would suffer less impact. Various management strategies have been created for different types of coastline. These include construction techniques like stabilization using barriers (which can be problematic in that their construction disturbs the natural condition of the asset being preserved), planning techniques incorporating engineering design as well as monitoring approaches the use of warning systems and mapping. In the process of monitoring, the effects and time frames of coastal hazard events have to be understood to create solutions and manage systems effectively. The information gleaned from on site analysis and research used by engineers on the coastline to mitigate the impact of natural disasters could be incorporated in planning and used strategically.

Generally combinations of procedures are used to produce a plan. A matrix has been created based on a narrow understanding of coastal management plans to illustrate how the various tools for coastal management planning can be used to create a management plan (refer to table 3.2.1).

3.2.1. Table Showing the Matrix of some of the tools use for coastal management

	Methods	**Tools**	**Programmes [Software]**
Methods	Priorities from National and Provincial plans; literature reviews;	SWOT analysis; physical structures	Microsoft office tools
Tools	Participatory methodologies : Consultation and workshops	Setback lines; management plans; legislation and the internet	Satellite images
Programmes [Software]	Microsoft office tools	Aerial photography	GIS; GAP and TIP

Planning tools are made for specific purposes and to address different priorities. In this research, the key challenge is uncertainty which can be explained in many different ways. Here the term refers to the risks that face development along the coastline. There are other factors, like hazard and vulnerability, which have been considered together with risk. Three elements used to analyse coastal management were: coastal risks, hazards and vulnerability.

3.3. CAUSE AND EFFECT

There are a number of belief systems that refer to cyclical processes: In this system the principle that actions create reactions is a fundamental tenet. The concept of cyclic event is not new in evaluating how the coastline changes for e.g. sand washed away from one side of an estuary can be deposited on the other side creating a split that protects the interface of the estuary with the sea.

A number of activities along the coastline form part of the urban landscape which required coastal research and management of resources. Reference was made to the example of Durban which suffered infrastructure damage from as a result of a storm surge (refer to chapter ones" introduction). The extent of destruction and the exacerbated erosion resultant from the climate event has been demonstrated. This example brought in sharp relief the fact that human activities often clashed with natural processes (or vice versa). The intervention / encroachment of the built environment (cause) into the natural environment along the coast have major impacts (effects). The model of cyclic linkage is present in explanations of Climate Change, where it has been argued that if the cause and effect of activities is understood, remedial actions and plans can be put in place to redress the problem. A good example of this type of approach was the Kyoto Protocol addressing carbon dioxide (CO2) emission and their reduction to eliminate global warming.

The disregard for the long term effect of carbon dioxide emissions on climate change, particularly by developed and developing nations in the North e.g. China and America, have rendered the world vulnerable to changed weather patterns and coastal events. Institutes, for example Worldwatch, have issued dire warnings stating that internationally, the long term impacts of climate change spell catastrophe (Worldwatch Institute, 2009). The influence of the cyclical paradigm predicts an increase of climatic hazards that increase vulnerability to food security, human health and water availability (Hare, 2009; Vordzorgbe, 2007). In terms of coastal management; "*Hazards are created by a conflict between human use of the land, and physical processes at the coastline*" (Ministry for the Environment, 2009: 2). These conditions affect the local economy as infrastructure along urban coastlines is impacted on, where sea-level rise, coastal erosion, and flooding threaten to displace and destroy coastal habitats. As result, significant coastal hazards have been identified.

The outpouring of carbon dioxide from modern industrial activity has detrimentally affected the atmosphere of the planet. Man-made hazards have been have been observed along the coastline of south Durban, KwaZulu-Natal, by the proximity of hazardous areas (both natural and industrial) to residential and conservation areas. Cause and effect are part and parcel of the development of coastal management strategies for climate change. The United National Educational Scientific and Cultural Organization (UNECSO, 2006) defined hazard, risk and vulnerability as part of the decision-making process. The terms "hazard", "risk", and "vulnerability" have been defined (refer to figure 8 below) and represent a key challenge of coastal management.

RISK= HAZARDS × VULNERABILITY

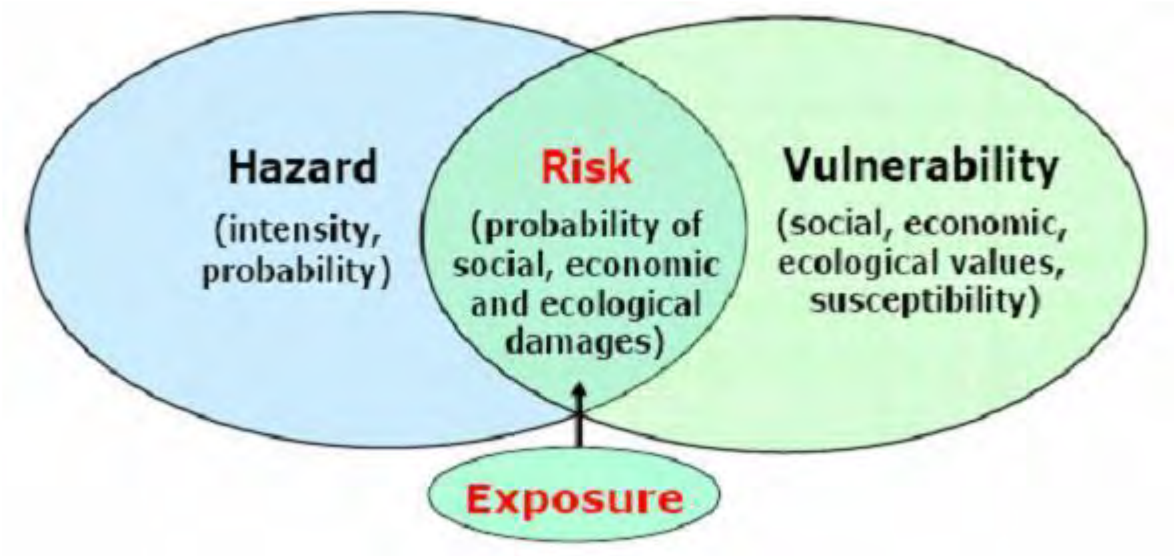


Figure 8: Schematic representation defining the terms "risk", "hazard", and "vulnerability" (UNESCO, 2006).

Hazards and vulnerability have created risk scenarios. Vulnerable coastal settlements and ecosystems are effected by coastal hazards. Hazards are catalysts that affect the urban landscape because of the high levels of activity along the coastlines; "*Part of the reason for this is population growth and the increasing amount of infrastructure built in coastal areas susceptible to damage. Another part of the reason is the poor placement of this infrastructure and damage to the natural capital which could have protected it if it had been designed and built with ecosystem services in mind. For example, had the coastal wetlands fringing New Orleans been intact, there is a good chance that hurricane Katrina would not have overtopped the levies and flooded a large part of New Orleans*." (Costanza and Farley, 2007: 249-250). This quote emphasized that intact natural systems have an important role to play in mitigating the impacts of coastal hazards.

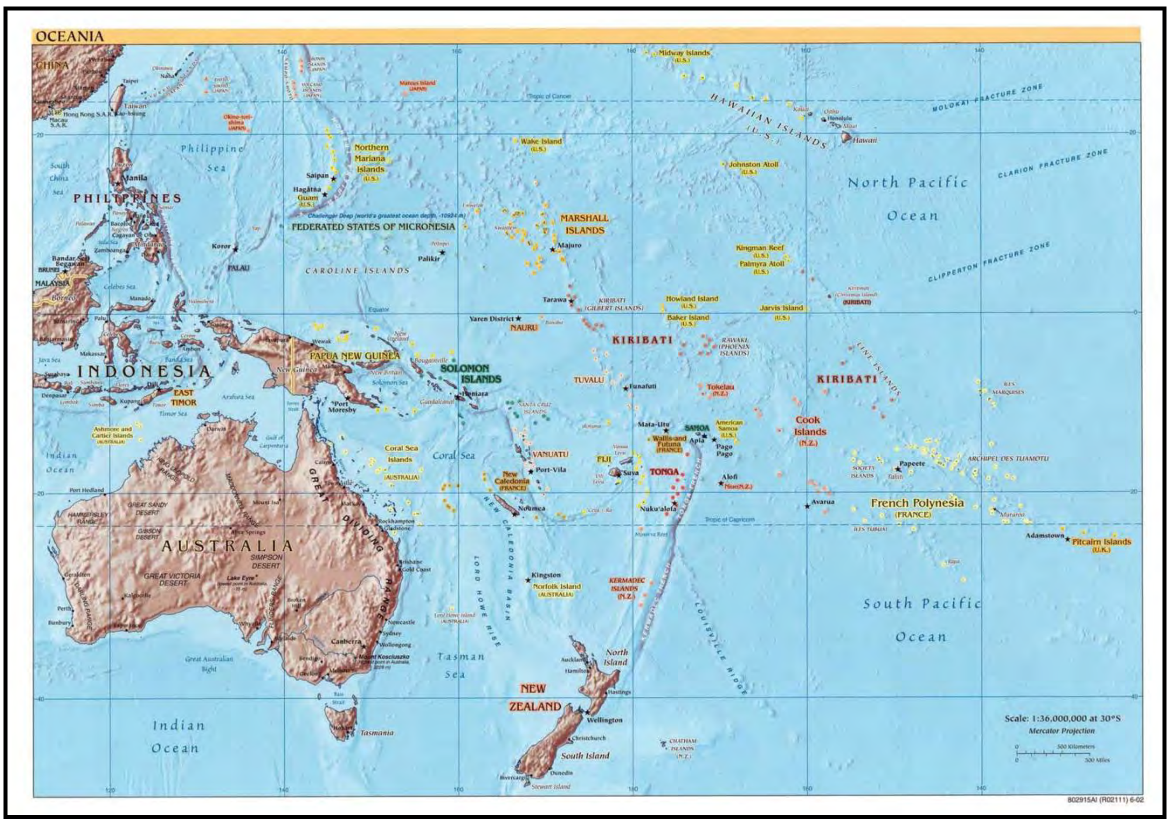
High population densities and development in low-lying areas along the coast have increased risks for exposure to natural hazards. Residential and commercial development built on the primary dunes or sites where dunes have been removed are at higher risk than those located further away from these coastal features.

For the purpose of this study the three main types of hazards, which were prevalent throughout the literature, are examined namely - coastal erosion; coastal inundation (flooding); and sea level rise either from tsunamis or „inherited" local conditions (Ministry for the Environment, 2009; Mustelin, et. al. 2010). They have been discussed for the purpose of investigating the tools required for management initiatives that mitigate the impact of the coastal hazards. The potential impact of a hazard event is determined to be greater when larger densities of the population are affected. In an urban environment, infrastructure and development compete with natural systems to accommodate increased population. Hence risks for property and infrastructure damage are intrinsically increased.

Technological tools could be used to lessen the impact to vulnerable land uses along the coastline (Toressan, et. al., 2008). Coastal management practices generally follow the concept of ICZM, but land use planning provides an understanding of how the impact of an individual land uses affects the overall environment; "*Land-use planners need to understand how each individual land use may contribute to contextual changes of the larger environment and to the more immediate areas. The state of science must be interpreted continuously for application to planning, if we wish to minimize future uncertainties and to maintain or improve the quality of life for this and future generations. In summarizing the state of science, the large environmental and site related findings are separated, though it should be realized that the two are often interrelated,*" (Fabos, 1985: 25).

Since the 1980"s planners have been aware of the importance of land use location. Climate change has made this issue more pressing in terms of managing the effects imposed by coastal hazards. Different levels of governance determine coastal management strategies in diverse contexts and locales. Government is responsible for integrated decision-making which incorporate the diverse decision making processes, for example; whilst the national government may set regulations (such as the overarching framework of NEMA in South Africa), provincial government of coastal provinces are responsible for strategic development, and the local municipalities are responsible for the implementation and management of projects. Planning initiatives for coastal zones contributes to a better understanding of how to manage coastal hazards. The catalytic impacts of climate change have initiated a movement toward more rapid sustainable development. More research and support infrastructure, in the form of PSS, would support the data and analysis requirements for professionals. The product results in the provision of higher quality of information and knowledge to the decision-makers.

Several cases of coastal management initiatives that address managing coastal hazards are prevalent in New Zealand. Through legislation such as the Resource Management Act (Act No. 69 of 1991), policy and clarity of coastal management objectives showed a high level of involvement as well as use of technological tools in urban coastal research and management. The two case studies of Australia and New Zealand show different attributes. The legal environment of New Zealand informs the country‟s approach to coastal management initiatives and the methodologies of Australia can be used to derive good practice guidelines. The findings from literature have been distilled to explore what applications would be useful in the South African context, more specifically in south Durban. The map presented below serves to show the proximity of the two case studies to each other (refer to Map 2).



Map 2: Australia and New Zealand
(Rivera, 2011)

3.4. NEW ZEALAND: POLICY AND LEGISLATION

New Zealand is situated adjacent to Australia in the South West Pacific. The country has 74 districts: 49 North island districts and 25 South island districts. Coastal land has been increasingly urbanized. The rises in the population of coastal cities have increased the demand for real estate, using up resources for development. Further stresses on resources occurred when changing natural processes created risk factors for development along the coastline. Thereby coastal hazards escalated along with the thresholds within coastal zones. Wilson (2010: 2) has stated that; "*A debate arises as to when the property rights of land owners to protect their asset become outweighed by the negative externalities such as loss of amenity for the public and increased erosion of adjacent properties. Not only this, but who will pay if a property is lost due to erosion.*" Policy and legislation guide decision-making and play a role in regulating the development process to ensure the public is protected. In the plan-making process there has to be input from relevant authoritative sources. Therefore, as part of this case study, the New Zealand mandates referred to are the Resource Management Act (Act No. 69 of 1991) and Coastal policies.

3.4.1. New Zealand: Policy and Legislation

From the 1980‟s onwards, New Zealand designed legislation and policy to accommodate for risk and hazard factors in managing the environment; ‗*Three themes converged in natural resource management: market-based solutions to problems, increased public support for conservation and Maori values for the environment. Enactment of the RMA reflected these themes and was considered groundbreaking legislation*" (Bess, 2010: 693). One of the factors that have determined the quality of plans has been the legislative mandates that guide the plan making process. Erickson, et. al. (2004: 34) defined the main steps in plan development and provided a diagram to illustrate the process (refer to the adjacent figure 9).

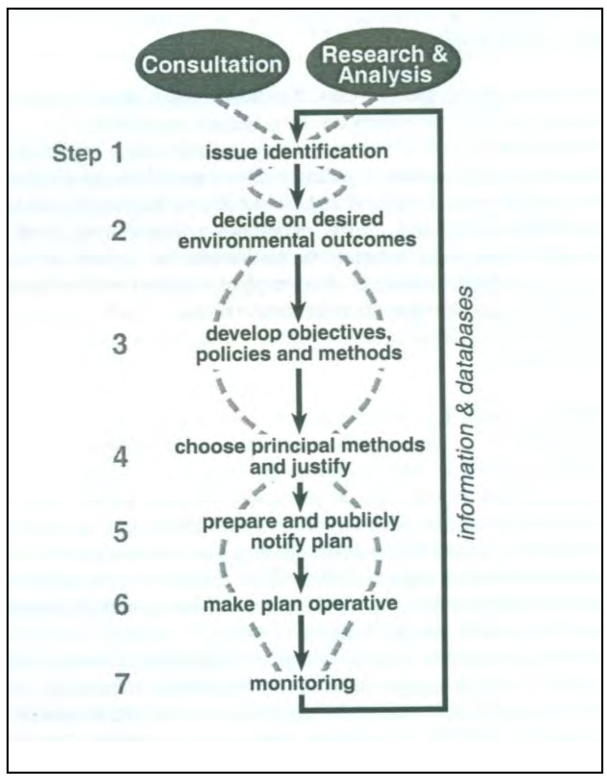


Figure 9: Main steps in plan development and how they relate to the activities of research and analysis

Further the steps have been accompanied by assessing the quality criteria for plans under the RMA (Act No. 69 of 1991). The eight criteria are as follows (Ericksen, et. al., 2004: 38);

1. Interpretation of the national mandate;
2. Clarity of purpose;
3. Identification of issues;
4. The quality of the facts base;
5. Internal consistency;
6. Integration with other plans and policy instruments;
7. Provisions for monitoring and responsibilities; and
8. Organization and presentation.

Policy and legislation guide decisions made in regard to new developments and integrated coastal management. National environmental standards and policy statements derived from the RMA (Act No. 69 of 1991) have streamlined regional and district plans. In order to achieve the following purpose:

> *(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.*
>
> *(2) In this Act, sustainable management means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—*
>
> > *a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
> > *b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and*
> > *c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.*

The RMA (Act No. 69 of 1991) has provided a framework for ICM which makes the New Zealand Coastal Policy Statement (NZCPS) mandatory (Scouller, 2011). The NZCP has several specific policies to address areas in the coastal environment that are potentially affected by coastal hazard. As cited by Scouller (2011) this includes: "*(e) cumulative effects of sea level* *rise, storm surge and wave height under storm conditions; (f) influences that humans have had or are having on the coast; (g) the extent and permanence of built development".* Research and development of management strategies are reflected as clear priorities in the policy statement.

The legal requirements of the Act that relate to planning include the preparation of District Plans to restrict development along areas of the coastline; plans that protect the coastal environment and control measures in local land use planning (Wilson, 2011 and Bess, 2010). According to provisions in a District plan, Wilson (2010) stated that a Geographical aerial system and coastal oblique photo records were analysed using Microsoft Excel to determine hazard risk to North Shore City. Other methods of coastal management used participatory methods and consultants where both methods require information systems. Bess (2010: 695) confirmed that localities under the Marine Protected Areas (MPA) planning process required consistency in the classification and mapping of coastal and oceanic resources.

Specific local issues had to be addressed theoretically through the integration of national and local planning. Research on New Zealand"s coastal management practices has shown that the broad spectrum legislation was idealistic and has does not provide for implementation at a local level without creating disputes. The radical changes in the shift towards focusing and enforcing sustainable development have not addressed current capacity challenges. Therefore planning was less of an issue than governance. In terms of this research, a best practice outcome was derived from the combination of policy and legislation contributing to adequate quality input for a PSS to create a quality plan.

Best practices are determined by the results of policy implementation. Plan quality informed by consultation and professional work affect implementation. To determine the best scenarios for a district a number of variables have had to be understood, which involved an overload of knowledge and data. Planners use a number of reports from several professionals to create coastal land use plans, for example: environmental data, community perspectives and economic considerations to creating a development in the coastal zone. In order to process the amount of data a modelling system or tool is required. Factors that promoted the use of technology in designing plans in New Zealand, particularly for coastal zone management, were; climate change and location of urban land which makes it vulnerable to coastal hazards. Hence the applications of PSS have been established to provide an accessible format for the large amount of data. Plan quality has to be informed by consultation and professional work affect implementation. Best practices lessons are determined by the results of how well a project has achieved the goals of sustainability and balancing the environment and development pressures in an area.

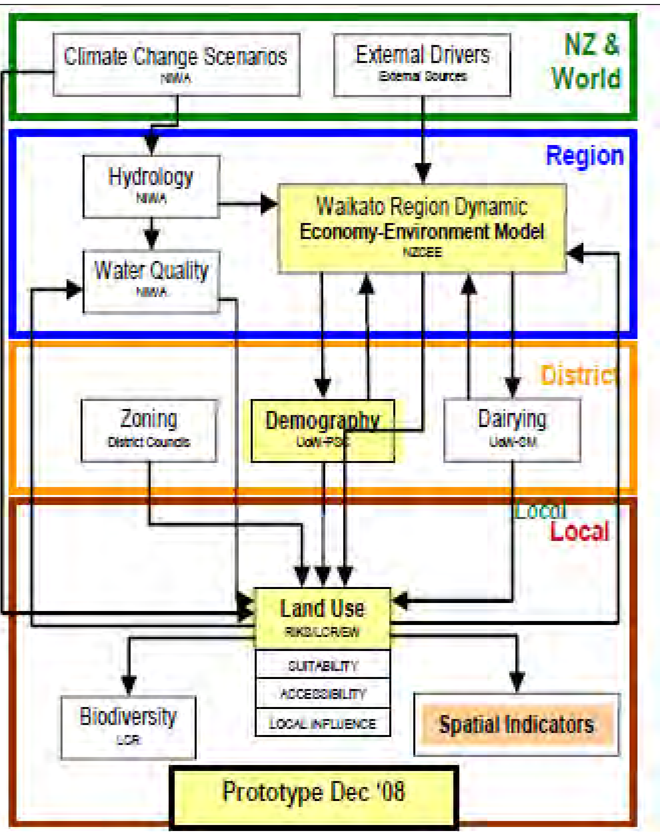
3.4.2. Applying PSS in Local Planning

An example of an applied PSS was one that was created for the Waikato region situated in the North Island of New Zealand (refer to figure 10). Waikato is located south of Auckland and has 1,138 km of coastline. The area has a warm, dry settled climate during the summer and cool winters. The Ministry for the Environment (1998- 2011) has discussed how climate change could affect the region; briefly, more extreme weather events and sea level rise are predicted for the region. „Creating Futures" Spatial Decision Support System (SDSS) was a system designed to be an integrative modeling tool which provided for the different components of strategic sustainable development. Husser, et. al. (2009) stated that the SDSS should;

Figure 10: The Location of Waikato Region in New Zealand
(Waikato Regional Council, 2011)

"(1) integrate results from different models and assess them at various spatial scales;
(2) allow nontechnical users to readily create a scenario and analyze its impacts;
(3) be run during stakeholder processes (e.g. analysis of scenarios, deliberating options, strategic planning, regional policies) to facilitate learning and group understanding; and
(4) provide a centralized repository of documentation (metadata) that can be transferred to the development of an ISDSS for other regions."

The planning support technology was not designed to provide high volumes of data but to increase communications between stakeholders for determining the best alternative scenarios for land use (refer to figure 11). The diagram shows that the interaction of variables at different scales impacts on land use at a local level. The prototype used the information from available data on climate change scenarios and zoning to develop spatial indicators for future sustainable development scenarios. This provides for planning support because it creates informed plans for better decision making at a regional level.



EW= Environment Waikato;
ME = Market Economics;
MW = Manaaki Whenua;
NIWA = National Institute of Water and Atmospheric Research;
NZCEE = NZ Centre for Ecological Economics;
RIKS = Research Institute for Knowledge Systems;
UoW = University of Waikato.

Figure 11: SDSS system design
(Husser, et. al., 2009: 2373)

The Spatial Decision Support System (SDSS) has been designed to provide an integrated system in which to analyze different scenario outcomes and the impact of different variables. Impacts of climate change, coastal erosion and the input of the numerous role players have to be considered for sustainable development.

New Zealand is a good example of best practice procedures, containing high quality legislature, which produces an environment for the application of PSS. However research has shown that a variety of factors contribute to how a plan is implemented and created. Therefore PSS along with other planning initiatives in legislation are only as effective as the capacity of a local district municipality / local government to implement the plan. Hence methodologies that are compliant with policy / legislative frameworks link national, local and institutional government dynamics at local specificity should be promoted.

3.5. AUSTRALIA: TOOLS AND METHODOLOGIES

Australia has implemented PSS strategies for coastal management and has also developed legislation toward sustainable development. The research thus far has described many tools and methodologies (refer to chapter two). Methodologies used in Australia have been described as leading best practice for coastal management based on extensive research conducted by various professions e.g. coastal managers, coastal engineers and planners. The use of PSS has been described by Geertman (2006), Klosterman (1999), and other advocates of technological planning tools to show the advantages and disadvantages of PSS. This case study aimed to breakdown, through literature, the perceptions of using planning support technologies in practice.

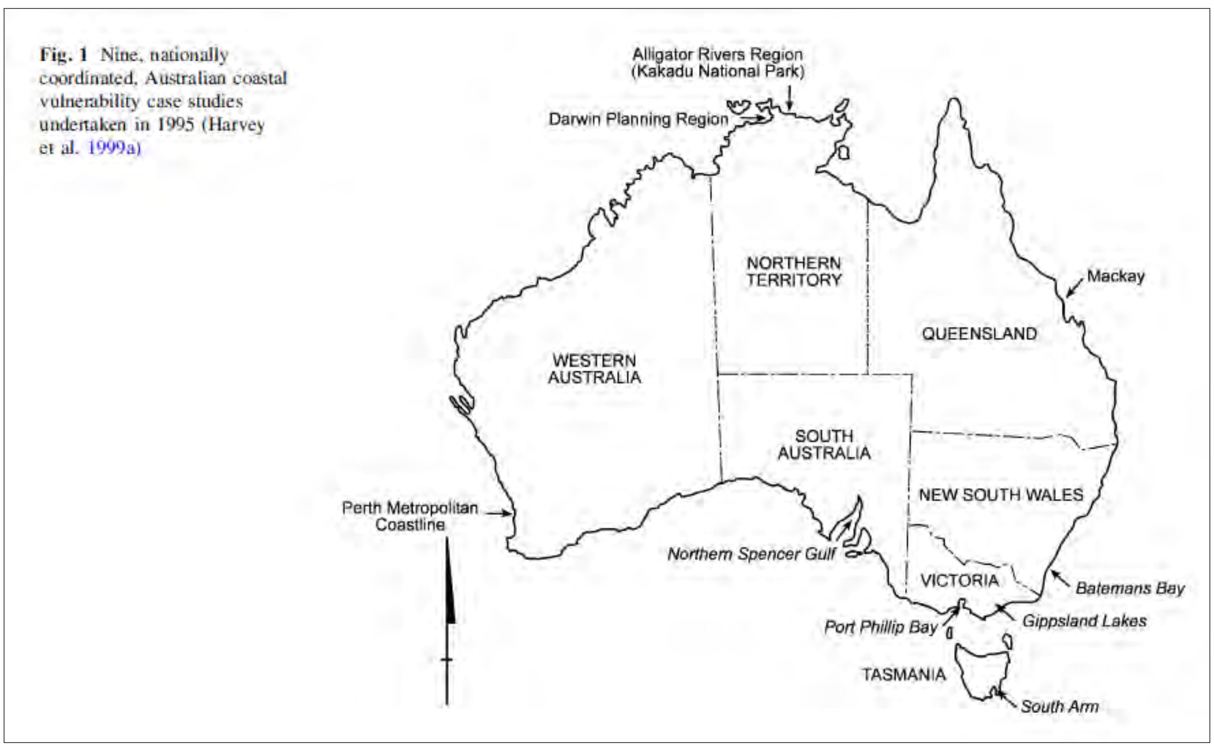


Figure 12: Australian Territories
(Harvey and Woodroffe, 2008: 71)

Petit (2005), Abuodha and Woodroffe (2006) observed that the Australian continents‟ unique attribute was the longest coastline of any continent and approximately 80% of Australia‟s population occupy the coastal areas; "*The Australian coastline is one of the longest of any nation, but its length depends upon how the shoreline is defined and measured*" (Harvey and Woodroffe, 2008: 67). The area of a particular coastline could be measured differently depending on what factors are considered part of the shore. The Australian coastline has been defined as the broader coastal zone and „shoreline‟ represents where the point where ocean and land meet. The coastline, inclusive of the mainland, islands and mangrove areas, has a length of about 60 000 km (Short & Woodroffe, 2009).

3.5.1. ICM in Australia

The guidelines for the planning and management of the coastline were based on the Precautionary Principle which stated that „a lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.‟ The principle applies to ICZM, which is a governance mechanism for sustainable development. Australia‟s Oceans Policy was designed to provide consistency in- and coordination of the planning and management of the marine environment. This policy follows from the following national policy and legislation;

• the *National Strategy for Ecologically Sustainable Development* (1992);
• the *National Strategy for the Conservation of Australia's Biological Diversity* (1996); and
• the *Intergovernmental Agreement on the Environment* and the *Heads of Agreement on Roles and Responsibilities* (1998).

There has been an emphasis on the significance of coastal seas in the Environment Protection and Biodiversity Conservation Act (1999) which sets out the statutory regulations for coastal zones. The objectives of the EPBC Act, as stated by the Commonwealth of Australia (2011), are to:

- *provide for the protection of the environment, especially matters of national environmental significance*
- *conserve Australian biodiversity*

- *provide a streamlined national environmental assessment and approvals process*
- *enhance the protection and management of important natural and cultural places*
- *control the international movement of plants and animals (wildlife), wildlife specimens and products made or derived from wildlife*
- *promote ecologically sustainable development through the conservation and ecologically sustainable use of natural resources*

Despite the objectives of the legislature regarding coastal zones an Independent Review of the EPBC Act 1999 stated that mechanisms for integrating ocean policy with coastal zone policy have yet to be realized: "*The lack of legislative support for coastal policy at the national level has meant that the Commonwealth has not taken a strong role in coastal planning and management despite the critical impacts present and into the future of climate change and 'sea change' (coastal development)*," (Wescott, 2008). In terms of local planning initiatives there needs to be strong national component consisting of a database and accessibility to knowledge to ensure that coastal management initiatives are met at a strategic level and implemented locally. However there has not been an overall national strategy for Australia;

> "*Although Australia played a central role in applying a common methodology (CM), developed from IPCC guidelines in the 1990s, and in devising alternative approaches, which were initially trialed at nine sites on the Australian coast, there has not been a nationally coordinated approach to assessing the coastal vulnerability of Australia, and such an approach is only emerging now. Instead, there have been a series of different approaches adopted to look at the different parts of the Australian coast, including wetland mapping in northern Australia; geomorphic unit mapping in South Australia; storm surge vulnerability modelling in Queensland; probabilistic approaches to beach erosion in New South Wales; indicative mapping of potential coastal retreat in Tasmania*." (Harvey and Woodroffe, 2008:67).

Evidence in the literature described the use of support technologies for planning. The value of spatial information to integrate the approaches to coastal zone management in Australia is high but the literature indicates an inconsistency of data versus demand (Wheeler, et. al., 2011).

The tools and methodological studies conducted in Australia have contributed to global advances in coastal science. Each tool that has been used was based on initiatives by stakeholder interest groups, generally local government as the following statement indicates;

*"Climate change adaptation is a topic naturally suited to consideration at a more local level. For a start, the benefits of adaptation measures tend to be quite localized (e.g. construction of a sea wall or levee to reduce coastal erosion at a given beach with rising sea levels)," (*Peel and Godden, 2009: 38). Adaption is one of the ways in which to manage coastal development. Planned retreats behind natural defences as protection from storm surges featured prominently as a pro-active adaption strategy. In the case of South East Queens, a case study conducted by Abel, et. al. (2011), the planning system under the Sustainable Planning Act (2009) defined the hierarchy of role-players and scale of involvement (refer to figure 13). The figure clearly shows the levels of authority and accountability for managing the coastline. Coastal management at a local scale requires a lot of input and planning to establish and maintain adaption strategies.

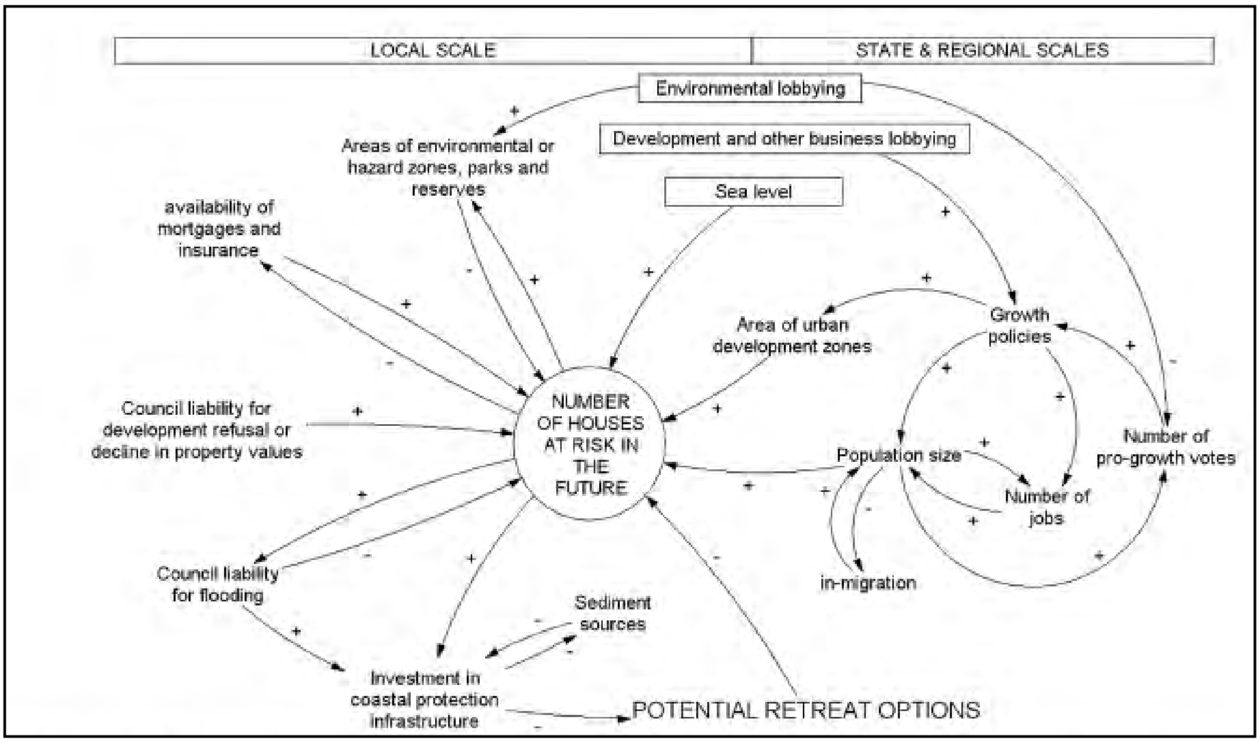


Figure 13: Hierarchy of Role-players in the coastal planning system; Queensland, Australia
(Abel, et. al., 2011: 282)

To accommodate for urbanization along the coastline a key component for research is establishing information about major changes that could occur and the distribution of resources toward the affected areas (Abel, et. al., 2011). Abuodha and Woodroffe (2006) have looked at the different regions of the Australian coastline and provided the contextual description of the population and physical characteristics. Many of the major Australian cities are located along the coastline. Therefore planning initiatives have to accommodate for the impact of climate change on the land uses of the coastal areas;

> "*The potential for residential and other coastal development to be adversely affected by climate change has important ramifications for the associated responsibilities of planning authorities, which act as ‗the stewards of the coast.' In Australia, planning is primarily the responsibility of state governments pursuant to state planning laws and policies, although decision-making on approvals for individual projects is generally delegated to local governments*," (Peel and Godden, 2009: 37).

Therefore the application of PSS, to model scenarios and provide data in an accessible format, enables a stronger presentation by the planner to inform decision-making. Practical planning for ICM according to the conceptual framework (refer to Chapter 2) requires modeling via an integrative system in support sustainable development. Petit (2005), Geertman (2006), Naude, et. al. (2008), and numerous other authors have defined, discussed, and tabulated the opportunities and constraints of PSS for various scales and areas.

3.5.2. Challenges in applying a PSS

Technical issues resulting from hardware and software complications have been largely looked at in the literature. For example: The What if? ™ Software package requires computer systems that support Windows XP or Later models. The technology that is required for using PSS provides an additional cost factor to acquiring and maintaining the use of that system. The technical problems, while presenting a challenge, have not been elaborated here because there is a focus on the application of PSS for urban coastal research and management.

Australia was considered a leader in coastal management practices. However they have not implemented national approach or use of a PSS despite all the research and development surrounding the beneficial use of it. This has been attributed to;

- Capacity to implement and maintain PSS;
- Diversity of coastlines; and
- Misunderstood application purposes of PSS.

Nevertheless a common trend of using technology to assist in the planning process has arisen. It has "*been realised, and it is clear that well-managed geospatial data are fundamental and will provide a foundation not only for vulnerability assessment but for a wider series of activities in the coastal zone. As the Australian population continues to disproportionately focus on the coastline, it is particularly appropriate that there be a renewed emphasis on the likely impacts that these diverse systems might experience in the face of climate change."* (Harvey and Woodroffe, 2008: 87). Decision-making for planning toward sustainable development has to be pro-active to avoid potential impacts.

Lessons can be drawn from reactive cases to establish how to move forward with applying a PSS in practice. The changes in Thailand have been well documented and have been discussed briefly to further elaborate on scenarios for the application of planning support technologies in a hazardous environment in urban coastal research and management.

3.6. THAILAND: POST-TSUNAMI INITIATIVES

The December 2004 Indian Ocean Tsunami, which affected South Asia significantly, drew attention to coastal hazards and the need to be prepared for natural disasters. Initiatives to design systems to model and plan for climate change were catalysed internationally. The impact of the tsunami generated global awareness to urban coastal vulnerability. Potential risks to natural hazards have provided scope for detailed studies in Thailand and around the world; *"post-tsunami research has focused on the search for effective hazard mitigation and emergency preparedness strategies to decrease future vulnerability to tsunamis and other disasters,"* (Steckley and Doberstein, 2010:2). Thereby it became essential to assess the populations risk and vulnerability to hazards especially in terms of early warning systems and mitigation (Wegscheider, 2011; Steckley and Doberstein, 2010).

Post-tsunami initiatives in Thailand provide perspectives of what should be done / could be done better in planning and development along a coastline. There are communities are located along the Andaman coast in the southern province of Thailand. In the cases of Khao Lak and Koh Phi Phi, which were considered the worst affected of the tourism communities, there was a high level of developed coastline. Koh Phi Phi is an island located in the Andaman Sea and Khao Lak is located along the Gulf of Thailand (refer to map 3). Studies conducted in the area revealed that the coastal terrain lacking environmental defences amalgamated with inappropriate development resulted in extensive damage to the areas (Calgaro, et. al., 2008). Steckley and Doberstein (2010) have stated that; before the tsunami, the approvals and development of dense property along the coastlines in contravention to existing setbacks were poorly planned. ICM post tsunami needs to consider the implications of hazard, risk and vulnerability in a proactive way for future development.

Map 3: Depiction of the islands and coastline of Thailand
(Google- Imagery, 2011)

Wegscheider (2011) explained the hazard, vulnerability and risk assessments, within the framework of the GITEWS (German-Indonesian Tsunami Early Warning System) for the area of Bali. The data sets for the system were not prioritized at a high level of detail because the methodology aimed to provide risk information which could be practically used at a local level.

> "*People near the coast have a higher probability of being exposed than those farther away. Thus, it is a great difference, if, within one administrative unit, a settlement is located close to the coastline or inland*," (Wegscheider, 2011: 252).

In light of this knowledge, it was decided that in the case of vulnerability assessments details about population dynamics have to be precise to determine risks from hazards. Steckley and Doberstein (2010) discussed how the spatial implications of disaster management in Thailand proved necessary for management planning.

3.6.1. Developing a PSS toward sustainable development

Disasters caused major damage to the built environment. It has been agreed that poorly enforced planning guidelines are a factor of the problem; ―*Much of the damage can be attributed to the fact that physical infrastructure was inappropriately sited and constructed before the tsunami struck,"* (Coastal Resources Centre, 2005). Many areas in Thailand are exposed to numerous types of plans which are not co-ordinated and likely to be disregarded (Atkinson and Vorrantchaiphan, 1996) "*Modelling provides information about the estimated time of arrival of the tsunami wave at the coast and the parameter of flux, which is a function of flow velocity and inundation depth*," (Wegscheider, 2011: 251). Patterson (2006) derived that, „*contingency planning needs to encompass multiple scenarios and indeed completely unforeseen situations'* to be flexible and adaptable to an unexpected situation". The strategic planning of development along the coastline cannot obliterate coastal property and tourism opportunities but effective emergency plans and locations could be accommodated via transport and shelter protection measures which are easily accessible by those affected.

Resources Centre the University of Rhode Island (2005) has discussed an example of an ICM post-Tsunami. The program intended to achieve several purposes toward the goal of building sustainable livelihoods (refer to Wegscheider, 2011: 249 which had similar purposes for planning toward sustainable development). Descriptions of each of the technical elements were provided and many of the tasks described are suited to the software available as PSS. In terms of the planning profession, the tasks involve the assessment and analysis for coastal management and disaster prevention. The objectives of the programme and the technical elements that would occur from implementation of the programme could benefit from a PSS to integrate the various project components. For example, using the objectives of the programme;

–Negotiate with local and national Thai authorities, and most specifically with communities themselves...Develop a diversity of alternative coastal livelihoods and micro enterprises that are viable and environmentally sustainable...Assist local authorities and communities in the siting, design and construction of damaged coastal infrastructure and shoreline protection that are environmentally responsible and reduce vulnerability to future natural hazards," the PSS, as discussed in chapter two, could assist in the formatting of communications and plotting alternative scenarios.

Since the use of PSS has not been common practice, coastal management planning practitioners have most commonly used GIS; "*By using common GIS tools available in open-source software, the risk assessment can be performed at community level without using expensive or complex software or possessing high-level expert knowledge,"* (Wegscheider, 2011: 256). There have been many perspectives on handling crisis but each situation presents unique circumstances. Individual property rights and location of infrastructure play an important part in coastal management. Information and knowledge about plans have to be accessible to non- professionals. Lessons derived from the Thailand case from a purely planning perspective is that; the practicality of a PSS would need to be flexible in identification of strategic hotspots, routes and other spatial risk reduction measures.

3.7. SOUTH AFRICA DEVELOPING PSS AND COASTAL MANAGEMENT LEGISLATION

The context, terminology and theoretical framework discussed in chapter two provided the basis for unpacking the facets of the research question. The case studies followed showing that legislation and policy is at its infancy in regard to coastal management practices and how planners should accommodate for climate change. Nevertheless international precedents have created best practices and local planning can derive value from the research. The challenges faced in KZN, South Africa provide further indication that technology could play a role in urban coastal research and management.

3.7.1. Challenges in South Africa: Case of KwaZulu-Natal (KZN)

Legislation for coastal management in South Africa is in its infancy. The Implementation of the Act in terms of planning for development along the coastline faces numerous challenges.

According to practitioners involved in the private and public sectors of urban planning and coastal management; common challenges are faced in designing coastal management plans. Key informants revealed that the coastal management sector lacks a champion to promote its implementation in the province. Plans are created according to legislative requirements but they are not implemented as there is no buy-in from the various levels of government. For example there are plans to re-develop the coastline when the pertinent questions regarding granting planning permissions in the face of forecasting scenarios which indicate that sea levels will rise and the potential damage to infrastructure is high. Since there are conflicting functions between departments and professionals involved in coastal management there needs to be learning process at all levels of governance.

Another challenge municipality‟s face is the failure to implement strategies due to budget constraints. The cost of coastal defence is exorbitant, and despite strategies and plans there is the cost factor that hinders their implementation. To finance a PSS and to maintain a coastal management system there are cost factors that are deemed by practitioners to be too expensive thereby rendering the model financially unsustainable. Despite this market forces act to distribute coastal property. There is depleting value of property situated in areas of coastal erosion and tidal action, refer to „Living with coastal erosion‟ showing what is left of the coast and how nature should be used as a defence (Breetzke, et. al., 2008). Development on the coastline should be retreating. However coastal property is still regarded as prime land due to the aesthetics and status derived of the land value.

From the South Durban Basin (SDB) Coastal Management Plan (CMP) case study creating the CMP proved difficult because there was no precedent/ guiding documentation to use. There were no studies of a similar nature, previous information or empirical data of how to create a CMP for the local area. The environment was considered a challenge due to the impact and perceptions of the 2007 storm surges. The implication of making people aware of the risks but not traumatizing them was a participatory challenge to the project. The SDB CMP looked at the operational as well as management aspects in planning which was usually done separately. It was a pilot project that was designed in the same timeframe as the national and provincial guidelines were being developed for coastal management. A shoreline management plan is derived from the CMP and is more specific in addressing the direct needs of a local area. Comprehensive data was collated and analysed for the pilot project in Durban, KZN. With regard to the data: consultants collated the information in partnership with the department/ sector. This information could form a valuable component to a PSS designed for the metropolitan. The process of plan making is iterative. The challenges of maintaining the data to build a system for future development did not appear to feature in the pilot project.

The terminology used for coastal management planning has become confusing. A plan is a tool. Technologies used to create a plan are also considered to be tools. Hence a distinction has been made between technological tools for designing plans and the actual methods of coastal management using plans as a tool. Technologies used to create plans have been put together in software packages specifically as a tool for urban planning. Since the use of a PSS was in phases of testing the system it has not been popularly used among planners let alone coastal management practitioners in Durban.

This lack of popularity has forced a redefined understanding of PSS to focus on the support systems used to design coastal management plans. Tools such as GIS, internet, remote sensing and consultation were used for sharing information and mapping. Methodologies for planning coastal strategies used by practitioners, in Durban, involved workshops, community development initiatives (mainly sustainable livelihoods programmes), sector meetings with national and provincial government (refer to chapter 3 for the case study details). Set Back lines defined by the Admiralty Reserve (AR) now form part of regulations under ICMA and supposedly locally enforced. The AR policy goals have been changing over the years. Currently the AR refers to coastal public property and the reduction of that property size to determine boundaries. Outcomes of the tools used in designing coastal management plans are development planning tools. An example of a development planning tool has arisen from the KwaDukuza CMP which places a spatial layer for the coastline into a town planning scheme. The layer ensures that environmental authorization would be required before any development can occur as per planning regulations contained in the Scheme thereby enforcing coastal management practices. There are many initiatives strategized for coastal management since the implementation of the *National Environmental Management: Integrated Coastal Management Act (G 31884, GoN 138)*. However the ICM Act does not specify how to develop the bylaws spatially but states that the coast has to be protected.

There were no cases of a PSS specifically designed for coastal management or any other scenario planning specifically for the coastline. However use of the technological tools available and scenario methods clearly showed that planning for coastal management and research would benefit from a PSS. Access to reliable and relevant information for coastal management, as a whole, was a key aspiration among the key informants. The idea that a database of knowledge and information easily accessible was unanimously approved of but despite requesting PSS/ data base there are several denouncing implications based on legislation, capacity and implementation of the tool foreseen by the key informants. In general there was no solid understanding of the practicality of applying a PSS in coastal management sectors as the work is carried out in a silo of differing departments and professions (which ironically is the exact opposite goal of what PSS application intends).

3.7.2. Applicability: Local Context

From the cases described several aspects can be modified and applied to eThekwini Municipality. To clarify, it has been understood that the CMP is a strategic tool itself, and support tools can be used to create them. Damage to infrastructure and property along eThekwini‟s coastline prove that changes are required in developing the coastline. The erosion issues persisted due to the changing climate and Southern Durban has been affected albeit in comparatively minor damages (refer to the photograph panel 2: Anstey‟s Beach).

2011

2010

Photograph panel 2: Anstey's Beach

The Beach was stabilized after the 2007 storm. In 2010 the sand was flat but images from 2011 showed coastal erosion.

Setback lines and reclaiming land for alternative land uses formed part of management strategies (Vordzorgbe, 2007). Developing a PSS has a role in providing alternative scenarios and visualization tools to local practices. Legislation and policy encourage the development of technology in planning practices.

> "*How a city is planned, managed, and governed also has important implications for how it will cope with the impacts of climate change. Most cities in low-income nations in Africa and Asia have very low emissions per person. Yet they house hundreds of millions of people who are at risk from the increased frequency or intensity of floods, storms, and heat waves and from the water supply constraints that climate change is likely to bring."* (Satterthwaitte and Dodman, 2009: 77).

There seems to be a clear indication that in all contexts, the policy and legislative situation created an enabling environment to generate PSS. Glavovic (2006) described the changing legislative/ policy context of coastal management in South Africa (refer to Chapter 2). It was concluded that an integrative approach, which focuses on the socio-economic aspects of ICM can achieve ecological imperatives. The management of coastal resources, in terms of land and functions, is an important factor toward sustainable development.

3.7.3. Case: Integrated Planning and Development Modeling

According to the IPDM workshops (2010) research was conducted by the CSIR, on developing support for integrated planning using information and modelling. The multi-phased research project has been designed to encompass, "G*eo- Spatial Analysis Platform (GAP)* (which) *can be described as a common, mesoscale geospatial platform, developed for the assembly, analysis and sharing of strategic geospatial information. In very simple terms, this can be translated as providing spatially nuanced information about (a) what is where? (b) how much is where? (c) where are the main concentrations / hot spots to be targeted? and (d) what can be reached from where?"* (Huyssteen, et. al., 2009). The IPDM initiative provided a case of PSS development in South Africa. The arguments toward the use of the tool are similar to those discussed in the preceding case studies. However the IPDM initiative does not focus on coastal zone management. Instead it focussed on the interaction of location with regard to socio-economic and housing concentrations. This case looked at the objectives of the project and its relevance toward further developing PSS.

In the year 2010 the PSS was in its initial phases. The data available was based on CSIR‟s research into the applicability of modelling and simulation systems for several metropolitan areas, namely: Cape Town, eThekwini, Nelson Mandela Bay and Gauteng (CSIR, 2010a). The profiler was based on user requirements, undertaken to include the content of: climate change scenarios categorized under „natural features‟, population, migration, poverty as well as spatial distribution of socio-economic activity. The goal of the initiatives were to improve the quality of spatial and infrastructure planning (CSIR, 2010b).

Adaption and mitigation against hazards have been discussed as the key factors that impact planning along the coastline. A key informant stated that technology has been extensively used for coastal vulnerability assessment (CVA) and adaptation planning. Future studies will likely become a part of CMP‟s and widely applied methodologies have been described in United Nations Framework Convention on Climate Change (2008). Research can be conducted to use models and urban simulation of coastal management initiatives for better quality plans in South Africa. These tools have to be implemented through training and innovation. The potential of support technology cannot spontaneously occur. Therefore planning practitioners would have to make a decision about the use of tools.

3.8. TECHNOLOGICAL DRIVERS AND THE PROFESSIONALS IMPLEMENTING PLANS

The application of planning support technologies have been determined, by creators, to function with planning professionals. Those professionals would distribute the findings created by a PSS to the public. Different professions have been involved in the coastal zone. These operate on a silo of functions at different levels of government. The application of PSS falls within a range of debate on how successful its use would be depending on the perceptions of the users. In terms of assessment for proactive planning- vulnerability is key to determining land uses for planning. The socio-economic and topographical elements can be determined to show the scenarios to determine future planning initiatives.

Scenarios are derived from indicators of changes in the environment. *―Specific indicators are needed to address climate-change related issues for coastal zones and to identify vulnerable areas at the regional level,”* (Toressan, et. al., 2008). Hazards and risk factors that form the indicators for PSS scenarios cannot be provided in this short dissertation, but the literature has revealed the implications for coastal management planning. At a local level, professionals have formed strategic goals and priority actions, and through PSS, land patterns incorporating the impact of climate change could be assessed to determine development alternatives (Bowen and Riley, 2003). Through PSS information could become more easily available or, on the negative side, capacity and lack of structure in funding and departments could create more harm than good. The application of PSS hypothetically forms a continuum of acceptability as a tool for coastal management. The authors have explored in length the benefits of technology to the world, but in the case of PSS the diversity of land uses shown by the coastal zone, could pose a good argument against the application of systems approach. Instead the tools can be incorporated as reflected by PSS by a dedicated coastal management team (this presents a separate topic to explore).

3.9. CONCLUDING COMMENTS

The precedent cases have shown common characteristics in implementing ICM at a local scale to support global initiatives (view chapter three). The approaches to coastal management were varied. Support tools available for planning were also varied. What was clear was that the planning profession cannot cover all aspects of coastal management but it requires the information from other sectors for improved quality of plans. A generalization of coastal issues does not address any issue sustainably but local research and plans contribute to larger goals.

3.9.1. Conflicting areas of interest

Several implications affected the research position. Challenges for ICM arose from physical implications, methodological issues and misunderstandings. The following points summarize the key challenges for the implementation of a PSS as well as the ICM process;

- The physical challenges have been expounded based on climate change. Uncertainty plays a major role in contributing inefficiency. This is due to the differing stakeholder opinions that vary scenarios according to biases.
- Procedural challenges are faced between conflicting stakeholders in terms of the division of roles and responsibilities. This is not solely a governance issue despite the lack of clarity in the roles of different tiers (national, provincial, district and local) of government. The coastline, based on thresholds is a national priority but spatial and institutional scales have no clear definition. There is also conflict in terms of professional sectors as there are many

disciplines that contribute toward coastal practices. Further interests on the ground, i.e. conflict between stakeholders and interested and affected parties, whom clash over the use of coastal resources.

- The budget constraints for the different issues in a locality affect how much work can be done. There are costs involved in PSS and coastal management strategies. Ultimately priority issues obtain a higher budget and with many priorities funding becomes ambiguous.
- The key challenges for the use of support technology were: Data availability that is reliable and relevant.

Each item represented a characteristic for the use of a support technology. It is improbable for one system to solve all these issues, many of which can be accounted for with traditional methods. Therefore in terms of looking at challenges for planning, a combination of the physical risks, data availability challenges, and costs have been considered. Key information in terms of coastal management has been derived from various sources to provide the context for the use of PSS. From the research several deductions were made regarding the challenges, types of tools used and the application to the local case study.

The writer"s limited knowledge about coastal processes was restrictive factor to the research. This research process has showed that planners can utilize stored data to create better land use management systems for the urban coast from using informants and presenting different scenarios. The tools used to conduct this research centred on a consultative and literature base. Data obtained from each of the sources served to provide the scope for the application of PSS. The precedent cases showed the lack of implementation of planning systems however there was increasing interest in developing functional PSS.

CHAPTER 4: THE SOUTH DURBAN: A CASE STUDY

4.1. INTRODUCTION

Contextualising the application of planning support technologies for ICM was covered in the previous chapters. For the purposes of this research a local case study was chosen to determine the practical applicability of PSS. The South Durban Basin (SDB) is located within the metropolitan area of the eThekwini Council. An examination of the local environment of the SDB was carried out to ascertain if there were suitable areas of the coastline that could be used for a pilot study. Identified focal areas contained a mix of land uses along the coastline. The metropolitan of eThekwini is characterized by a diversity of land uses. In this regard the „mix" described not only the land use, but the social and cultural dynamics as well.

4.2. THE STUDY AREA

The study area is located in the South Durban Basin of the province of KwaZulu-Natal, in South Africa. The area is situated in the central functional district of the eThekwini municipality.

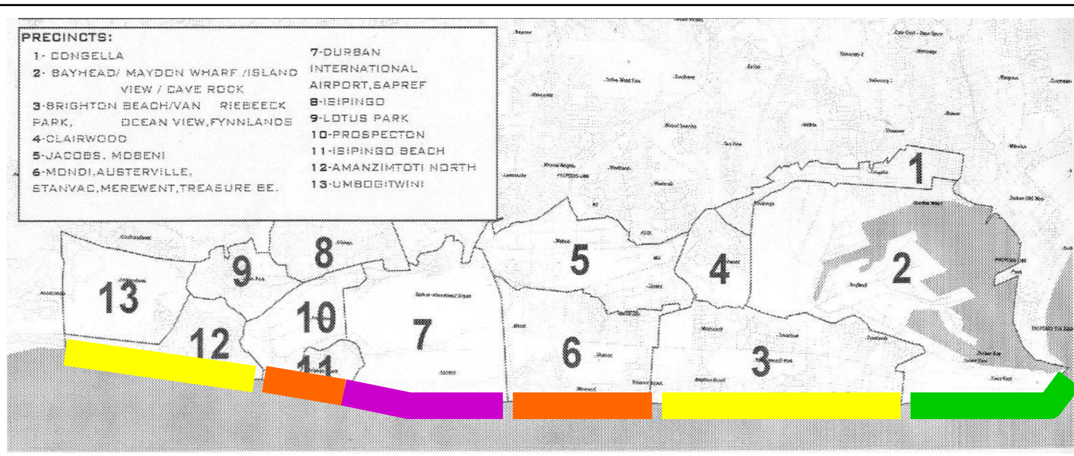


Figure 14: Precincts of South Durban Basin Study Area

The area, notorious as a manufacturing and industrial zone of the city, has been the subject of numerous plans and redevelopment proposals related to both the economic assets of the area and pollution associated with its industries. The draft South Durban Basin Coastal Management Plan (CMP) identified six precincts out of twelve which border the coastline. The CMP was used to select study areas for this dissertation (Futureworks, 2008).

A Coastal Management Strategy was drafted that identified the need to prepare CMP"s to support eThekwini"s Integrated Development Plan (IDP) in 2005 (Futureworks, 2008: 1). The coastal management plan for the South Industrial Basin has defined the coastline area using precinct boundaries, as follows:

- The Bluff - (Precinct 2);
- Brighton Beach - (Precinct 3);
- Merewent / Treasure Beach - (Precinct 6);
- SAPREF Dune - (Precinct 7); and,
- Isipingo Beach - (Precinct 11); and Amazimtoti North - (Precinct 12).

These precincts are depicted in figure 14 above. The eastern boundary"s twenty-eight kilometres of shoreline, from the suburb of Bluff to Amanzimtoti, formed the border of the study area. The total study area was at measured at 14 447 115m², and encompassed many diverse land uses. Table 4.2.1 below defines the area and length of each suburb along the coastline. The study area was further divided in this chapter to compare the land uses in different suburbs along the coastline.

4.2.1. Table Showing the Breakdown of the SDB study area

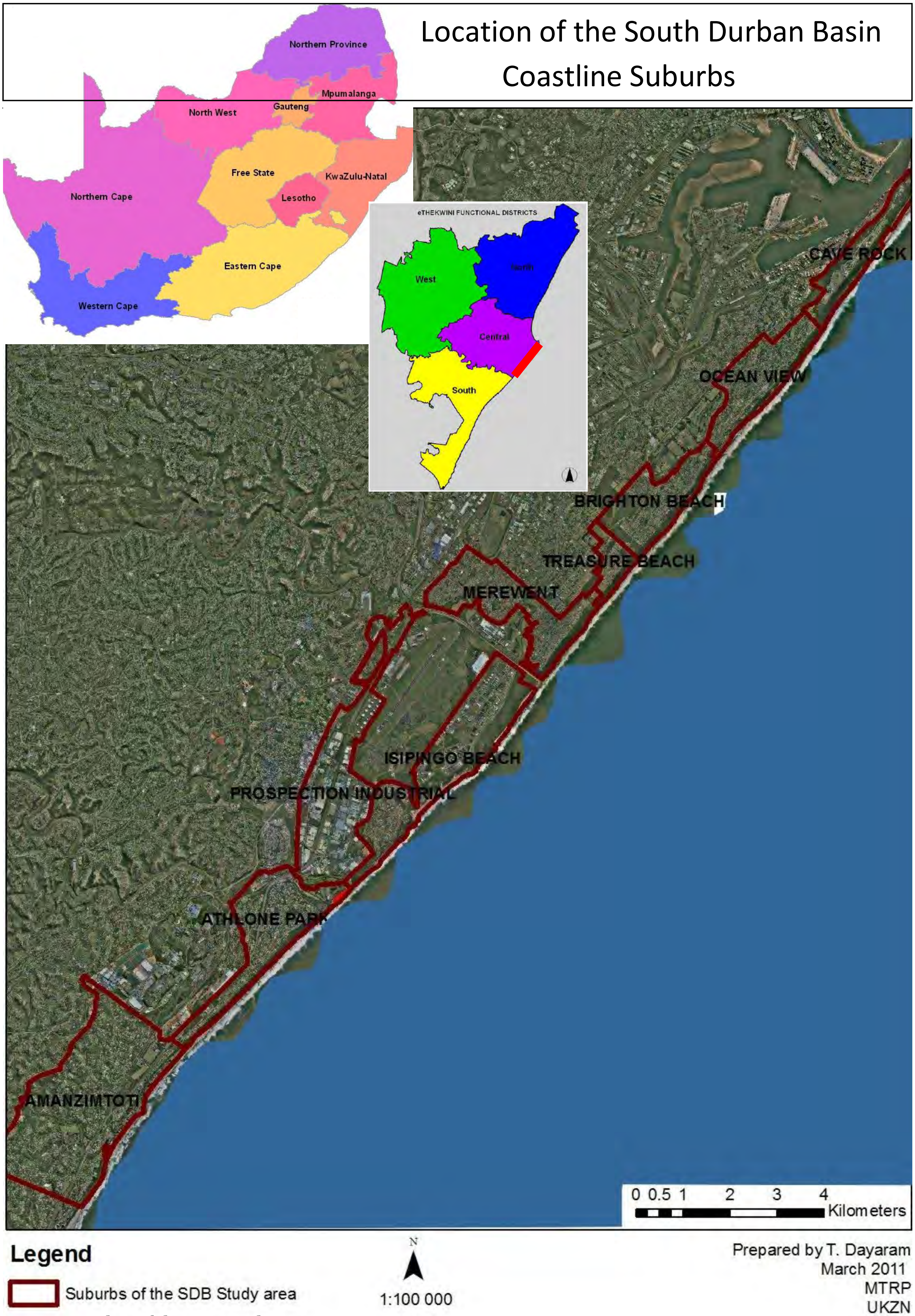
Suburb	Total Area (m^2)	Strip (m)	Length (m)	Study Area (m^2)
Cave Rock	1835961.62	500	4521.88	2260940
Ocean View	2693659.45	500	3572.6	1786300
Brighton Beach	2565725.15	500	2671.31	1335655
Treasure Beach	812781.16	500	1327.33	663665
Merewent	3506286.4	500	1939.67	969835
Isipingo Beach	5005593.88	500	5913.04	2956700
Athlone Park	3725692.43	500	4817.83	2408915
Amanzimtoti	8781851.14	500	4130.21	2065105
Total Study area	-	-	28 893.9	14 447 115

The research identified the suburbs that border the coastline because: a) the suburb boundaries (provided by a GIS) depicted the land uses that are directly affected by the coastline, and b) historically, the suburbs were master planned which highlighted the results of effective pro-active planning. From the selected locations the following were chosen as study areas; Amanzimtoti, Merewent and Bluff (made up of the suburbs Ocean View and Brighton Beach) which have been mapped in greater detail for the purpose of comparing the diverse land uses and functions.

Differing data sources have been used to produce maps and information at a variety of scales and boundaries. For example, ward profiles for the south of Durban contained the demographic and socio-economic data. However, the ward data have different boundary definitions to the precinct data on the GIS used. Another factor to acknowledge was that the old data sources were used, as new population census data was to start being collected in 2011. Additional data for the areas were also obtained internet sources, such as; CAMPON statistics on population and services from. This research has focused on the suburbs along the coastline. GIS and aerial photography was used to present the coastal suburbs.

4.3. REALITIES: SOUTH DURBAN BASIN BEACHED

The southern part of Durban was historically designated for heavy industry and the provision of housing for industrial labour forces. Until the relocation of the airport to the north, the SDB was identified as having the majority of industries related to the port, oil storage facilities and manufacturing industries (also termed „dirty industries") of the city. This spatial designation was further given racial divisions determined by apartheid planning. The apartheid legacy influenced post-industrial developments. The nature of public space and private space was affected along the coastline. Residential zones generally conflicted with big business on a spatial and social level. This conflict has occurred due to the historical legacy of residential areas having been developed in close proximity to polluting industries (eThekwini Municipality, 2011). These conflicting land uses are developed areas where, in some cases, there is a higher risk to existing and proposed infrastructure due to extreme wave run-up (Mather, 2011).



Map 4: Locality of the SDB Study area

The beaches of South Durban offered many opportunities for development in terms of property, recreation and tourism. Beaches are also significant for the maintenance of the natural environment. The impact of technology and design concepts was discussed in the local area analysis of SDB coastal suburbs.

4.3.1. The Physical Environment

In the planning profession the spatial attributes of a land parcel are established through mapping, zoning schemes, statutory clauses and municipal by-laws that either enable or hinder the development of land. The physical attributes of the study area were retrieved from various sources and mapped via the Arc Map GIS software programme. The partial local area analysis provided indicators that could be incorporated into a PSS for this area.

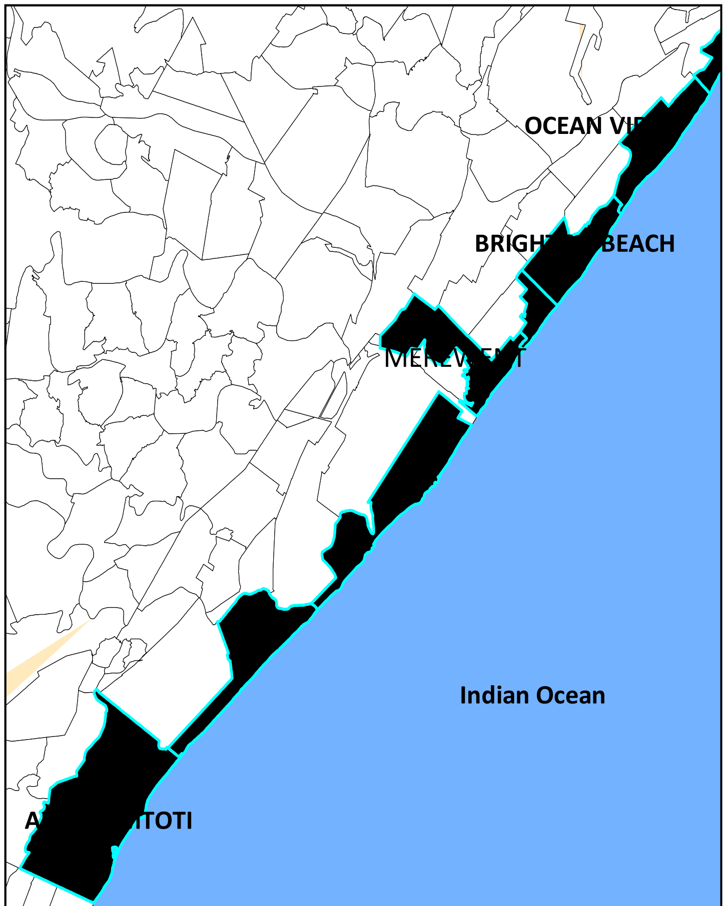
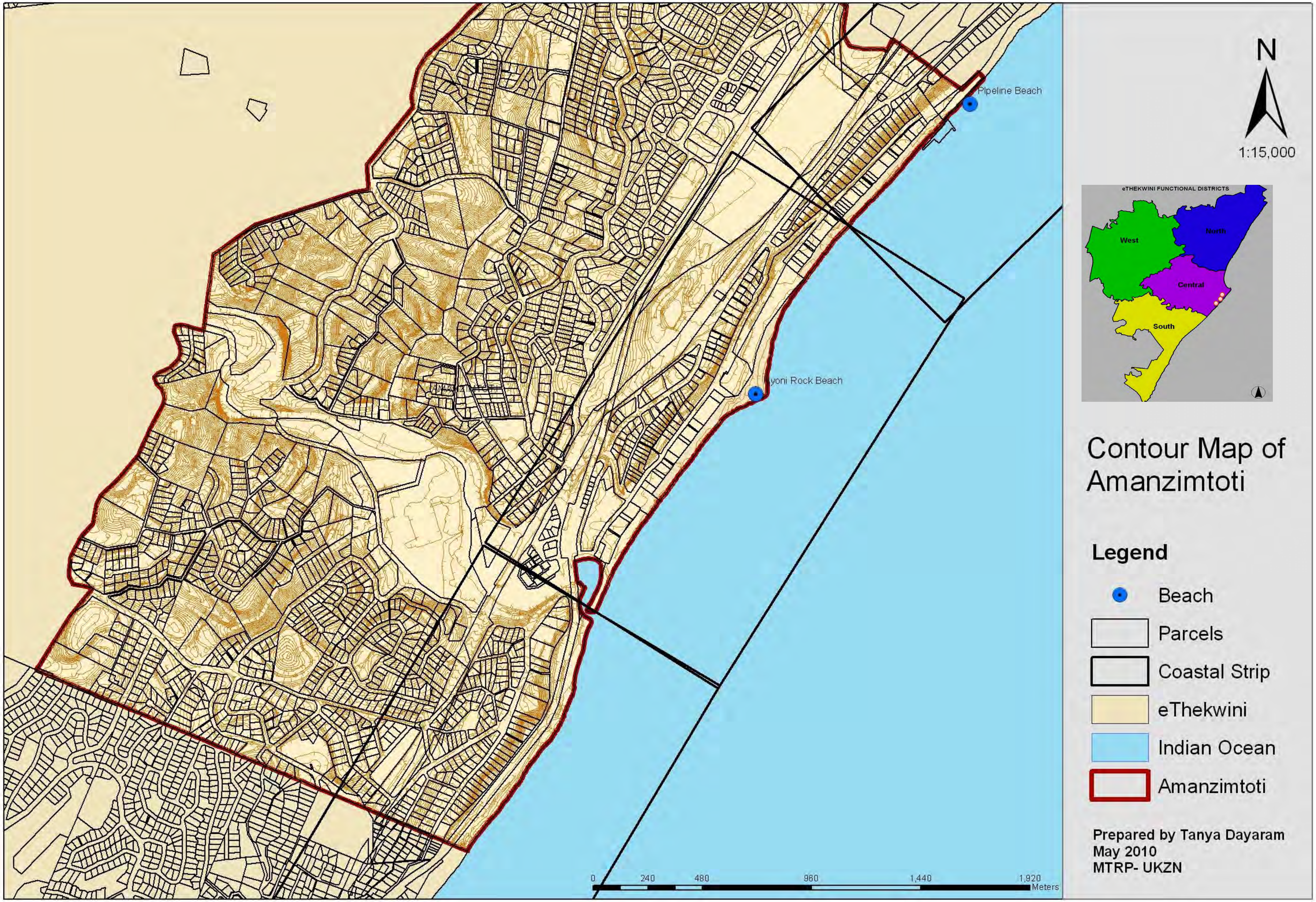


Figure 15: Breakdown of Compared Suburbs in SDB

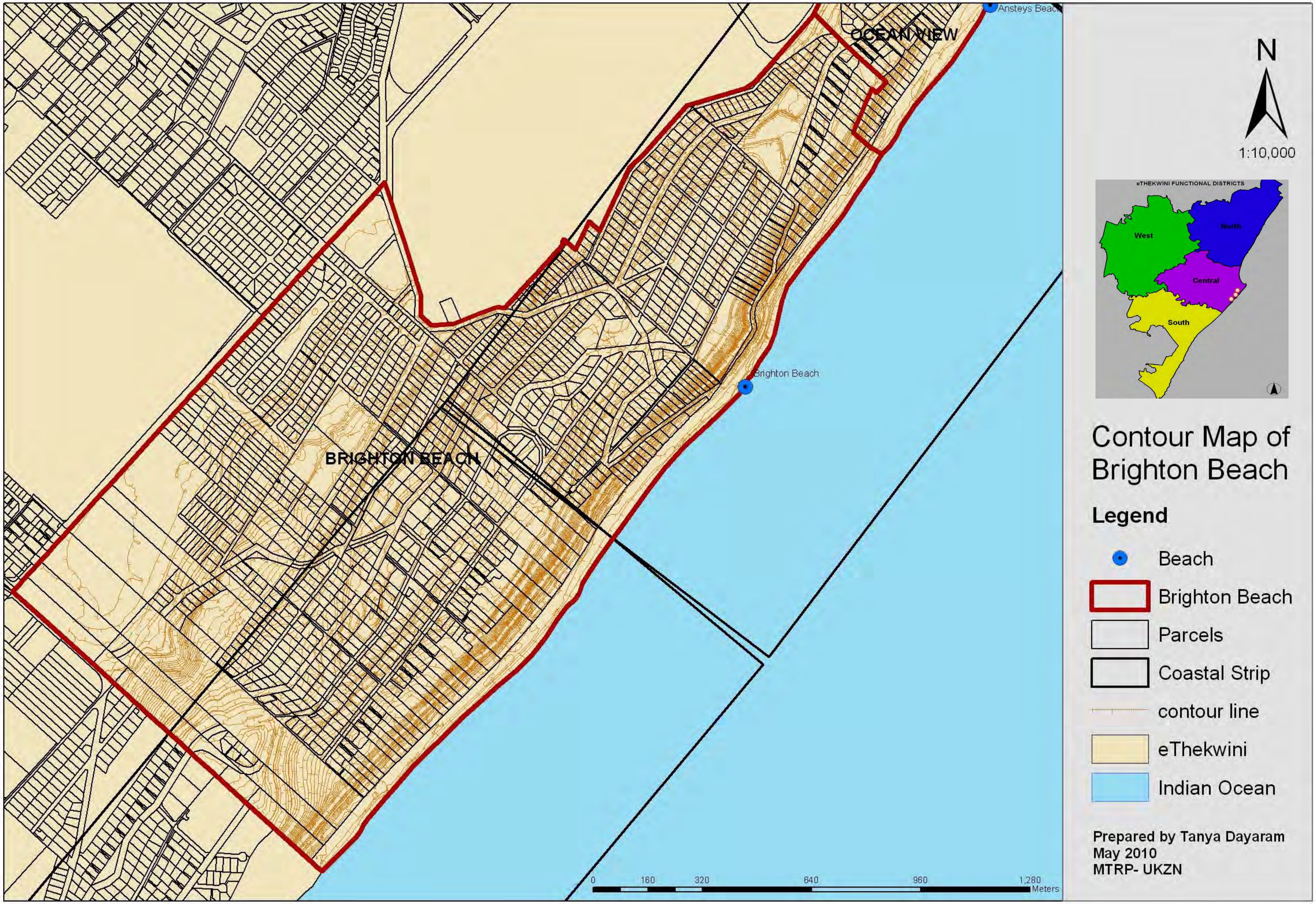
The physical features of the study area are; topography, environmental attributes coastal form and geology. The maps show that there are different gradients along the coastline of the study area.

The steepest slopes are along the Brighton Beach coastline and the flattest along the Amanzimtoti coastline (refer to maps 5-8: Contour Maps of the study area). These aspects determined the opportunities and constraints of the site. The study area has been further subdivided for the purpose of comparing the land uses along the coastline (refer to figure 15, right).

Map 5: Contours of the Amanzimtoti Study Area

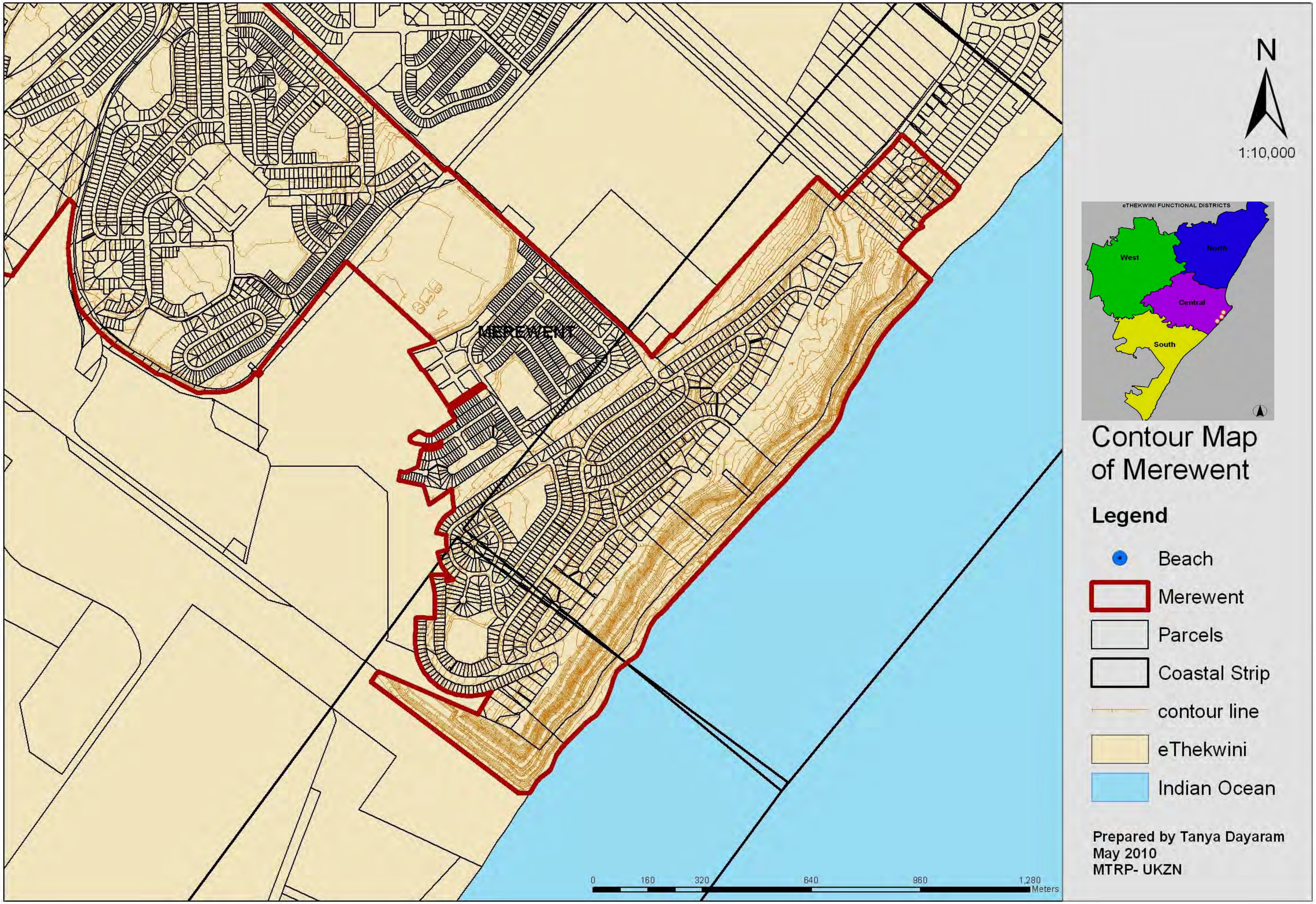

Pipeline Beach
yoni Rock Beach
N
1:15,000
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
Contour Map of Amanzimtoti
Legend
Beach
Parcels
Coastal Strip
eThekwini
Indian Ocean
Amanzimtoti
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
0
240
480
960
1,440
1,920
Meters

Map 6: Contours of the Brighton Beach Study Area



Ansteys Beach
OCEAN VIEW
N
1:10,000
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
Brighton Beach
BRIGHTON BEACH
0
160
320
640
960
1,280
Meters
Contour Map of Brighton Beach
Legend
Beach
Brighton Beach
Parcels
Coastal Strip
contour line
eThekwini
Indian Ocean
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN

Map 7: Contours of the Merewent Study Area



N
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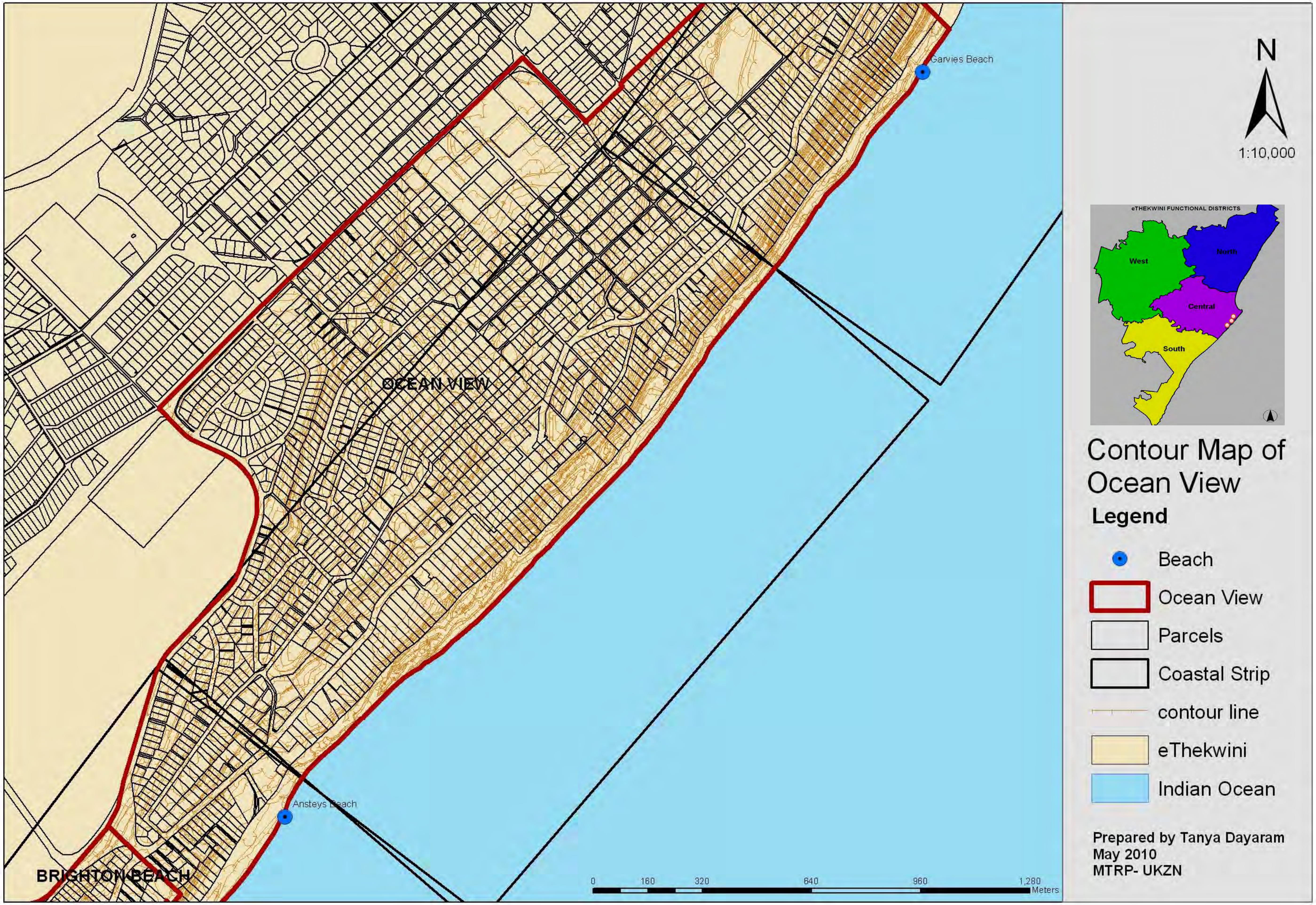
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
MEREWENT
Contour Map of Merewent
Legend
Beach
Merewent
Parcels
Coastal Strip
contour line
eThekwini
Indian Ocean
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
0
160
320
640
960
1,280
Meters

Map 8: Contours of the Ocean View Study Area


Garvies Beach
OCEAN VIEW
Ansteys Beach
BRIGHTON BEACH
0
160
320
640
960
1,280
Meters
N
1:10,000
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
Contour Map of Ocean View
Legend
Beach
Ocean View
Parcels
Coastal Strip
contour line
eThekwini
Indian Ocean
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN

Durban is characterized by a low lying coastal system which means that the entire urban area is vulnerable to extreme climatic events (refer to figure 16 of catchment map, alongside text).

Developments along the coastline have been located directly behind primary coastal dunes, excluding certain recreational and residential zones. The sample chosen for mapping showed extensive conservation, as opposed to north of Durban where there was more destruction as a result of tidal surges (refer to photograph panel 3 below).

Environmental attributes are used to describe the many features of the coastal land- and seascape. For the purpose of this study land uses, vegetation and geology have been detailed.

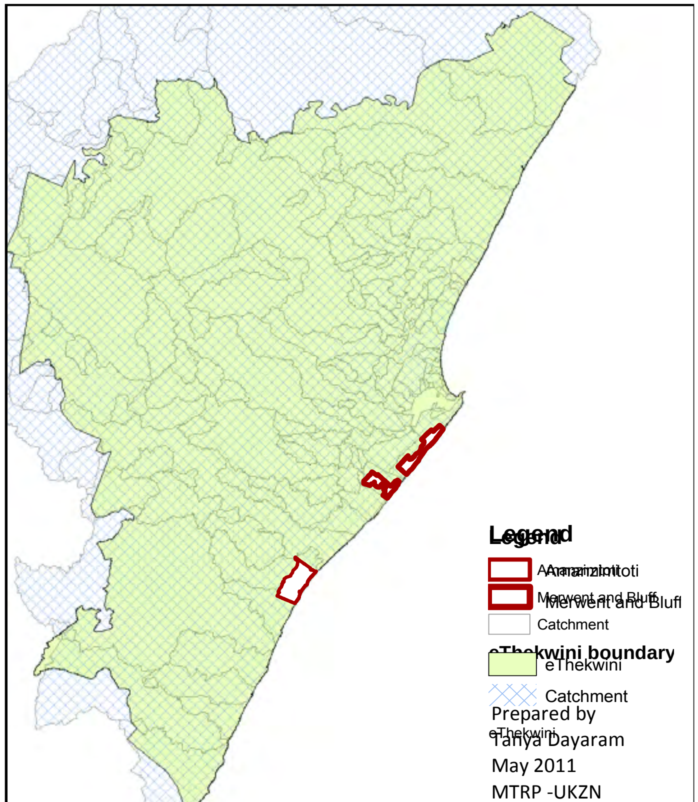


Figure 16: Catchment map showing eThekwini and the Study Areas

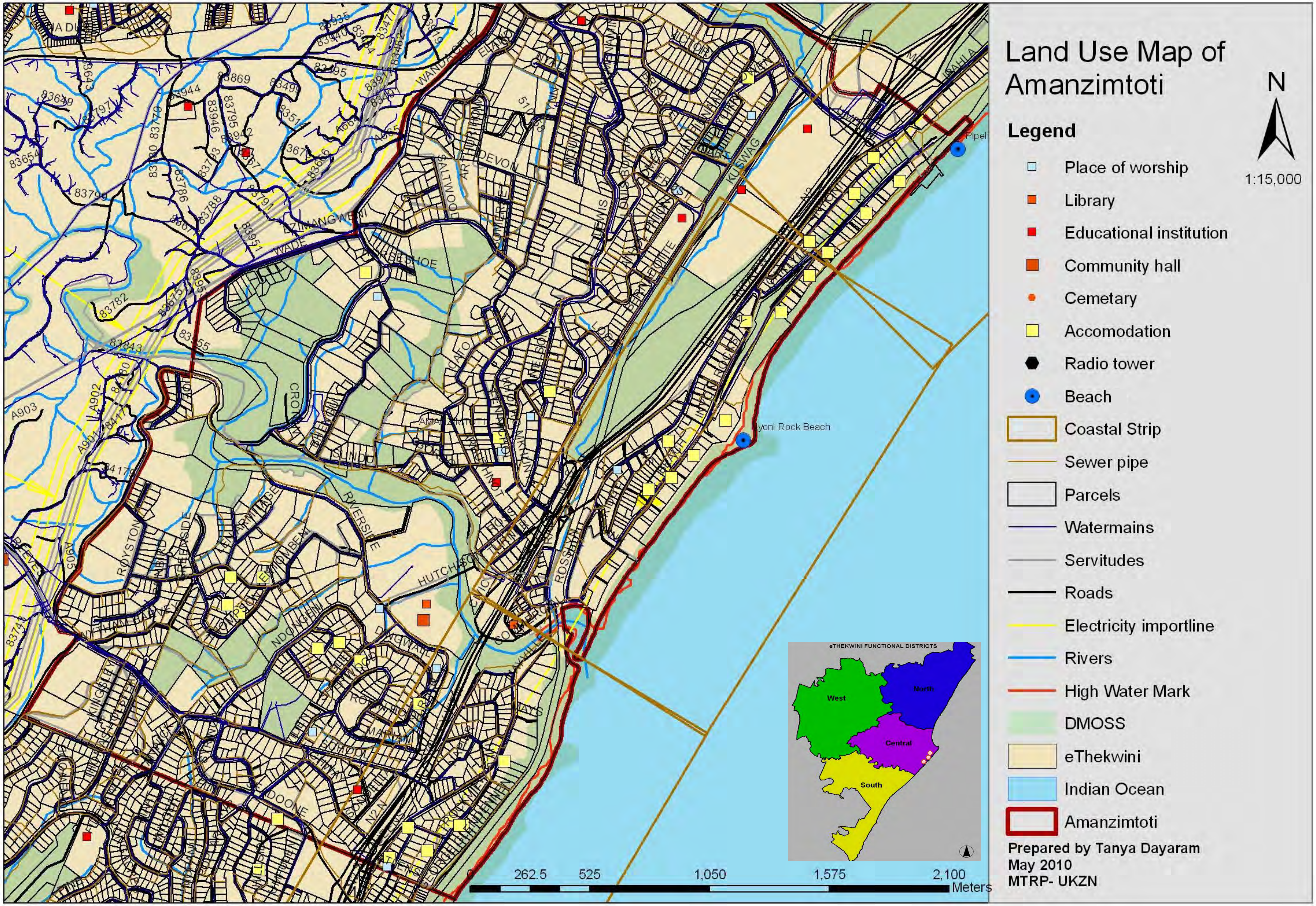
Photographs showing damage to coastal property and erosion in Ballito due to wave action (Smith et al 2007 and PDCC, 2008)

Photograph panel 3: Durban North

The coast has been described as „rich in resources" because it contains a multitude of flora, fauna and ecosystems. The coastline is a protected area in the country, and in the SDB this is shown in the land use maps, via the Durban Municipal Open Space System (DMOSS) (refer to maps 9-12 of the land uses in the study area). More recently the Coastal Management Act has introduced a one kilometre setback along the sea edge, from the high water mark, as an additional protection measure for the coast.

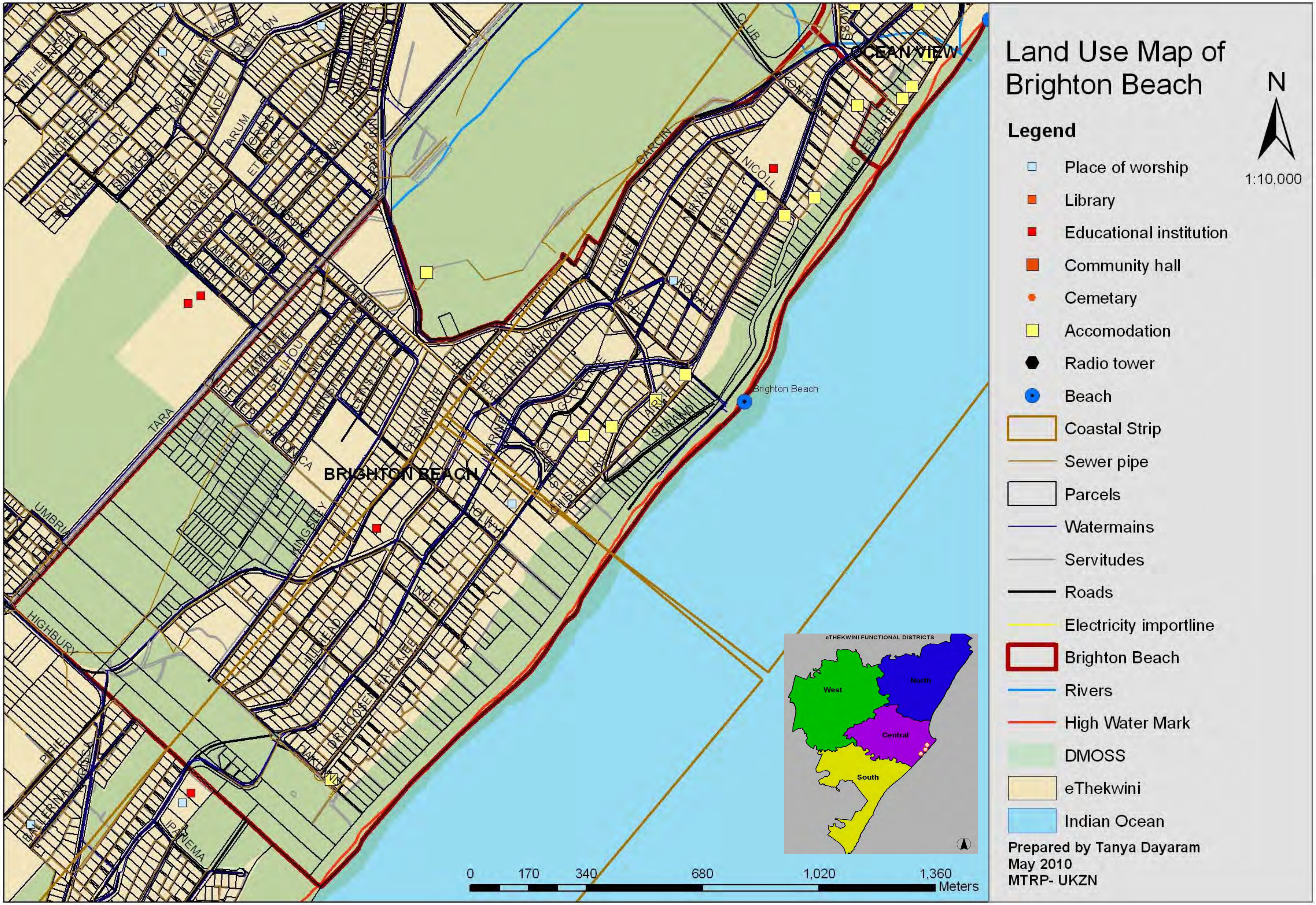
Geology and soil types are technical components which classify land into what is stable and unstable for developing. The main soil types along the SDB coastal strip are of the Berea formation types and are characterised by beach and dune sands. It was clearly shown that there are cadastral boundaries within the coastal strip that are also classified as „Bluff slopes No Development" (refer to maps 13-16). The maps illustrated the contradiction between was planned and the reality of development along the coastline.

Map 9: Land Uses of the Amanzimtoti Study Area

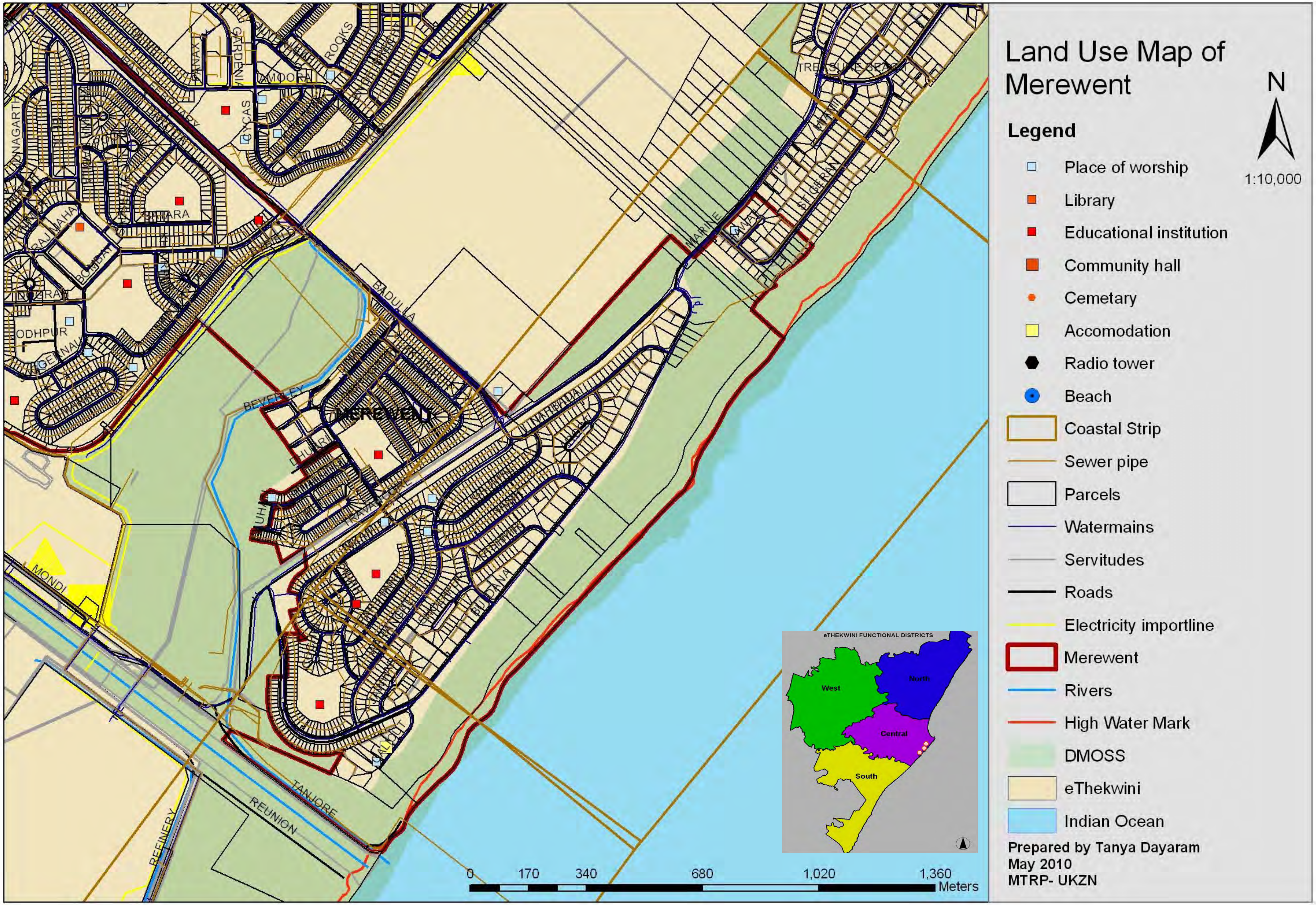


Land Use Map of Amanzimtoti
N
1:15,000
Legend
Place of worship
Library
Educational institution
Community hall
Cemetary
Accomodation
Radio tower
Beach
Coastal Strip
Sewer pipe
Parcels
Watermains
Servitudes
Roads
Electricity importline
Rivers
High Water Mark
DMOSS
eThekwini
Indian Ocean
Amanzimtoti
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
0 262.5 525 1,050 1,575 2,100
Meters
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South

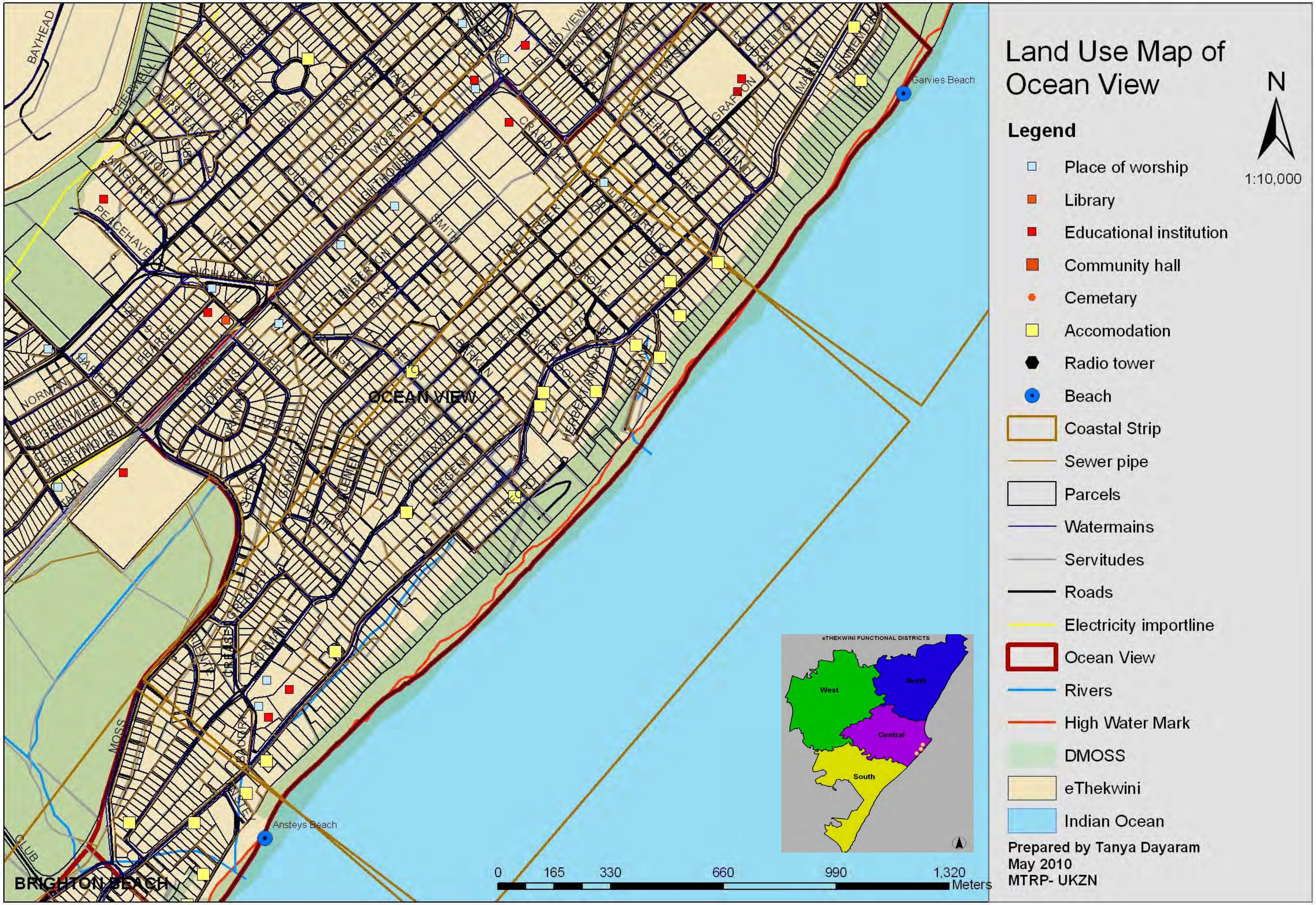
Map 10: Land Uses of the Brighton Beach Study Area


Land Use Map of Brighton Beach
N
1:10,000
Legend
Place of worship
Library
Educational institution
Community hall
Cemetary
Accomodation
Radio tower
Beach
Coastal Strip
Sewer pipe
Parcels
Watermains
Servitudes
Roads
Electricity importline
Brighton Beach
Rivers
High Water Mark
DMOSS
eThekwini
Indian Ocean
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
BRIGHTON BEACH
OCEAN VIEW
Brighton Beach
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
0 170 340 680 1,020 1,360
Meters

Map 11: Land Uses of the Merewent Study Area


Land Use Map of Merewent
Legend
Place of worship
Library
Educational institution
Community hall
Cemetary
Accomodation
Radio tower
Beach
Coastal Strip
Sewer pipe
Parcels
Watermains
Servitudes
Roads
Electricity importline
Merewent
Rivers
High Water Mark
DMOSS
eThekwini
Indian Ocean
N
1:10,000
0 170 340 680 1,020 1,360
Meters
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
MEREWENT
BEVERLEY
BADULLA
MARINE
TANJORE
REUNION
REFINERY
MONDI
ODHPUR
ROOKS
GARDENIA
AMOORA
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN

Map 12: Land Uses of the Ocean View Study Area


Land Use Map of Ocean View
Legend
Place of worship
Library
Educational institution
Community hall
Cemetary
Accomodation
Radio tower
Beach
Coastal Strip
Sewer pipe
Parcels
Watermains
Servitudes
Roads
Electricity importline
Ocean View
Rivers
High Water Mark
DMOSS
eThekwini
Indian Ocean
N
1:10,000
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
0 165 330 660 990 1,320
Meters
OCEAN VIEW
BRIGHTON BEACH
Garvies Beach
Ansteys Beach
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South

4.3.2. Coastal form

Development, wave action and climate conditions create the shape of coastal areas. The conservation / „green" areas along the coastline and industrial areas define the southern Durban coastline (refer to land use maps in annexure 9-12). Coastal form was described using the following terms:

- Coastal profile;
- Coastal shape;
- Coastal type; and,
- Coastal modification.

For example, an aerial photograph of Ocean View identified low lying special residential areas; image 17 (Aerial photograph Ocean View) illustrated „Anstey"s Beach" and development overlaid by the High Water Mark.

Figure 17: Aerial Photograph of Ocean View

Coastal form has been defined by the aesthetic qualities of the coast which are based on the natural features, oceanic movement and modified by built form along the coastline. Mather (2007) researched the combined marine storm and Saros spring high tide erosion events along the KwaZulu-Natal coast in March 2007. His research revealed that seawalls provided some measure of protection against rising sea levels. However, erosion prevailed and the property damage was worse where „land was reclaimed from the sea". Another factor that distinguishes coastal form is the dune system. Emphasis has been placed on the preservation of natural coastal dunes because they have been regarded as providing a significant barrier against the impacts of natural processes e.g. sea surges.

The specific biophysical conditions of different dune systems were described in the KZN Admiralty Reserve (PDCC, 2008: 15-20). The research documented the role that vegetation plays in stabilising the coastline, as well as the negative human impacts on the natural environment.

The entire study area is vulnerable to sea level rise and unstable land (Mather, PPDC, 2008 and Roberts, 2010). Accordingly, there are potential risks to investing in facilities and infrastructure which will have economic repercussions for the local area and community.

In terms of structural challenges, auditing solutions have been adopted, and engineering solutions were designed; for example the eThekwini Municipality has incorporated measures such as groynes and sand dredging to mitigate against the impact of erosion. (eThekwini Municipal Communications Unit, 2011).

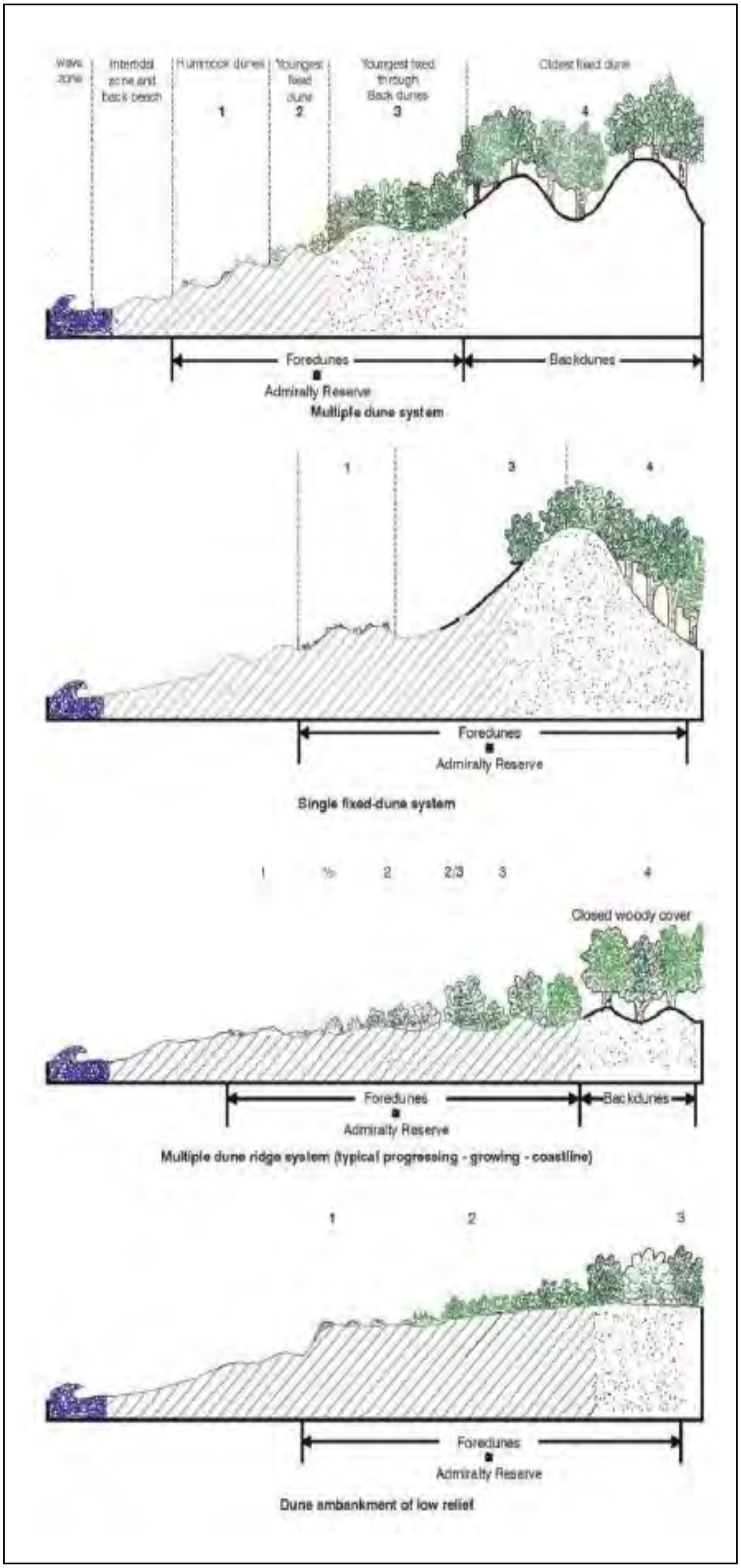


Figure 18: Sea Shore profiles
Shows different dune profiles and the area protected by the Admiralty (PPDC, 2008: 18).

The planning profession plays a role in strategically allocating land uses and development along the coastline as well as providing the appropriate schemes and recommendations for the purposes of managing sustainable development. Therefore, it has been identified that these issues need technical input from specialists to monitor and control changes along the coastline. The application of planning support technologies to determine the most appropriate use of land for the area could be a successful methodology.

4.4. CLIMATE CHANGE

Changes in climate gradually shift global temperatures causing modifications in sea levels. According to Hare (2009) the climate system has warmed 0.7°C, most likely due to the impact of human activities, and if unabated Earth‟s temperature could increase by 4 - 6°C. Temperature change has serious repercussions for ecosystems and water security. Along the coastline structural damage affects fresh water sources by salination. Potential threat of property and infrastructure damage from increasing sea levels and associated storm surges are increasing. SDB‟s high levels of omissions created the assumption that higher levels of polluting activities along the coastline will exacerbate the impacts of coastal hazards (depicted in figure 19 below).

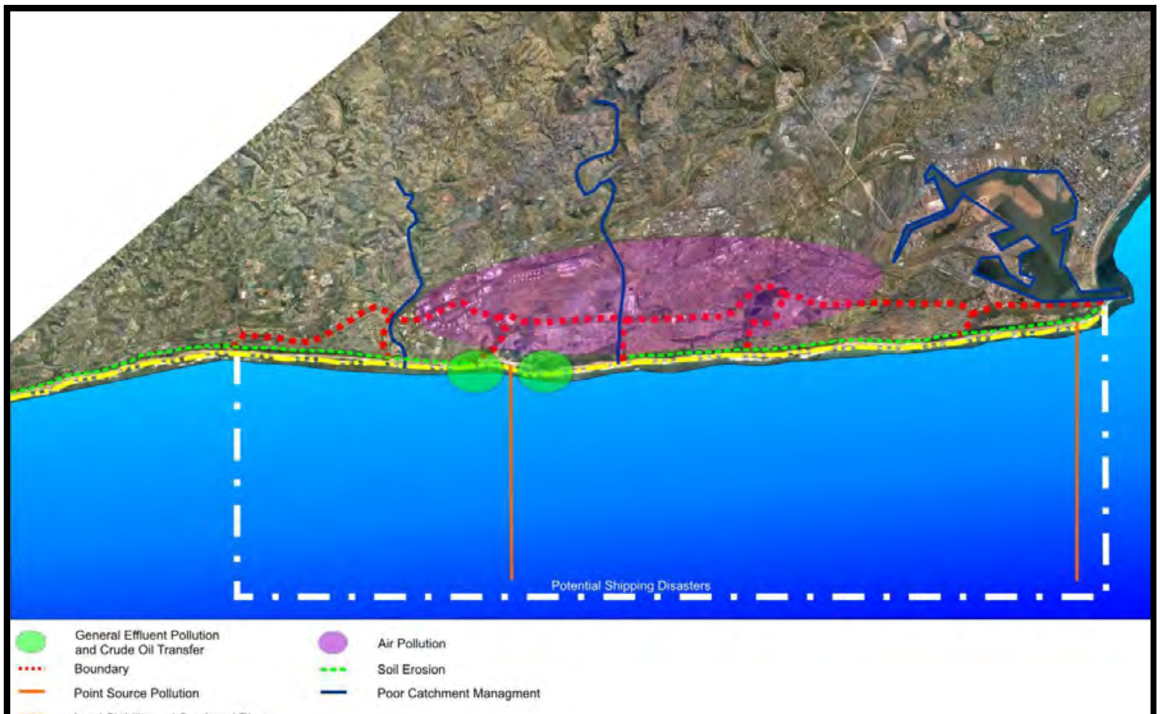
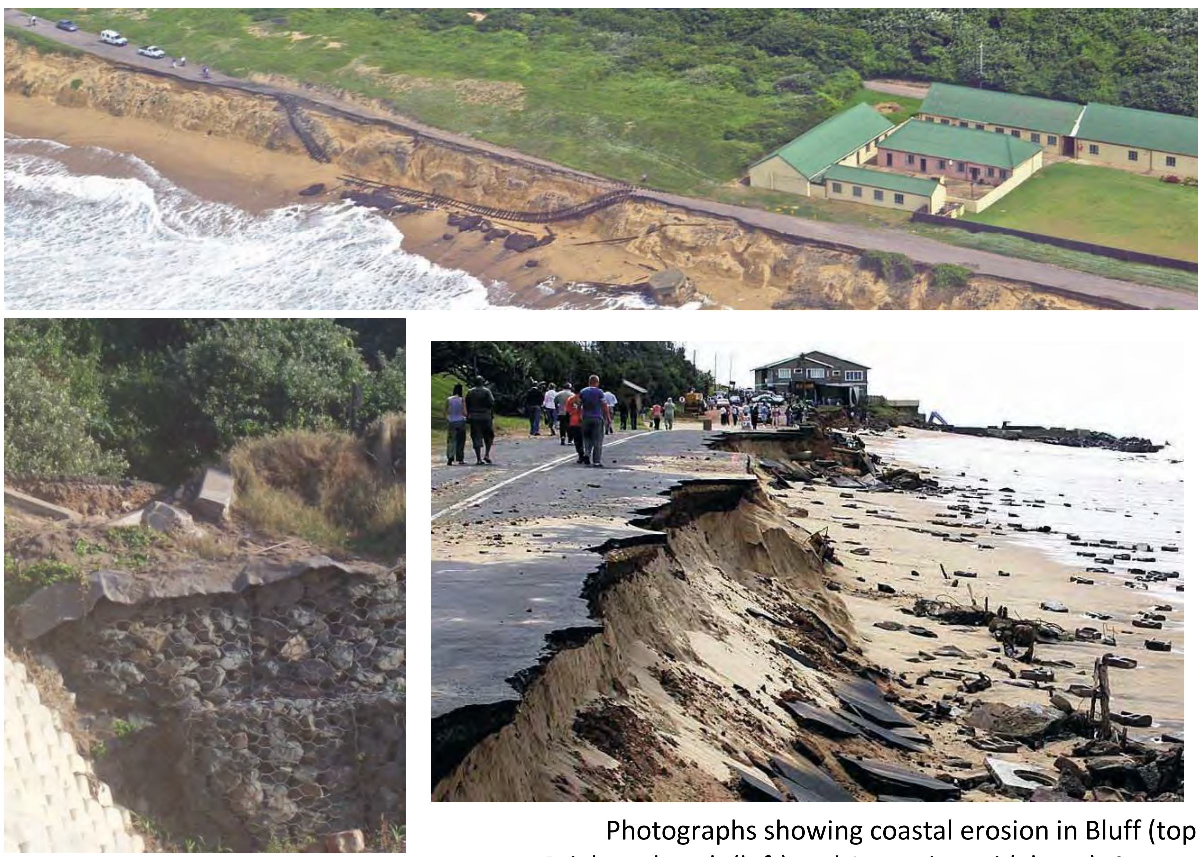


Figure 19: Pollution in the SDB

Severe environmental stresses have increased potential risk of the area, especially considering the densities of buildings and population. At a local level climatic changes have been observed in southern Durban in the form of unseasonal weather patterns, more specifically increased storm events, for example the 2007 storm surges. The average climate experienced in the locality affects the micro-climate within the study area. A subtropical weather pattern characterizes Durban‟s climate, with heavy rainfall on steeper slopes that cause serious soil erosion.

Chapter two has discussed local innovations and technological input toward addressing climate change. Due to the natural stability of the Durban coastline Mather (2007) stated that the coastline of Durban is one of the few sites that can be used to assess global sea level rise.



Photographs showing coastal erosion in Bluff (top), Brighton beach (left) and Amanzimtoti (above). Sources: Breetzke et al. 2008 and Davaram. 2010.

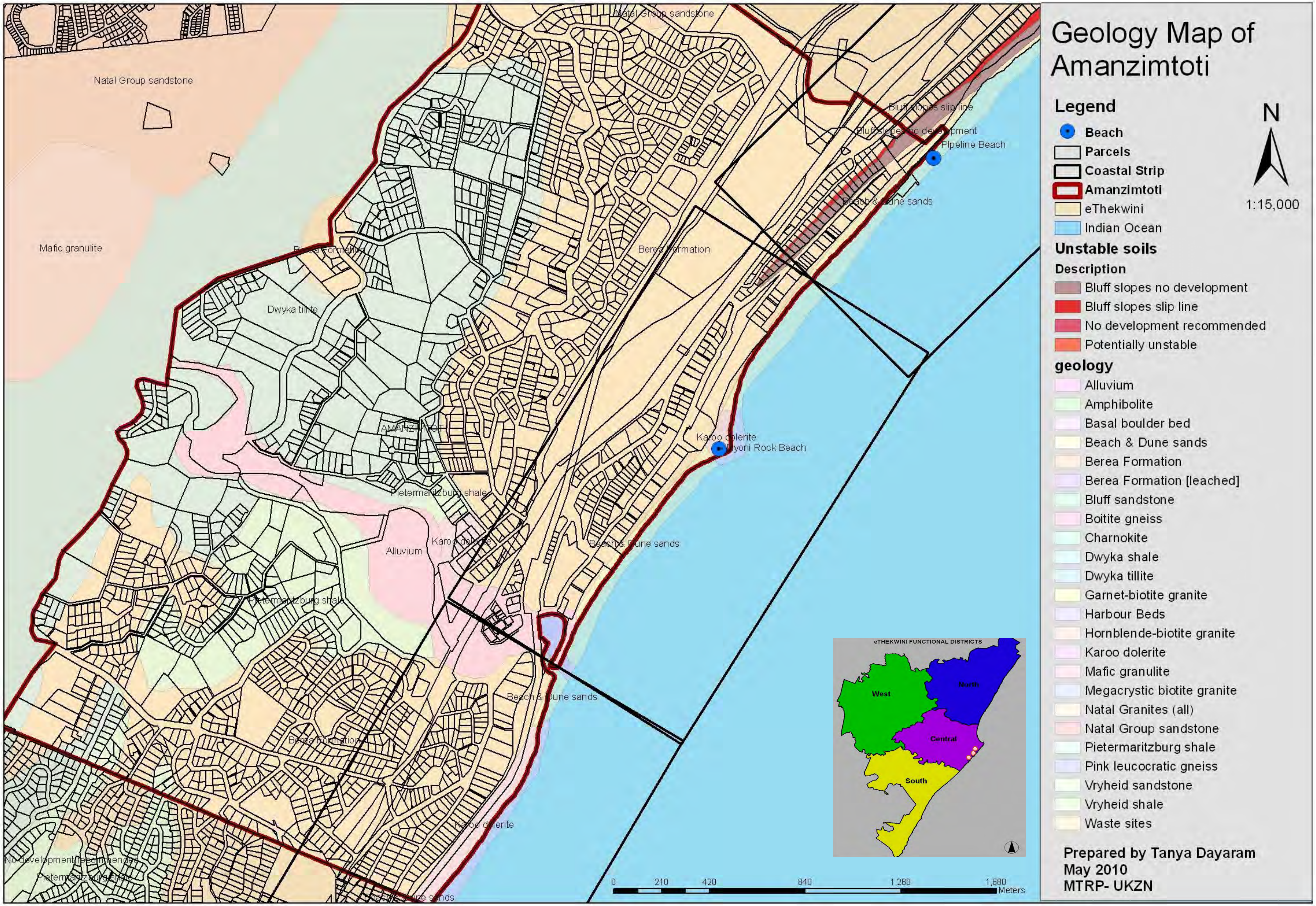
Photograph panel 4: Images of Coastal Erosion

The urban coastline was affected by erosion resulting in costly damage (refer to photograph panel 4 above).

> “*Property damage resulted from unwise urban planning during the coastal building boom of the last two decades. Local exacerbating factors included construction too close to the high water mark, adverse coastal profile, and coastal modification,”* (Smith, et. al., 2007).

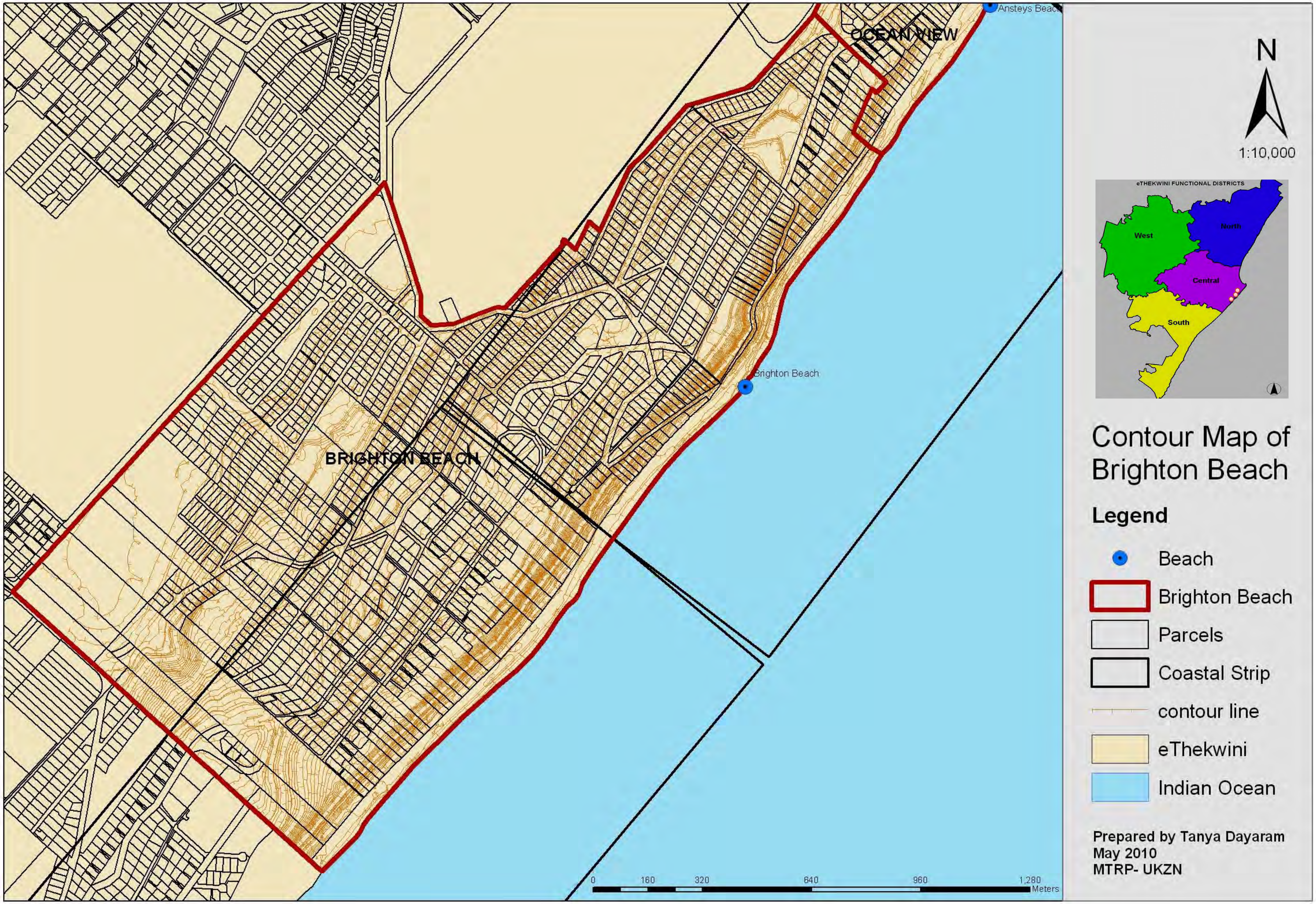
Natural coastlines can absorb the impact; while low profile coasts such as the north of Durban suffered more extensive damage. When coastal dunes are destroyed beaches cannot rebuild after sever storm events. The literature has argued for a strictly enforced building setbacks and regulatory buffer zones along the coast (Smith, et. al., 2007 and Mather, 2007).

Map 13: Geology of the Amanzimtoti Study Area



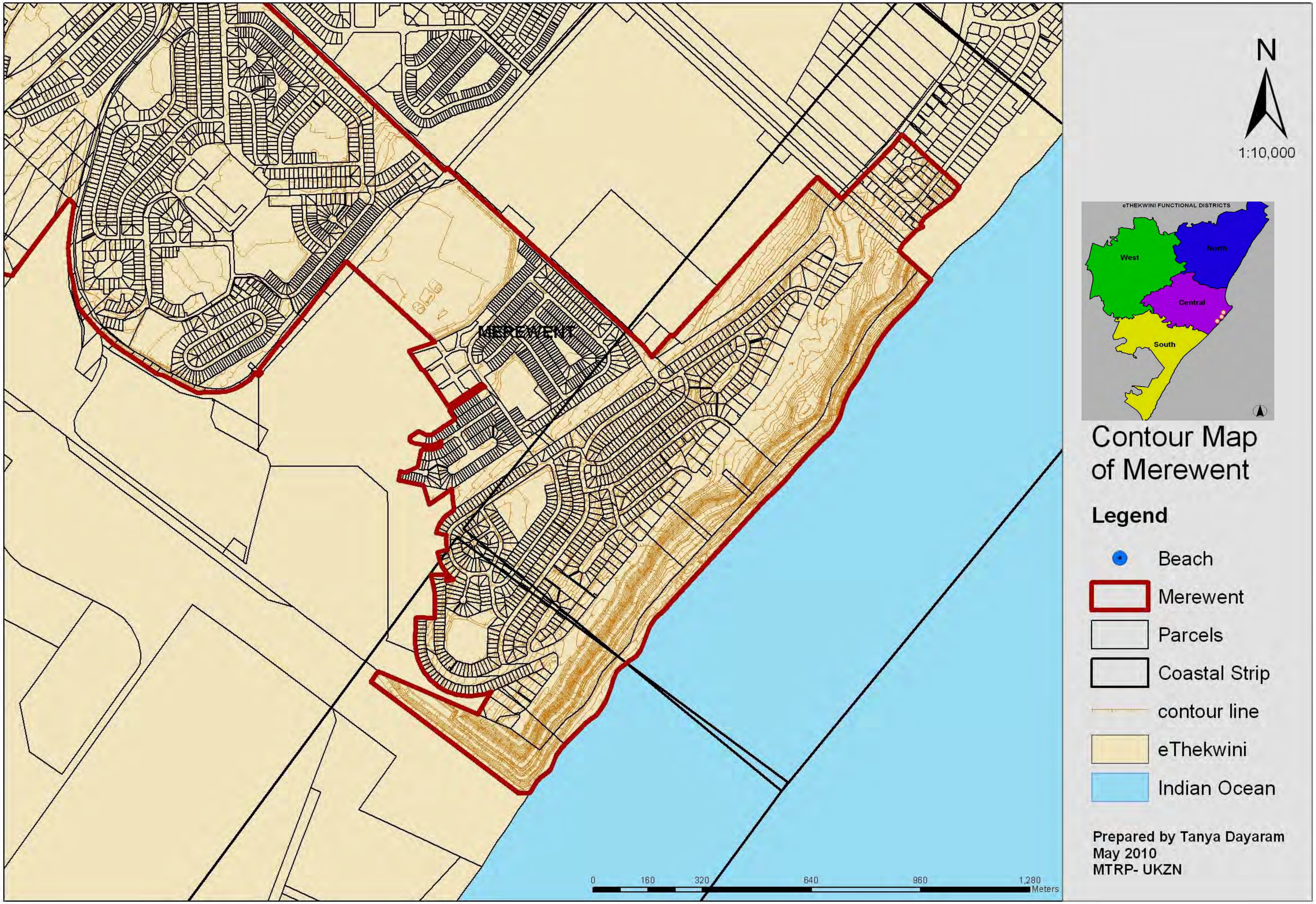
Geology Map of Amanzimtoti
Legend
Beach
Parcels
Coastal Strip
Amanzimtoti
eThekwini
Indian Ocean
Unstable soils
Description
Bluff slopes no development
Bluff slopes slip line
No development recommended
Potentially unstable
geology
Alluvium
Amphibolite
Basal boulder bed
Beach & Dune sands
Berea Formation
Berea Formation [leached]
Bluff sandstone
Boitite gneiss
Charnokite
Dwyka shale
Dwyka tillite
Garnet-biotite granite
Harbour Beds
Hornblende-biotite granite
Karoo dolerite
Mafic granulite
Megacrystic biotite granite
Natal Granites (all)
Natal Group sandstone
Pietermaritzburg shale
Pink leucocratic gneiss
Vryheid sandstone
Vryheid shale
Waste sites
N
1:15,000
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
Natal Group sandstone
Mafic granulite
Dwyka tillite
Berea Formation
Pietermaritzburg shale
Alluvium
Karoo dolerite
Beach & Dune sands
Pipeline Beach
Bluff slopes slip line
Bluff slopes no development
Karoo dolerite
Pietermaritzburg shale
No development recommended
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
0
210
420
840
1,260
1,680
Meters

Map 14: Geology of the Brighton Beach Study Area



OCEAN VIEW
Ansteys Beach
Brighton Beach
BRIGHTON BEACH
N
1:10,000
eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
Contour Map of Brighton Beach
Legend
Beach
Brighton Beach
Parcels
Coastal Strip
contour line
eThekwini
Indian Ocean
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
0
160
320
640
960
1,280
Meters

Map 15: Geology of the Merewent Study Area


N
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eTHEKWINI FUNCTIONAL DISTRICTS
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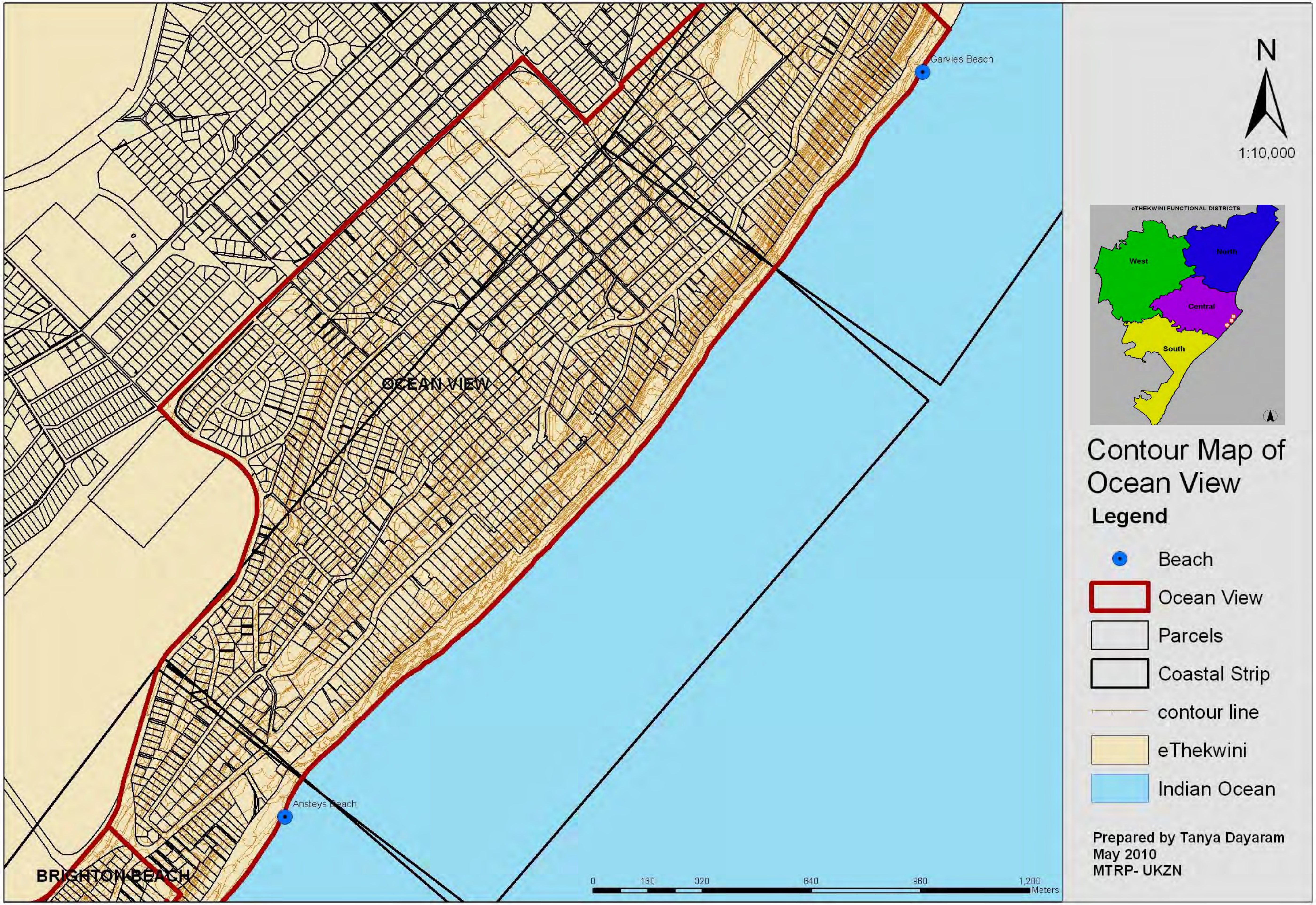
Central
South
MEREWENT
Contour Map of Merewent
Legend
Beach
Merewent
Parcels
Coastal Strip
contour line
eThekwini
Indian Ocean
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN
0
160
320
640
960
1,280
Meters

Map 16: Geology of the Ocean View Study Area



Garvies Beach
OCEAN VIEW
Ansteys Beach
BRIGHTON BEACH
0
160
320
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Meters
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eTHEKWINI FUNCTIONAL DISTRICTS
West
North
Central
South
Contour Map of Ocean View
Legend
Beach
Ocean View
Parcels
Coastal Strip
contour line
eThekwini
Indian Ocean
Prepared by Tanya Dayaram
May 2010
MTRP- UKZN

4.5. DEVELOPMENT AND INFRASTRUCTURE

Density of development and infrastructure along the coastline determine the level of risk to coastal hazards. The aim of the survey was to describe the characteristics of land use along the coastline for the purpose of uncovering the consequences of location decisions. The primary land uses have been tabled based on observations and secondary research. The zoning map provided the permissible land use along the coastal strip (refer to Map 17 - 20). A land use survey sought to identify any discrepancies between the map and what was observed as well as noticeable disparities along the coastline (refer to map 9 - 12).

4.5.1. Facilities and level of development

From the survey several factors were noticed; residential / special residential property was in close proximity to the high water mark. Industrial activity situated within residential zones along the coastline inevitably posed risks to the community. Furthermore, since the study is an urban area, a higher level of infrastructure was involved. The previous Durban International airport site falls into the study area. The site has been considered for numerous development scenarios, one being a new port, and impacts of the new land uses have to be thoroughly researched before development can occur. The risks, hazards and vulnerability to activities along the coastline have to be strategically assessed and managed to reduce storm related damage to the area.

From the images and survey the following factors were established;

- A lower level of built form directly along the SDB coastline;
- Brighton Beach and Ocean View areas contain more recreational facilities and low density housing within the coastal strip. There was evidence of coastal management strategies that deal with the issues of erosion and the impact of climate change (refer to PPDC, 2008; Breetzke, et. al., 2008 and Futureworks, 2008). This area specifically showed that vulnerability to coastal hazards falls on the higher income groups that have invested in the coastal strip;
- The Merewent coastline had steeper dunes and dense vegetation buffers. The spatial characteristics of the area showed a high level of conservation which has also characterized Treasure Beach. Paradoxically conservation, residential and industrial activities are closely entwined; and,

- Amanzimtoti had a completely different profile from the rest of the study area due to the higher densities and flatter topography.

The consequences of diverse land uses along the coastal strip meant that there are more factors to consider and identify when creating plans for the area. Various alternatives have to be processed, including the climate agenda. Local issues take precedence over future uncertain events but planning as a profession has the ability to counter negative consequences through pro-active and strategic plans (refer to table 4.6.1 below for ward priorities).

The study area represents a micro-environment of the KZN coastline. There are other areas that have not preserved the integrity of the natural coastline, thereby increasing risks of damage to property. Considering the environment, economy and spatial characteristics of the coastline; any planning scenarios created for KZN would need a feasible strategy of expropriation and rehabilitation. The South Durban Basin was a prime example to consider in this research. Various indicators from the environment could input into developing scenario based approaches to future planning because the varied socio-economic and environmental attributes.

4.5.2. Infrastructure, Road Hierarchy and Circulation

The road network is inherently urban therefore contained the infrastructure needs of the community (in terms of water, electricity, and sanitation). Storm water drains, water pipes and a waterborne sewerage system were provided. There is electricity in the area and DSW bins were visible for solid waste disposal. Hence the study area is well serviced by the local government.

Road network and activities in an area determine traffic circulation. Varied levels of traffic occurred, that peak during holiday seasons, due to the recreational and economic activities along the coastline. The study area has distinct road networks of a warped grid pattern; local distributer roads are clearly visible in the attached Google maps which showed that the grid system changes along the coastline as the residential roads form cul-de-sacs (see figure 20 for Marine Drive and Kingsway Str.).

The road hierarchy can be identified from Figure 20 (right) as follows:

Class 2 roads: N2 and M4

Class 3 roads: Solomon Mahlangu Dr; Bluff Rd;

Marine Dr; and Kingsway Str.

Class 4 and 5 roads are identified in the land use maps (refer to maps 9-12), but are clearly shown here in white.

The images could have been more clearly detailed at a larger scale. However visualizations were excluded for the purpose of focussing on the research objectives.

The images are available with satellite imagery and options to find specific locations. The internet was a useful tool in visualizing the road network of the study area.

Sources: Google-Map data (2011) AfriGIS; *Image Source: 2011 Google, DigiGlobe, Cnes/Spot Image, GeoEye, Map data, AfriGIS (pty) ltd. Tracks4Africa [online].*

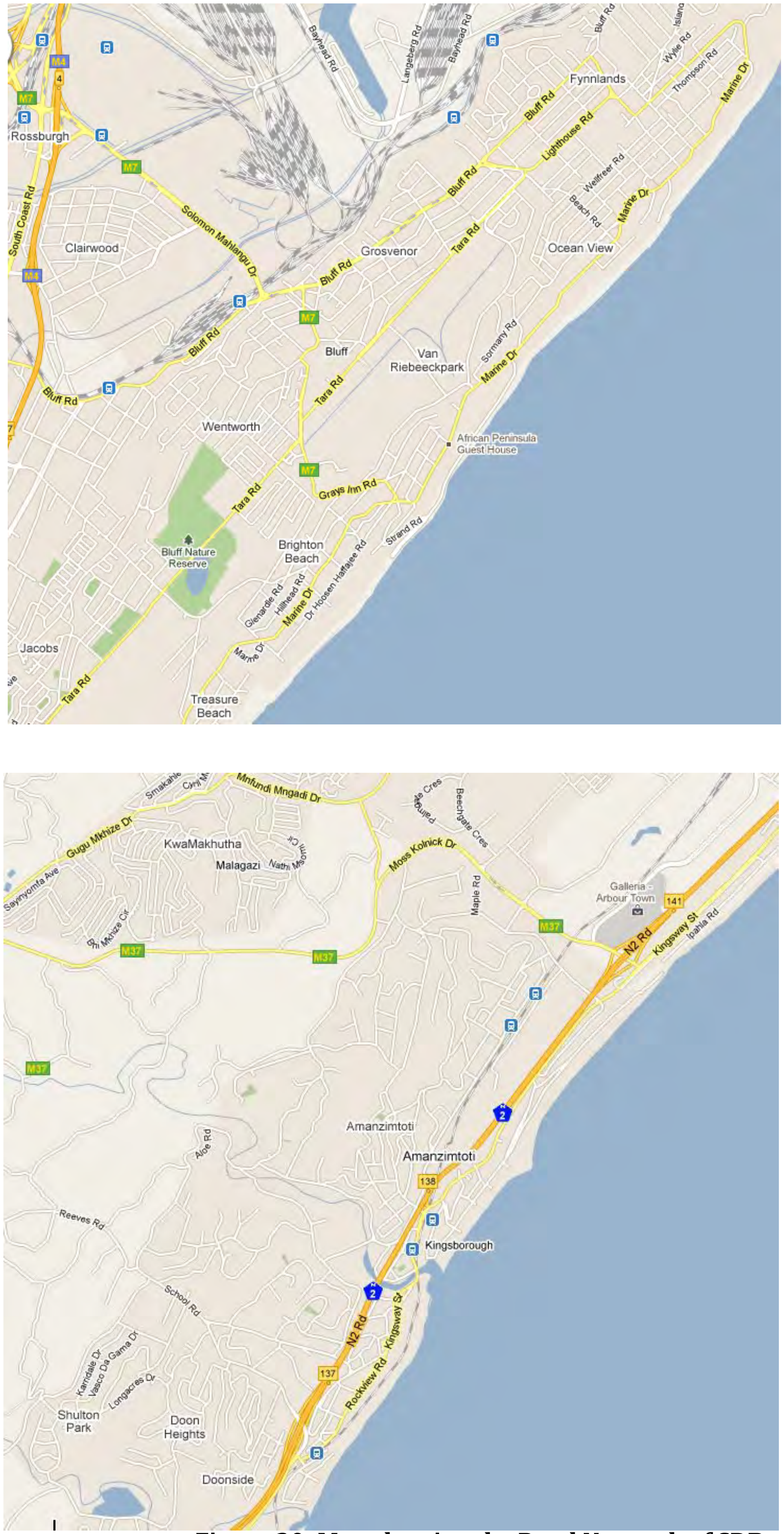
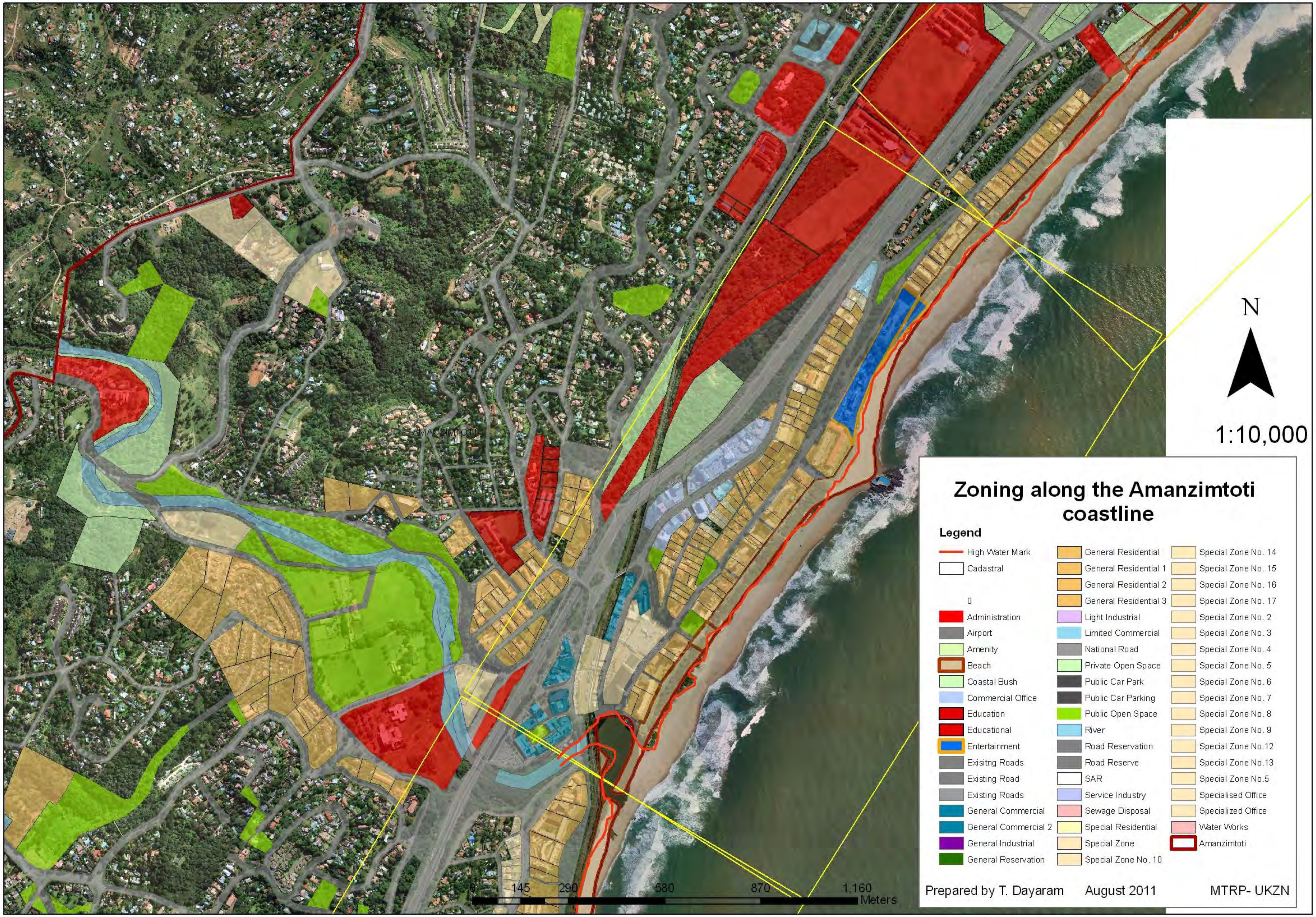


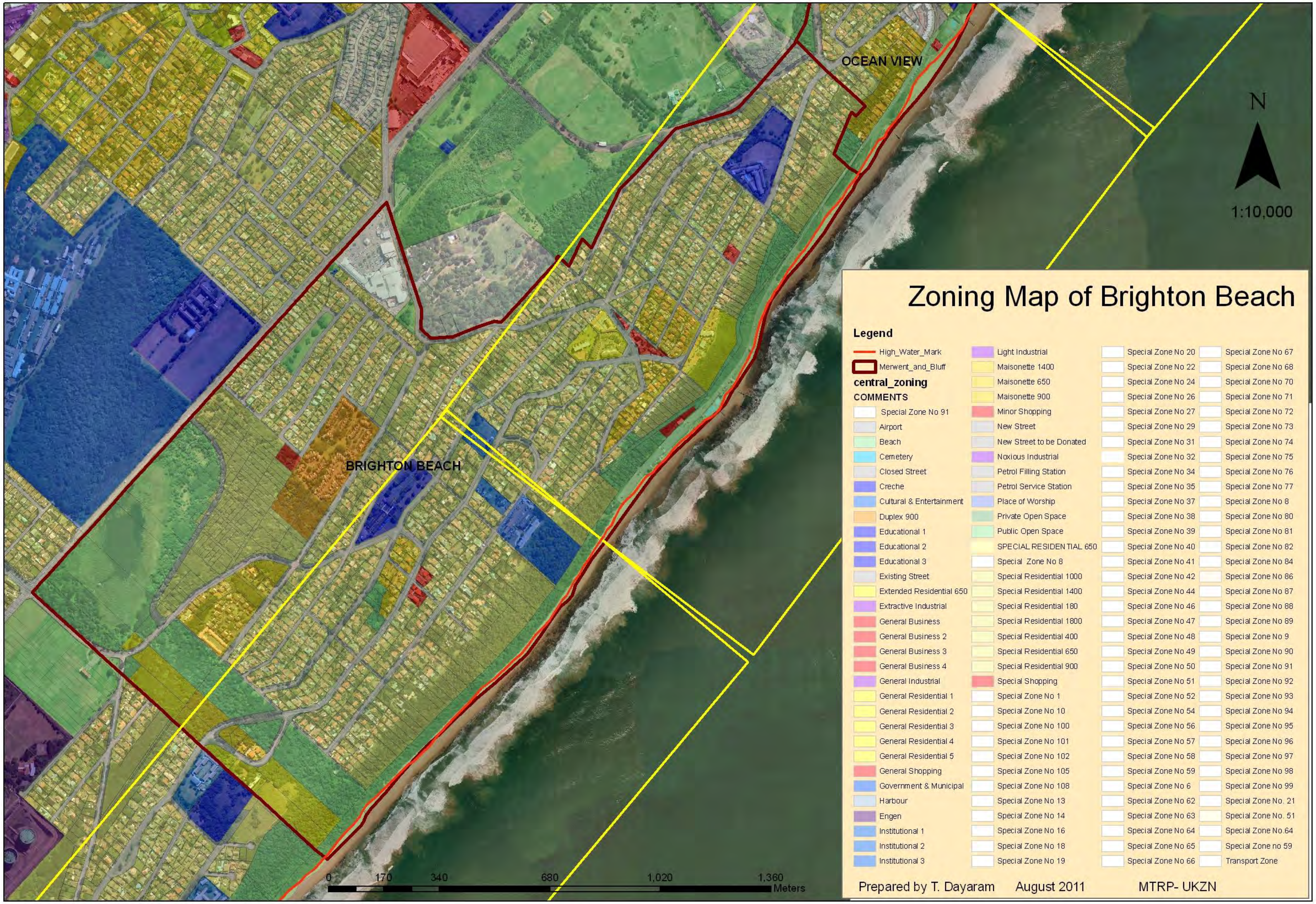
Figure 20: Map showing the Road Network of SDB

Map 17: Zoning of the Amanzimtoti Study Area



Zoning along the Amanzimtoti coastline
Legend
High Water Mark
Cadastral
0
Administration
Airport
Amenity
Beach
Coastal Bush
Commercial Office
Education
Educational
Entertainment
Exisitng Roads
Existing Road
Existing Roads
General Commercial
General Commercial 2
General Industrial
General Reservation
General Residential
General Residential 1
General Residential 2
General Residential 3
Light Industrial
Limited Commercial
National Road
Private Open Space
Public Car Park
Public Car Parking
Public Open Space
River
Road Reservation
Road Reserve
SAR
Service Industry
Sewage Disposal
Special Residential
Special Zone
Special Zone No. 10
Special Zone No. 14
Special Zone No. 15
Special Zone No. 16
Special Zone No. 17
Special Zone No. 2
Special Zone No. 3
Special Zone No. 4
Special Zone No. 5
Special Zone No. 6
Special Zone No. 7
Special Zone No. 8
Special Zone No. 9
Special Zone No.12
Special Zone No.13
Special Zone No.5
Specialised Office
Specialized Office
Water Works
Amanzimtoti
N
1:10,000
0 145 290 580 870 1,160
Meters
Prepared by T. Dayaram
August 2011
MTRP- UKZN

Map 18: Zoning of the Brighton Beach Study Area



OCEAN VIEW
BRIGHTON BEACH
N
1:10,000
Zoning Map of Brighton Beach
Legend
High_Water_Mark
Merwent_and_Bluff
central_zoning
COMMENTS
Special Zone No 91
Airport
Beach
Cemetery
Closed Street
Creche
Cultural & Entertainment
Duplex 900
Educational 1
Educational 2
Educational 3
Existing Street
Extended Residential 650
Extractive Industrial
General Business
General Business 2
General Business 3
General Business 4
General Industrial
General Residential 1
General Residential 2
General Residential 3
General Residential 4
General Residential 5
General Shopping
Government & Municipal
Harbour
Engen
Institutional 1
Institutional 2
Institutional 3
Light Industrial
Maisonette 1400
Maisonette 650
Maisonette 900
Minor Shopping
New Street
New Street to be Donated
Noxious Industrial
Petrol Filling Station
Petrol Service Station
Place of Worship
Private Open Space
Public Open Space
SPECIAL RESIDENTIAL 650
Special Zone No 8
Special Residential 1000
Special Residential 1400
Special Residential 180
Special Residential 1800
Special Residential 400
Special Residential 650
Special Residential 900
Special Shopping
Special Zone No 1
Special Zone No 10
Special Zone No 100
Special Zone No 101
Special Zone No 102
Special Zone No 105
Special Zone No 108
Special Zone No 13
Special Zone No 14
Special Zone No 16
Special Zone No 18
Special Zone No 19
Special Zone No 20
Special Zone No 22
Special Zone No 24
Special Zone No 26
Special Zone No 27
Special Zone No 29
Special Zone No 31
Special Zone No 32
Special Zone No 34
Special Zone No 35
Special Zone No 37
Special Zone No 38
Special Zone No 39
Special Zone No 40
Special Zone No 41
Special Zone No 42
Special Zone No 44
Special Zone No 46
Special Zone No 47
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Special Zone No 51
Special Zone No 52
Special Zone No 54
Special Zone No 56
Special Zone No 57
Special Zone No 58
Special Zone No 59
Special Zone No 6
Special Zone No 62
Special Zone No 63
Special Zone No 64
Special Zone No 65
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Special Zone No 67
Special Zone No 68
Special Zone No 70
Special Zone No 71
Special Zone No 72
Special Zone No 73
Special Zone No 74
Special Zone No 75
Special Zone No 76
Special Zone No 77
Special Zone No 8
Special Zone No 80
Special Zone No 81
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Special Zone No 88
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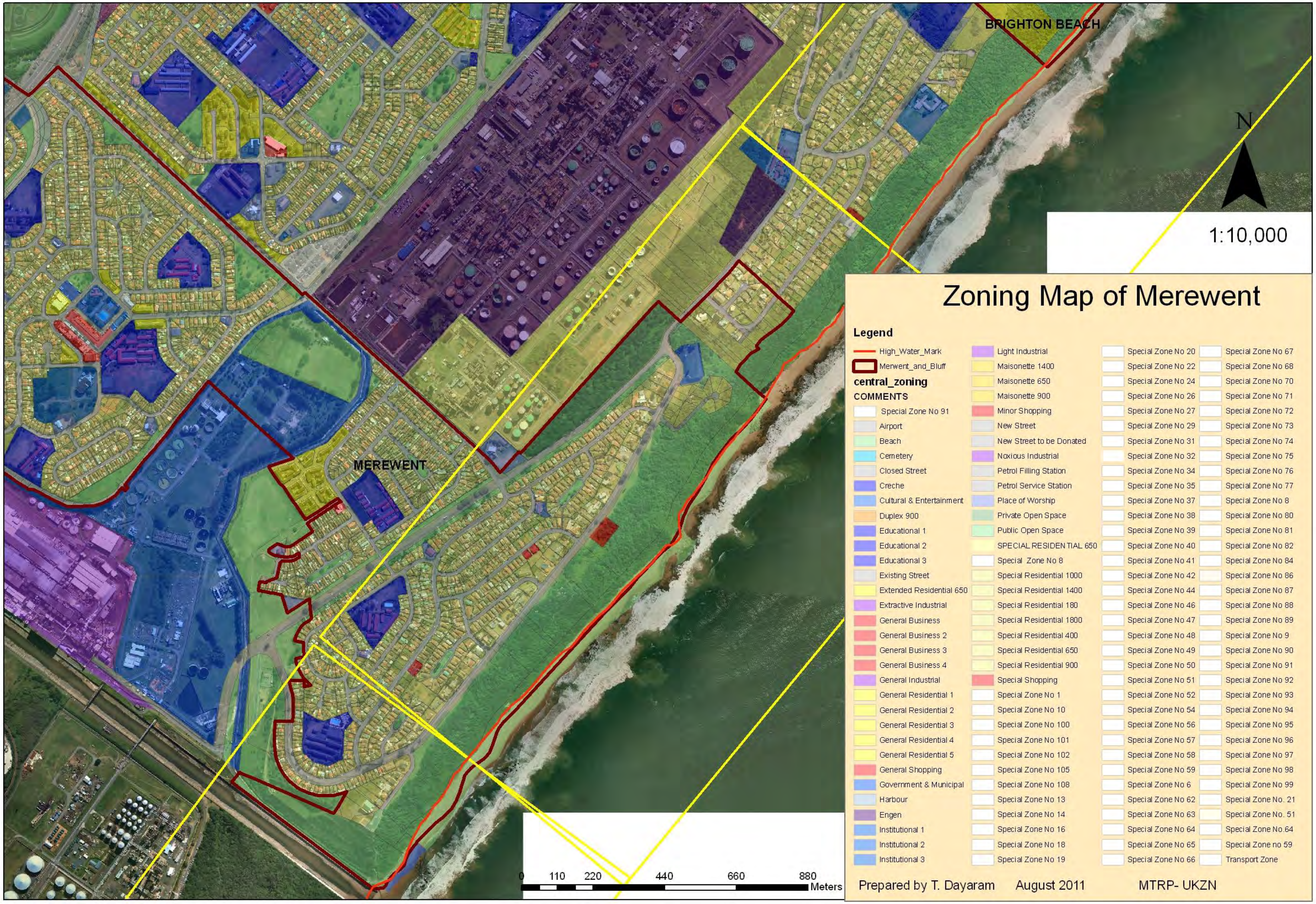
Special Zone No 90
Special Zone No 91
Special Zone No 92
Special Zone No 93
Special Zone No 94
Special Zone No 95
Special Zone No 96
Special Zone No 97
Special Zone No 98
Special Zone No 99
Special Zone No. 21
Special Zone No. 51
Special Zone No.64
Special Zone no 59
Transport Zone
0 170 340 680 1,020 1,360 Meters
Prepared by T. Dayaram August 2011 MTRP- UKZN

Map 19: Zoning of the Merewent Study Area


BRIGHTON BEACH
MEREWENT
N
1:10,000
Zoning Map of Merewent
Legend
High_Water_Mark
Merwent_and_Bluff
central_zoning
COMMENTS
Special Zone No 91
Airport
Beach
Cemetery
Closed Street
Creche
Cultural & Entertainment
Duplex 900
Educational 1
Educational 2
Educational 3
Existing Street
Extended Residential 650
Extractive Industrial
General Business
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General Business 4
General Industrial
General Residential 1
General Residential 2
General Residential 3
General Residential 4
General Residential 5
General Shopping
Government & Municipal
Harbour
Engen
Institutional 1
Institutional 2
Institutional 3
Light Industrial
Maisonette 1400
Maisonette 650
Maisonette 900
Minor Shopping
New Street
New Street to be Donated
Noxious Industrial
Petrol Filling Station
Petrol Service Station
Place of Worship
Private Open Space
Public Open Space
SPECIAL RESIDENTIAL 650
Special Zone No 8
Special Residential 1000
Special Residential 1400
Special Residential 180
Special Residential 1800
Special Residential 400
Special Residential 650
Special Residential 900
Special Shopping
Special Zone No 1
Special Zone No 10
Special Zone No 100
Special Zone No 101
Special Zone No 102
Special Zone No 105
Special Zone No 108
Special Zone No 13
Special Zone No 14
Special Zone No 16
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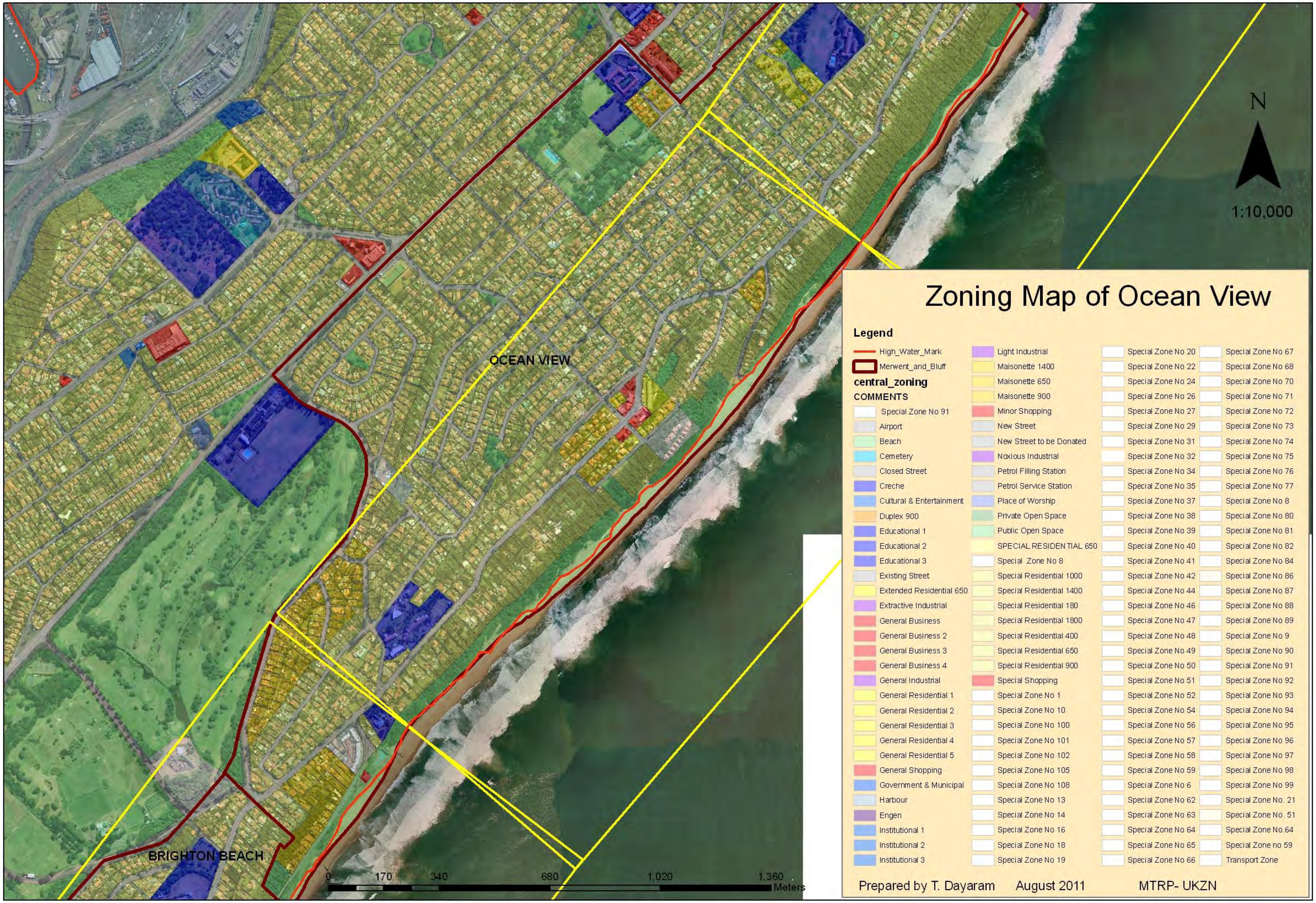
Special Zone No 92
Special Zone No 93
Special Zone No 94
Special Zone No 95
Special Zone No 96
Special Zone No 97
Special Zone No 98
Special Zone No 99
Special Zone No. 21
Special Zone No. 51
Special Zone No.64
Special Zone no 59
Transport Zone
0 110 220 440 660 880 Meters
Prepared by T. Dayaram August 2011 MTRP- UKZN

Map 20: Zoning of the Ocean View Study Area


Zoning Map of Ocean View
Legend
High_Water_Mark
Merwent_and_Bluff
central_zoning
COMMENTS
Special Zone No 91
Airport
Beach
Cemetery
Closed Street
Creche
Cultural & Entertainment
Duplex 900
Educational 1
Educational 2
Educational 3
Existing Street
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General Residential 1
General Residential 2
General Residential 3
General Residential 4
General Residential 5
General Shopping
Government & Municipal
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Institutional 1
Institutional 2
Institutional 3
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Maisonette 1400
Maisonette 650
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New Street to be Donated
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Petrol Filling Station
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Special Residential 400
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Special Zone No 101
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Special Zone No 97
Special Zone No 98
Special Zone No 99
Special Zone No. 21
Special Zone No. 51
Special Zone No.64
Special Zone no 59
Transport Zone
Prepared by T. Dayaram
August 2011
MTRP- UKZN
N
1:10,000
OCEAN VIEW
BRIGHTON BEACH
0
170
340
680
1,020
1,360
Meters

4.6. SOCIAL CHARACTER

Discussions of the socio-economic conditions that are affected by coastal vulnerability were projected in various studies and reports (found in the reference list of this paper). The economic impacts on the population characteristics formed indicators for planning support technologies to determine scenarios for management strategies. Sources of information in this case were: census data, ward profiles and secondary resources. Tools such as the *Geospatial Analysis Platform* (GAP) would have also been useful to determine regional information and visualization at a local spatial scale.

4.6.1. Table of Populations per Ward

(eThekwini Municipality, accessed: 2011)

Ward/ Population	66		67		68		69	
	No.	%	No.	%	No.	%	No.	%
African	8728	27	2207	9	5857	18	3303	11
Coloured	1944	6	14226	61	12368	37	337	1
Indian	3980	12	1220	5	15072	45	27044	88
White	17616	55	5828	25	32	0	19	0
Pensioners	2203	7	1343	6	1913	6	2027	7
Disabled	954	3	689	3	1293	4	876	3
Total/ward	47950	100	23481	100	33329	100	30703	100

Ward/ Population	89		90		93		Total of SDB coastal strip	
	No.	%	No.	%	No.	%	No.	%
African	15393	72	3788	17	29824	86	69100	35
Coloured	187	1	279	1	144	0	29485	15
Indian	5853	27	18583	82	455	1	72207	36
White	9	0	75	0	4080	12	27659	14
Pensioners	518	2	990	4	1542	4	10536	5
Disabled	662	3	646	3	1666	5	6777	3
Total/ward	21442	100	22725	100	34503	100	198451	100

Different characteristics of an environment contribute to how the coastline would have to be managed. Population characteristics (according to socio-economic, race / ethnicity, and age) determined the types of people a plan has to incorporate. South Africa historically promoted segregation and remnants of this legacy are still evident in present demographic profiles. The case study area historically had a higher number of the black[2] population due to the master planning which placed the specific racial profile in disadvantaged positions. Another factor to consider about population is the degree to which in migration has played a part in shaping the social economic profile. Migration levels tend to increase in urban spaces, an assumption incorporated as a factor along this coastal strip. The data revealed that the population groups generally fall between low to middle income. However prime development along prime coastal land caters to considerably higher income groups. In this case unique scenarios of a higher number of wealthy property owners along the coastline rather than poor are more vulnerable to the coastal hazards. Strategies need to accommodate accessibility to the coastline which has been privatized by the layout of the area.

The lifestyle of the population that characterized Durban is that of tourism and recreation, the study area conforms to the norm, but also contained residential and educational uses. There were different levels of social interaction and along the SDB coastline the major activities are recreational and residential (often a mix of the two). Since the lifestyle along the coast is differentiated, and seasonally transient, there were different tenure systems depending on the land use types. Although ownership is not a focus of the research it is important to consider the type of demand and ownership that is taking up land along the coastline.

Security and sense of well-being along the coast is affected by the housing estates that privatised beaches. Police and army presence, danger of water and air pollution and vulnerability of coastal hazards also affects the social character of the SDB coast. All activities and uses work in a dysfunctional disaggregated manner along the coastline of SDB. There are numerous coastal stakeholders that are involved in the coastal strip of the SDB. The main priorities defined for coastal management are ward based and not focused on coastal areas.

[2] Terminology: 'black population' has been defined to include the racial identity of the African, coloured and Indian population.

4.6.2. Community need assessment

Government organizations, NGO‟s, CBO‟s, private sector and coastal forums are stakeholders in coastal management. Influenced by national and international agenda, all local stakeholders need to have an input in the preparation of plans, their implementation through projects and decision-making based on democratic principles.

According to the ward data the key priorities for the area involve maintaining and providing infrastructure, housing, and job creation. Ward 67 stated a disaster management plan was a priority which formed a key consideration for intervention via plans and management strategies. Research into what made up the locality and how to deal with the various priorities can become outcomes of a PSS. Scenarios form these priorities reflected that the spatial economy of the locality had to be modified.

4.6.3. Economic factors

The income generation, job creation and production in the locality affect the economics of the area. These activities take up space along the coastline and are vulnerable to hazards;

> "*Developments that have historically been situated too close to the sea are in danger of erosion (e.g. Milnerton Golf Club and the adjacent restaurant, Paradise Beach development near Saldanha) or of wave attack (e.g. The Beach Club, Hermanus). Determining affordable protection measures for these developments is a problem. Taking into account sea-level rise it is vital that development setback lines are established so that such problems do not recur*". (WSP Africa Coastal Engineers, 2010: 2).

The ward data has provided a list of household incomes and the unemployment statistics per ward (eThekwini municipality, 2011). CSIR have mapped the spatial dynamics of economic factors at various scales, and have made the information in an accessible format (for example mapping GVA distribution in figure 21 below). Hence the characteristics of the economic priorities provide further detail for input toward a PSS in the process of creating a plan for the South Durban coastline.

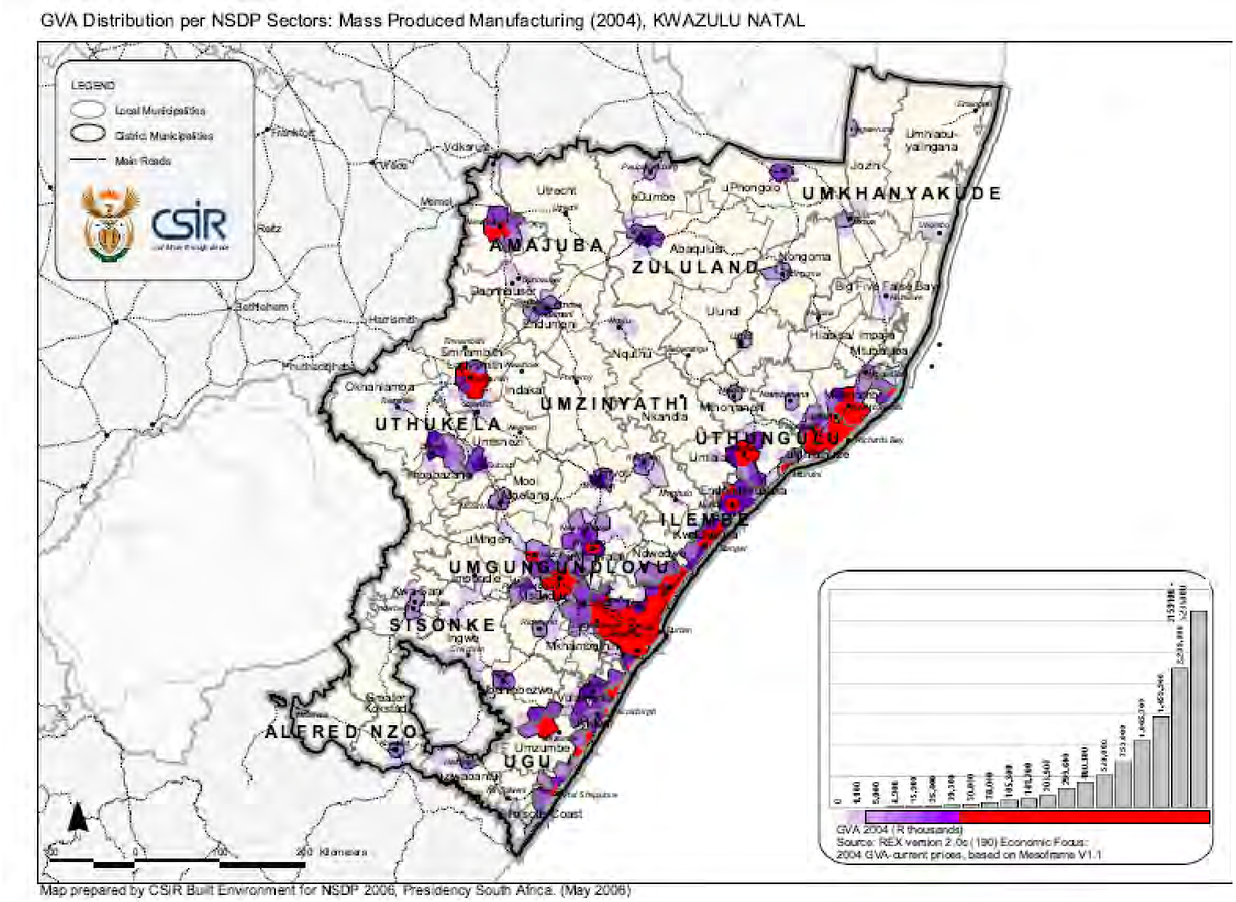

Figure 21: Map of GVA Distribution in KZN

Table 4.6.3.1 below shows the types of strategies that would produce differing scenarios of the locality. A PSS could use the data, including the impacts of coastal vulnerability to development, for determining various alternatives to support plans and decision making.

4.6.3.1. Table Showing Problem Definition and Possible Interventions

Challenge	Objective	Activity	Outcome
Infrastructure: maintenance	Prevent damages to infrastructure Provide places of social interaction	Strategic plans Creating public facilities	Well designed urban spaces
Housing	Increase the residential density To also address informal settlement	Build higher density housing of varied typology	Reduce housing backlog Security of tenure
Job creation	Create employment opportunities	Develop local businesses	Provide opportunities to increase employment thereby decreasing poverty

4.7. DIFFERENT BUT THE SAME: CONCLUDING COMMENTS

The local environment of the SDB has a diverse variety of land uses and functions. The natural environment was a key attribute in coastal defence and the topography, in the majority of the study area, which prevented development in high risk areas. The breakdown of the study area revealed that there were major differences between suburbs, but the common factor was potential exposure to coastal hazards.

Future development along the urban coastline, based on population projections, could have a major impact on the economic development of eThekwini and provide jobs within the locality. Despite the benefits, uncertain natural events have the ability to destroy this scenario. Therefore plans and management strategies have to accommodate the most adequate scenario for the area.

The damages to the SDB coastline in the recent storm surges were minimal. In part, this could be attributed to observed management measures to combat coastal erosion. However, there was no visible evidence of longer term plans for the more severely affected areas. It was assumed that economic drivers will eventually force coastal property stakeholders to retreat. The storm surges destroyed property, infrastructure and exacerbated coastal erosion. Short term solutions for solving the issues had to be put in place at the time but there is also a need for a long term strategy to mitigate future disaster.

CHAPTER 5: CONCLUSIONS AND LESSONS LEARNED

5.1. INTRODUCTION

Planning support technologies and coastal management paradigms have contextualized the background toward a PSS for South African integrated coastal management (refer to the context in chapter two). Results of the data collection process have corroborated several points made evident in the literature. The key informant interviews provided data on the processes and challenges faced by practitioners as well as the gap between the roles played by differing professions in ICZM. Chapter four provided a case study, with many dualities, to assist with an understanding of the local environment of KwaZulu-Natal. Challenges specific to the KZN region have been analyzed to derive the spatial criteria for coastal management plans. Conflict in terms GIS and PSS have been further highlighted due to the increased use of GIS software for plans (refer to Chapter 2). The development of land management practices along the coastal zone has therefore been a topic in which PSS was unpacked to uncover that it has been defined by the application of technologies which supports planning and the systems created by practitioners.

Practitioners of urban coastal management have a large base of tools used to manage resources along the coastline. A PSS has not been designed or mainstreamed as a tool for planning along the coast, but there was evidence of a growing interest in using technology for planning. Increasing development along the coastline, such as new opportunities for a port in SDB, creates more risks of exposure to the impacts of climate change along the coastline. The tools used to manage the urban coastline have to be adequate; the conceptual outline shows the linkages for plan quality (refer to figure 7). Good planning practices mitigate against the direct impacts of extreme climate conditions from affecting the urban coastline. Therefore this research aimed to examine the application of PSS in urban coastal research and management. The purpose was to show the value of support tools which determined where planning support systems can be applied in research and management of the urban coast. Several research objectives were met, as follows: Defining planning support technologies; Providing a local case in which to determine the requirement of an integrative system for ICM; Discussing PSS applications from more established areas; and finally, Making recommendations regarding land use management along the urban coastline.

Based on the research, there was a correlation between the quality of plans and the knowledge / data that was used to create those plans. The literature highlighted the contested theoretical debate of applying PSS to urban coastal research and management. The research findings suggested that despite developing ICM legislation, S.A. had a long way to go to ensure sustainability in coastal cities. A summary of the findings toward the research objectives follows as well as the lessons learned which discussed the applicability of support technology.

5.2. SUMMARY

The pros and cons of using support technology, specifically PSS, was inherently part of the objectives of this research. The understanding of PSS was repeatedly questioned in the context of urban coastal research and management. Case studies identified various tools and methodologies for ICM. Key factors of the research were based on arguments for or against support technology for integrated planning.

5.2.1. Integrated Planning

Different approaches have been applied to coastal management. Theoretical concepts such as sustainable development and ICZM have been prominent. Professions use varied methodology to manage urban coastlines. GIS tools were considered adequate for planning along the KZN coastline while in other parts of the world more complex tools are used to strategically plan urban coastal areas. Examples of different methods of urban coastal management ranged from:

- Structural engineers whom mitigate impacts along the coastline by physical barriers; to
- Marketing methods of sustainably development that used indicators based on resource management along the coastline to promote environmental conservation.

Legislation and policy toward ICM have also been developed. The concept of ICM has been accepted internationally. The precedent cases showed that initiatives for sustainable development have been incorporated into plans and policies. However the realities and challenges on the ground conflict with the theoretical perspectives of ICM. The guidelines and efforts made could contribute to designing tools for ICM in South Africa. In a local context;

increased ICM concerns into the IDP tool could create a platform for programme initiatives. Hence a database and PSS to monitor and track changes along the coastline has been recommended as an opportunity for ICZM.

The literature discussed the aforementioned theoretical perspectives. The local case SDB and its CMP revealed the diversity and dualities in urban coastal management. The hazard exposure along the urban coastline has the potential to cause a lot of damage. Therefore monitoring and control tools should be enabled. Precedent case studies showed how tools of policy, methodology and innovation dealt with the coastal challenges. It has shown that, if technological tools are implemented and understood correctly, there was higher quality of coastal management plans.

5.2.2. Re-defining PSS

This research utilized a pragmatic approach to data collection of undergoing site visits and conducting face-to-face qualitative interviews. According to the University of KwaZulu-Natal"s procedures the appropriate ethics and obligatory agreements were obtained (refer to Appendix 3: Ethical approval letter). There were four important facets to the research design, namely;

1. An extensive primary and secondary literature review,
2. The use of qualitative key informant interviews with practioners who have experience in coastal management and planning fields using a semi-structured interview guide,
3. Site survey; and,
4. Mapping.

It is imperative to understand that PSS are designed as a planner"s tool and that not all the activities along the coast would benefit from the use of a PSS. The methodologies discussed in the literature were emerging tools for assessing vulnerability along the coast. A key tool for creating PSS was GIS based software. However PSS can be reliant on spatial and aspatial databases. The definition of a PSS was redefined to accommodate the range of technological support tools in the toolbox of coastal management practices.

Planners have used these tools to contribute toward designing IDP"s and CMP"s. It was recognized that a reliable, accessible and updated data source would have high value for planning practices along the coastline. Tools for coastal management involved CMP"s, coastal setbacks and risk / vulnerability assessments. Quality of plans has already been improving via the use of technology. There is better legislation, standards and guidelines created via technological innovation. Mapping quality specifically has increased dramatically. A PSS seeks to do for planners what ArchiCad accomplishes for architects. The question this study has provoked was how a methodology could be developed to incorporate the activities of a planning practitioner. A coastal Planning Support System would have to be diverse enough to meet planning requirements (i.e. It would be improbable, at this point, to have just one resource for data). However, a coastal system with dedicated service providers may be the start of a national database.

5.3. LESSONS LEARNED

Data obtained from each of the sources corroborated and depicted the research findings to obtain answers for the research questions. There were no obvious solutions to planning for hazard prone areas. A PSS aims to develop better planning practices not universal solutions. A fundamental lesson derived from the research process was that there will always be limitations to research. In this case the time and cost factors prevailed, as well as the lack of a functional PSS and outdated data sources (10 year old census data) proved to be a challenge. The photographic and mapping images illustrated the spatial characteristics of the study area and were analyzed in relation to the information gathered in the context of the local condition. The images further provided graphic representation of the land use characteristics to compare areas, which were significant in showing impact of coastal hazards, based on the land uses of the locality.

5.3.1. Finally, What about the Application of a PSS in S.A.?

Key information in terms of coastal management was derived from various sources to provide the context for the use of PSS. From the research several deductions were made regarding the challenges, types of tools used and the application to the local case study. Additionally international and local comparisons have been made based on literature where different more technological tools are incorporated into coastal management. Several recommendations have been pondered toward developing planning support technology for S.A., namely;

- Identification of mechanisms available to local authorities toward the implementation of management options. Urban coastal research and management already has several set practices that incorporate a range of techniques and methods. Planning does not seek to change that, or take over from coastal management practices, but to allow for efficiency in land use decisions. Hence the discussion about a spatial overlay in land use schemes;
- Encouraging further research, for example: identifying coastal hazard risks to contribute toward PSS development; and,
- The data (census / ward) collected were from different sources and were inconsistent. Therefore any PSS would have to have a reliable source of relevant information.

Conclusions have been drawn based on critically analysing the results of the data collection process. The research has been presented through maps, tables and graphs throughout the paper. The research revolved around precedent cases in literature. It was interesting to note the comparisons between the impact of storms in coastal areas that have been developed and those that have maintained natural defences. Many have insinuated a better investigation would have been to assess the former, but in terms of pro-active planning it was decided that the solutions to development problems starts with development controls. The coastal management agenda in South Africa is, comparatively, less of a priority. There is much work to be done in collaboration with many stakeholders before any progress can be achieved. In terms of a planning system: The inclusion of a spatial layer to local planning schemes is a major step in the direction toward sustainable development.

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APPENDIX 1: SUMMARISED OBSERVATIONS OF EXISTING LAND USES

Land Uses	Description	Observation
Industrial	Mondi canal; Mondi and SAPPI factories 250m from the coastline Contained 1 public access point to the beach	Canals and factories and smoke visible
Residential	formal development behind the dune for middle - high income class	Informal dwelling situated in the dune
Business	Parking facilities	Not as well maintained as the other sites
Mixed use	Industry, residential and natural sites	Close proximity of these features
Natural Features	Steep dunes; Dense vegetation on dunes	Footpaths observed to be used by fishermen and informal dwellers
MEREWENT		

Land Uses	Description	Observation
Industrial		No visible industry
Residential	High rise, multi-story units	No free standing units along the coastline
Business	Small business along the coastline Restaurants on the beachfront River activities	Shops involving retail goods Under construction
Mixed use	Business/residential Park	Ground level units on multi-story buildings were shops
Natural Features	7 access points to the beach Gentle slope River mouth	Beachfront is relatively flat compared to the rest of the study area
AMANZIMTOTI		

Land Uses	Description	Observation
Industrial		Canals and factories and smoke visible
Residential	Special residential and medium densities, Ocean view has lower densities for high income classes Privatized public property, gated estates	The layout of the residential development along ocean view privatizes the beachfront as it hinders access Pan-handle sites Some properties within 100m of the HWM
Business	Live saving club houses Restaurants Bed and breakfast/ Holiday businesses Local centre	Private guards on duty No informality visible
Mixed use		
Natural Features	Steep dunes; Thick vegetation on the majority of the dunes; Tidal pool; and Conservation- Treasure beach	Development has occurred on the dunes; and Visible erosion
BRIGHTON BEACH AND OCEAN VIEW		

APPENDIX 2: KEY INFORMANT INTERVIEW SCHEDULE

Research Consent Form for Key Informant Interviews

Study Title:

Study to investigate Urban Coastal Research and Management: The Application of Planning Support Technology in Designing for a Changing Environment.

Good Morning

I am a Masters student from the University of KwaZulu-Natal and I am doing research on the use of Planning Support Systems for urban coastal management. Research is just a process to attain answers to a number of questions, and you may have information that would help me to get to such answers. I am requesting that you participate in this research study so that I can find out more information about Planning Support Systems, and how the Systems are applied to urban coastal management.

What is involved in the study: I have a questionnaire and I will ask you questions in order to complete it. There are no risks to being involved, and no one is forced to take part. There will be no negative consequences either, if you decide not to take part. If you agree to take part, we hope that the information that we obtain will be used to improve development along the South Durban coastline. You can choose not to answer a particular question, and are free to withdraw from the enquiry at any stage.

Confidentiality: Efforts will be made to keep personal information confidential. Absolute confidentiality cannot however be guaranteed. For example, personal information may be disclosed if required by law.

Contact details

For further information please contact:

Tanya Dayaram	083 4486 440
Annette von Riesen	031 260-1200

Please sign below to indicate that you understand what I have explained to you and that you are willing to participate and provide me with the information I need.
Thank you.

Signature of participant

Key informant 1: Private Consultant

What are the challenges facing designing integrated coastal management?
How was the South Durban Basin Coastal Management Plan created?
Did you use Planning Support Systems? Yes/No If so, what system? ☐
How could Planning Support Systems be improved for managing the coastal zone?

Key informant 2: eThekwini official involved in coastal management planning

What are the challenges are faced by planners in integrated coastal management plans?
What tools are used to create coastal management plans?
What do you know about the application of Planning Support Systems?
Is there an example of where you have used a Planning Support System? Yes/No Was it an appropriate tool? ☐
In what ways could the Planning Support System be improved?

APPENDIX 3: ETHICAL APPROVAL LETTER

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19 September 2010

Ms T Dayaram
39 Nasik Road
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4052

Dear Ms Dayaram

PROTOCOL: The Application of Planning Support Technology to Urban Coastal Research and Management: A Case Study of the South Durban Basin
ETHICAL APPROVAL NUMBER: HSS/1078 /2010 M: Faculty of Humanities & Social Sciences

In response to your application dated 10 September 2010, Student Number: **206517801** the Humanities & Social Sciences Ethics Committee has considered the abovementioned application and the protocol has been given **FULL APPROVAL.**

PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

Professor Steve Collings (Chair)
HUMANITIES & SOCIAL SCIENCES ETHICS COMMITTEE

SC/sn

cc: A von Riesen (Supervisor)
cc: Ms S van der Westhuizen